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Economic Growth with Endogenous Political Violence

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Abstract

Economic stagnation and civil conflicts persist in many developing nations, yet formal models examining their interplay remain scarce. This study develops an endogenous growth model that integrates a conflict game to investigate the mechanisms influencing both economic growth and political violence. Owing to imperfections in the capital markets of developing economies, households are divided into two groups: savers, who face market access costs to accumulate savings, and hand-to-mouth individuals, who depend on social benefits. A higher proportion of savers fosters capital accumulation and accelerates economic growth. Political violence, however, stems from rivalries between incumbent and opposition groups driven by the unequal distribution of social benefits. Using African data, our model demonstrates that, although institutional reforms can reduce violence, they do not necessarily promote economic growth. Similarly, increasing foreign aid or fiscal capacity has limited efficacy in mitigating conflict or fostering development. By contrast, lowering capital market access costs is more effective in stimulating economic activity and reducing violence. Counterfactual analyses further evaluate the economic distortions caused by conflicts under a hypothetical peaceful regime.

Keywords: Economic growth; Political violence; Civil war; Institutions; Africa

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1 Introduction

Economic growth and political stability are deeply intertwined in developing economies, where resource redistribution policies often aim to mitigate inequalities and prevent conflict. However, the success of these policies critically depends on the ability of political leaders to balance competing interests. In fragile nations, mismanagement or favoritism can exacerbate tensions, leading to internal conflicts that severely affect individual behaviors and the factors of production, thereby impeding sustained economic growth. As noted by Blattman and Miguel (2010), countries with histories of civil war often experience lower income levels compared with their peaceful counterparts. This paper addresses a fundamental question: What economic mechanisms underpin the relationship between political violence and economic growth?

To answer this question, we develop a growth model that incorporates endogenous violence, providing insights into the critical channels shaping economic performance and political stability. Conventional growth theories (e.g., neoclassical and endogenous models (e.g., Solow, 1956; Lucas, 1988; Barro and Sala-I-Martin, 2003)), typically treat political instability as an exogenous shock that causes deviations from a balanced-growth path. In contrast, this study integrates political violence as an endogenous outcome within a growth framework. More specifically, we build on the works of Okabe and Kam (2017) (hereafter, the "OK" paper) and Besley and Persson (2011a) (hereafter, the "BP" paper) with some modifications.

The OK paper extends the *AK* model of Barro (1990), where economic growth is driven by capital and productive public goods. Building upon their insights, we incorporate two types of households: savers, who make savings but face access costs to the capital market, and hand-to-mouth individuals, who rely on social benefits provided by the incumbent government. This capital market imperfection leads to two critical consequences. First, it acts as a direct barrier to capital accumulation and, therefore, growth. Second, it incentivizes individuals excluded from the capital market to resort to political violence in pursuit of greater benefits. The fraction of savers plays a pivotal role in shaping the growth rate, as capital accumulation is driven solely by savers. Importantly, the population distribution between savers and hand-to-mouth individuals is endogenously determined through an agent type choice problem.

The BP paper offers a game-theoretic foundation for understanding the dynamics of political violence. We adapt their game within our growth framework, where the players are two distinct groups within the household sector: incumbent and anti-incumbent. The incumbent leader (i.e., incumbent government) allocates fewer benefits to anti-incumbent members, representing institutional discrimination against the opposition group. Consequently, for both groups, gaining political power becomes crucial to securing benefits favorable to themselves. The likelihood of securing future power is enhanced through investment in military formations (i.e., political violence). From the anti-incumbent group's perspective, violence emerges as a strategic response to institutional discrimination, whereas from the incumbent group's perspective, violence is rationalized as a means of countering or suppressing attacks from opponents and enhancing their chances of retaining power.

Our framework maintains tractability despite its complex structure. This tractability arises, once again, from the distinction between savers and hand-to-mouth individuals. First, military formation policies are determined within the conflict game. Second, the level of productive public goods, which are embedded as inputs in the production function, is characterized in a social planner problem. The equilibrium policy turns out to be unique due to the differing bliss points of savers and hand-to-mouth individuals. Lastly, given these policy variables, social benefits are residually determined. Thus, our model structure allows for a logical and straightforward understanding of how each variable is determined through the interactions of agents with conflicting interests.

We present numerical illustrations using cross-country data from Africa, containing regions where civil wars have persisted for extended periods since the 20th century. This analysis demonstrates how politico-economic channels embedded in the model shape both growth and violence. Through comparative statics, we show that institutional improvements in benefit allocation (i.e., a less discriminatory incumbent) can eliminate violence, holding all else constant. Intuitively, more equal distribution of benefits directly reduces incentives for military formations in both groups, thus resulting in no violence. Meanwhile, growth is not promoted, partly because higher benefits encourage individuals to become hand-to-mouth. Another reason is that government revenues are prioritized for benefits over productive public goods. Furthermore, expanding foreign aid or taxation does not necessarily foster growth or achieve peace. Under the civil war regime, a marginal increase in aid, which constitutes extra government revenue, exacerbates attacks by the incumbent and stalls the economy. Similarly, a marginal increase in the income tax rate disproportionately increases spending on military formations compared with other government expenditures. These findings highlight the importance of fiscal expansions complemented by institutional reforms to achieve better economic and political outcomes. Another key insight is the critical role of capital market accessibility in mitigating violence. Reducing the costs of accessing the capital market encourages capital accumulation, which raises the marginal cost of conflict and ultimately curbs violence. Finally, counterfactual exercises offer additional insights into the economic distortions caused by civil conflict.

Herein, we review the relevant literature, focusing on growth and violence. Solid macroeconomic theories for investigating the causes and effects of endogenous conflicts remain scarce, but cross-country empirical studies have provided valuable insights into the relationship between political instability and macroeconomic performance.[1] For example, Collier and Hoeffler (2002, 2004) emphasized the economic motivations behind conflicts, showing how resource wealth and economic grievances influence the likelihood of rebellion. Similarly, Fearon and Laitin (2003) linked conflict risk to state capacity and geographic factors, identifying economic weakness as a significant driver of instability. These findings point to a critical need for theoretical models that integrate endogenous conflict dynamics into macroeconomic analysis. Additionally, North et al. (2009) provided a historical analysis of violence from the perspective of political economy. For a comprehensive review of the topic, see Blattman and Miguel (2010).

[1] A conceptually relevant theory is the dynamic framework incorporating capital proposed by Besley and Persson (2011b). However, their model is a two-period partial equilibrium framework and, as a result, does not explicitly address the growth rate. In this regard, their framework differs significantly from ours.

The importance of capital markets in developing countries has been widely acknowledged. For example, Banerjee (2003); Banerjee and Duflo (2010) examined malfunctioning capital markets in low-income countries, indicating their key barriers to growth. Several studies in development macroeconomics introduced heterogeneous households, like our study, to investigate capital channels. For example, Zanna (2010) and Shen et al. (2018) incorporated saver-and-hand-to-mouth agents in business cycle models to examine the effects of liquidity constraints in households. Similarly, Bilbiie (2008) analyzed monetary policy by incorporating similar household heterogeneity.

Finally, numerous studies have explored the institutional channels affecting economic performance. Among them, North (1990) provided a seminal contribution, clarifying the economic concept of institutions. Furthermore, Acemoglu (2008) developed a workhorse framework that explicitly examined the role of institutions within growth theory.

The rest of this paper is organized as follows. Section 2 presents our model, Section 3 details its calibration, and Section 4 presents the results of comparative statics and the impacts of violence on growth and welfare through counterfactual exercises. Finally, we conclude with Section 5.

2 Model

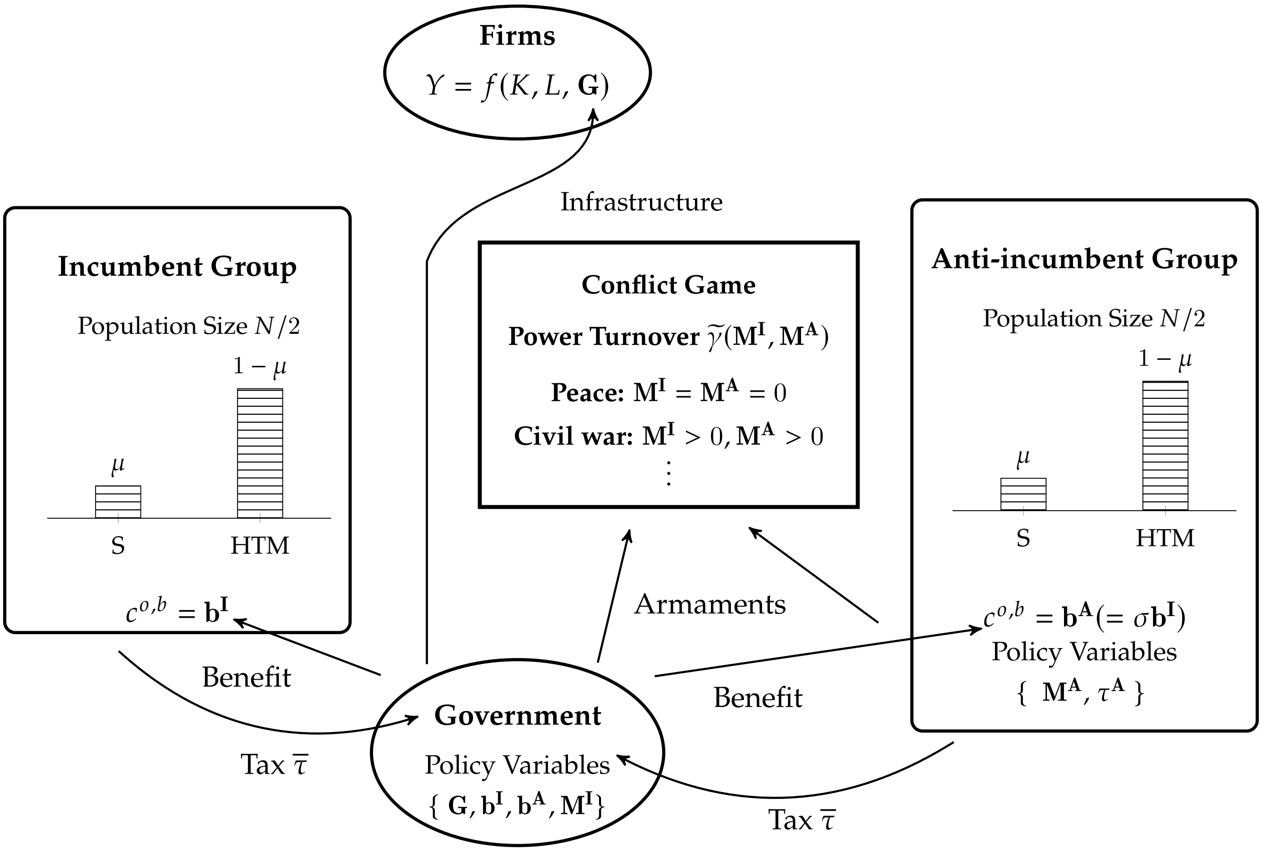
In this section, we consider a closed national economy. We assume a discrete time setting where the variable $t \in \{0, 1, \cdots\}$ denotes time periods. In each period, N individuals are born and live for two periods: a young age, y, and an old age, o. Each individual belongs to one of two political groups: incumbent group I or anti-incumbent group A. Each group comprises half of the population. This political rivalry and the associated mechanism of violence are largely based on Besley and Persson (2011b).

Independent of their political affiliations, individuals can also be categorized based on their economic behavior as either savers or hand-to-mouth. Savers are assumed to have access to the asset market, whereas hand-to-mouth individuals do not. The distribution of savers and hand-to-mouth individuals is symmetric across political groups. Let $\mu_t \in (0, 1)$ represent the fraction of savers among individuals born at time t.[2] Figure 1 offers a schematic of the model.

2.1 Households

In each period, individuals are born with an endowment of one unit of labor time and a randomly drawn ability level, e, uniformly distributed on $[0, 1]$. The utility function of an individual is expressed in a log-linear form as $u(c_t) + \beta u(c_{t+1}) := \ln c_t + \beta \ln c_{t+1}$, where c_t denotes consumption in period t, and $\beta > 0$ is the time discount factor. Individuals then choose to become either a saver or a hand-to-mouth type. Afterward, the model randomly assigns each individual a political group identity. The details of the *ex ante* process, which involves determining economic and political types, are deferred until Section 2.1.3. Next, we denote

[2] This structure of heterogeneous households was also employed in Okabe and Kam (2017), but we adopt the saver-hand-to-mouth terminology instead. This labeling is commonly used in the business cycle literature, particularly in two-agent new Keynesian models (e.g., Bilbiie (2008, 2020)).



* S refers to savers, and HTM refers to hand-to-mouth individuals.

Figure 1: Schematic of theoretical framework

savers and hand-to-mouth types using superscripts k and b, respectively.

2.1.1 Savers

The budget constraints of a saver are given by

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

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

where s_t represents savings, w_t is wages, r_{t+1} is the rental rate of capital, and τ is the income tax rate. The ability, e and the fixed payment ρ_t are, represent time and pecuniary costs associated with being a saver, respectively. For analytical tractability, we recast the pecuniary costs as a proportion of wages, w_t, i.e., $\rho_t = \rho w_t$ where $\rho > 0$. The budget constraints, (1a) and (1b), are then transformed into an intertemporal budget constraint:

$$c_t^{y,k} + \frac{c_{t+1}^{o,k}}{(1-\tau)(1+r_{t+1})} = \left\{(1-\tau)(1-e) - \rho\right\} w_t. \tag{2}$$

Individuals seek to maximize their utility based on these budget constraints. The first-order condition for utility maximization is given by

$$\frac{c_{t+1}^{o,k}}{c_t^{y,k}} = \beta(1-\tau)(1+r_{t+1}). \tag{3}$$

The optimal consumption and savings are characterized as

$$c_t^{y,k} = \frac{1}{1+\beta}\left\{(1-\tau)(1-e)-\rho\right\}w_t, \tag{4}$$

$$c_{t+1}^{o,k} = \frac{\beta}{1+\beta}(1-\tau)(1+r_{t+1})\left\{(1-\tau)(1-e)-\rho\right\}w_t. \tag{5}$$

$$s_t = \frac{\beta}{1+\beta}\left\{(1-\tau)(1-e)-\rho\right\}w_t. \tag{6}$$

2.1.2 Hand-to-mouth individuals

The budget constraints of a hand-to-mouth individual are given by:

$$c_t^{y,b} = (1-\tau)w_t, \tag{7a}$$

$$c_{t+1}^{o,b} = b_{t+1}, \tag{7b}$$

where $b_{t+1} > 0$ represents the benefit provided by the government. Note that market access costs are not imposed on hand-to-mouth individuals. Because they cannot save, their optimal consumption is directly determined by Eqs. (7a) and (7b).

2.1.3 *Ex ante* choice

This section describes the formation of individual heterogeneity. At birth, individuals undergo two stages. In the first, based on their endowed ability, e, individuals choose to become either savers or hand-to-mouth. In the second stage, they are randomly assigned a political group identity, I or A, which subsequently shapes the distribution of agents.

In the first stage, individuals assess *ex post* payoffs. Given the set of prices and the set of policy variables, the *ex post* payoff is a function of K_t.[3] Supposing every individual seeks to maximize their expected lifetime utility, the type choice problem is then given by

$$\max_{\{\text{saver, hand-to-mouth}\}} \left\{\mathbb{E}\left[U^k(K_t;e)\right], \mathbb{E}\left[U^b(K_t)\right]\right\}$$

$$s.t. \qquad \text{optimal consumption choices (1a), (1b), (7a) and (7b)}$$

where

$$U^k(K_t,e) := \ln c_t^{y,k}(K_t,e) + \beta \ln c_{t+1}^{o,k}(K_t,e), \tag{8}$$

$$U^b(K_t) := \ln c_t^{y,b}(K_t) + \beta \ln c_{t+1}^{o,b}(K_t), \tag{9}$$

Observe that $U^b(\cdot)$ is independent of e, as hand-to-mouth consumption is not dependent upon ability (see Eqs. (7a) and (7b)). This is an important distinction, in that it differentiates the lifetime utility between types. Additionally, we use the expectation operator to account for uncertainty in policy variables, which are contingent on the political identity during period

[3] The determination of equilibrium prices is detailed in Section 2.2, and the policy variables are discussed in Sections 2.3 and 2.4.

$t+1$. The following lemma is then immediately established:

Lemma 1 *Given K_t, a unique cut-off level of ability, $e^* \in (0,1)$ exists in the ex ante choice such that* $\mathbb{E}\left[U^k(K_t, e^*)\right] = \mathbb{E}\left[U^b(K_t)\right]$.

See Appendix A for the proof. Lemma 1 implies that those with $e \leq e^*$ (i.e., high ability) choose to become savers, whereas those with $e > e^*$ (i.e., low ability) choose to become hand-to-mouth. Because e is uniformly distributed on $[0,1]$, the cut-off level equals the fraction of savers.

$$e^* = \mu_t. \tag{10}$$

The result of Lemma 1 adequately describes the labor supply.

$$L_t := \int_0^{e^*} N(1-z)dz + N(1-\mu_t) = N\left\{\mu_t\left(1-\frac{\mu_t}{2}\right) + (1-\mu_t)\right\}. \tag{11}$$

In Eq. (11), the contribution from savers is aggregated in the integral component, whereas that from hand-to-mouth individuals corresponds to the remaining part.

2.2 Firms

The economy consists of identical firms forming a unitary continuum whose output is given by $Y_t = \Lambda K_t^{\alpha}\left[L_t(\Psi G_t)\right]^{1-\alpha}$, where $\Lambda > 0$ is the total factor productivity, G_t represents productive public expenditures (i.e., public infrastructure spending), and $\alpha \in (0,1)$ is the share of capital. $\Psi \in (0,1)$ serves as an efficiency parameter that transforms the gross investment into the net investment flow.[4] We assume competitive markets for capital and labor with an inelastic supply of both.

Firms seek to maximize profit $Y_t - w_t L_t - (r_t + \delta) K_t$, where $\delta \in (0,1)$ is the depreciation rate. This yields the first-order conditions:

$$w_t = \frac{(1-\alpha)Y_t}{L_t}, \tag{12}$$

$$r_t = \frac{\alpha Y_t}{K_t} - \delta. \tag{13}$$

The zero profit condition is given by

$$Y_t = w_t L_t + (r_t + \delta)K_t. \tag{14}$$

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

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{15}$$

where I_t denotes investment.

2.3 Government

The incumbent government raises tax revenue and allocates it toward financing public goods, social benefits, and military expenditures. Additionally, we assume that the tax rate remains fixed at $\overline{\tau}$ for all periods. Military service is provided not by households (i.e., no

[4] Ψ follows the model for developing economies proposed in Agénor (2010) and ensures consistency with macroeconomic data in numerical illustrations.

conscription) but by soldiers, each of whom is paid a wage.[5] The government budget is then given by

$$\overline{\tau} w_t L_t + \overline{\tau} r_t S_{t-1} + R_t = G_t + \frac{N(1-\mu_{t-1})}{2}\left(b_t^I + b_t^A\right) + w_t M_t^I.$$

where R_t represents exogenous revenue (e.g., foreign aid), S_{t-1} is aggregate savings, and M_t^I is the size of government forces.

The incumbent discriminates in the allocation of social benefits, favoring their own group over the other. To clarify the allocation process, we denote transfers to incumbent members as b_t^I and transfers to anti-incumbent members as b_t^A. The government implements an allocation rule given by

$$b_t^A = \sigma b_t^I \tag{16}$$

where $\sigma \in (0,1]$ measures the level of generosity. If σ equals one, it indicates that the incumbent is indifferent in terms of benefit provision. The balanced budget simplifies to

$$\overline{\tau} w_t L_t + \overline{\tau}(1+r_t) S_{t-1} + R_t = G_t + \frac{N(1-\mu_{t-1})}{2(1-\theta)} b_t^I + w_t M_t^I. \tag{17}$$

where

$$\theta := \frac{\sigma}{1+\sigma} \in \left(0, \frac{1}{2}\right].$$

2.4 Anti-incumbent platform

Anti-incumbent members are obliged to finance their own forces. Specifically, we assume that only the younger members of the group bear responsibility for covering these costs because they have an incentive to regain power and implement favorable policies in the next period. Denoting the proportion of the expense for this obligation falling on anti-incumbent members as $\tau^A \in (0,1)$, the balanced budget for the anti-incumbent group can be expressed as follows:

$$\chi w_t M_t^A = \frac{1}{2} L_t w_t \tau^A \tag{18}$$

where $\chi \in (0,1)$ is the parameter for the cost of private violence, and M_t^A denotes the size of the anti-incumbent forces. Notably, the anti-incumbent group can finance a unit of armament at an expenditure of χw_t. This contrasts with the incumbent forces, for which the unit cost is w_t, as shown in Eq. (17). By refining tax duty variables, individual budget constraints can be reformulated. See Appendix B for details.

2.5 Technology of conflict

The probability that the current anti-incumbent group will gain power and become the new incumbent in the next period is given by

$$\gamma_t = \widetilde{\gamma}(M_t^I, M_t^A; \xi) := \frac{\exp(M_t^A)}{\exp(M_t^A) + \exp(\xi M_t^I)} = \frac{1}{1 + \exp(\xi M_t^I - M_t^A)}. \tag{19}$$

[5] This setup for military expenditures follows the framework of Besley and Persson (2011b). We also consider an extended model with conscription, detailed in Appendix H. Although this extension introduces additional complexity in the equilibrium characterization due to a constrained labor supply, we find that it does not significantly alter the major outcomes regarding growth and violence.

where $\xi \geq 1$ satisfies the following condition:

$$\frac{\frac{\partial \widetilde{\gamma}}{\partial M_t^I}}{\frac{\partial \widetilde{\gamma}}{\partial M_t^A}} \geq 2\left(1 - \widetilde{\gamma}(0,0)\right). \tag{20}$$

This is a contest function proposed by Hirshleifer (1989).[6]

This conflict technology adheres to the following properties:

$$\frac{\partial \widetilde{\gamma}}{\partial M_t^I} < 0, \quad \frac{\partial^2 \widetilde{\gamma}}{\partial M_t^{I2}} > 0$$
$$\frac{\partial \widetilde{\gamma}}{\partial M_t^A} > 0, \quad \frac{\partial^2 \widetilde{\gamma}}{\partial M_t^{A2}} < 0.$$

These properties imply that no group can ever be completely certain of maintaining power. Moreover, military investment always yields positive returns for each group, albeit at a decreasing rate, assuming the rival group's military size remains constant. In the absence of conflict, where neither group invests in militant activities (i.e., $M_t^I = M_t^A = 0$), the transition of power occurs peacefully, with both groups sharing an equal probability of governing.[7] Thus, our model allows for stochastic changes in political power between incumbent and anti-incumbent groups. However, this does not result in random variations in the government's balanced budget due to the symmetrical distribution of agent types across the two groups (i.e., $\mu_t, 1-\mu_t$). Assuming that the incumbent maintains power, the leader allocates $N/2 \cdot (1-\mu_{t-1})b_t^I$ to their own group and σ times this amount to the opposing group. Should the incumbent lose power, the allocation is reversed. Regardless of the scenario, the total amount of transfers remains unchanged.

2.6 Market clearing condition

The aggregate consumption is characterized as

$$\begin{aligned} C_t = &\frac{N}{1+\beta} w_t \mu_t \left\{ \left(1 - \overline{\tau} - \frac{\chi M_t^A}{L_t}\right)\left(1 - \frac{\mu_t}{2}\right) - \rho \right\} \\ &+ N(1-\mu_t) w_t \left(1 - \overline{\tau} - \frac{\chi M_t^A}{L_t}\right) \\ &+ \frac{N\beta}{1+\beta}(1-\overline{\tau})(1+r_{t+1}) w_{t-1}\mu_{t-1} \left\{ \left(1 - \overline{\tau} - \frac{\chi M_t^A}{L_t}\right)\left(1 - \frac{\mu_t}{2}\right) - \rho \right\} \\ &+ R_t + \overline{\tau} w_t L_t + \overline{\tau}(1+r_t) S_{t-1} - G_t - M_t w_t \end{aligned} \tag{21}$$

[6] Besley and Persson (2011a) proposed various forms of the contest function for a conflict game. In this study, we employ the logistic formulation because its differentiability over the domain facilitates our computation. For a more comprehensive discussion on the contest function, see Konrad (2009).

[7] Appendix C illustrates the graphs of the contest function.

The asset market clears under the following condition[8]:

$$I_t = S_t = \frac{N\beta w_t \mu_t}{1+\beta}\left[\left(1-\overline{\tau}-\frac{\chi M_t^A}{L_t}\right)\left(1-\frac{\mu_t}{2}\right)-\rho\right]. \tag{22}$$

The equilibrium condition for the good market is given by

$$Y_t = C_t + I_t + G_t + w_t M_t^I + \chi w_t M_t^A \tag{23}$$

Combining Eq. (23) with the zero profit condition, (14), the government's balanced budget, (17), aggregate quantities, (21), and (22) yield a single market clearing condition given by

$$(r_t+\delta)K_t + \rho N \mu_t w_t = (1+r_t)S_{t-1} + R_t. \tag{24}$$

The market clearing condition states that the rental and access costs of capital must equal the net return on savings after adjusting for external resources.

Definition 1 *A competitive equilibrium is a sequence of relative prices (i.e., $\{w_t, r_t\}_{t=0}^{\infty}$), consumption and savings (i.e., $\left\{c_t^{y,k}, c_t^{y,b}, c_t^{o,k}, c_t^{o,b}, s_t\right\}_{t=0}^{\infty}$), capital stock (i.e., $\{K_{t+1}\}_{t=0}^{\infty}$), and distribution of agents (i.e., $\{\mu_t\}_{t=0}^{\infty}$, given the initial capital stocks, K_0, the initial distribution of old agents, and sequence of public policies $\left\{R_t, G_t, \overline{\tau}, b_t^I, M_t^I, M_t^A\right\}_{t=0}^{\infty}$), such that*

(i) individuals rationally choose their agent types and maximize utility,

(ii) firms maximize profits,

(iii) all markets clear, and

(iv) the government and anti-incumbent budgets are balanced.

2.7 Equilibrium policies

2.7.1 Public infrastructure

The incumbent government seeks to maximize the welfare of its own constituency through the selection of optimal public goods provisions. We assume that the incumbent prioritizes the interests of older agents.[9] The maximization problem is given by

$$\max_{\{G_t\}} V(K_t, G_t) := \max_{\{G_t\}} \frac{N}{2}\left[\int_0^{1-\mu_{t-1}} V^k(K_t, G_t; z)dz + (1-\mu_{t-1})V^b(K_t, G_t)\right] \tag{25}$$

where $V^k(K_t,\cdot)$ and $V^b(K_t,\cdot)$ are indirect utility functions with respect to the policy variable, G_t. Specifically, by recasting the rental cost and wage as $r_t = \widetilde{r}(K_t, G_t)$ and $w_t = \widetilde{w}(K_t, G_t)$, respectively, these indirect utility functions can be defined as

$$V^k(K_t, G_t; z) := \beta \ln\left[\frac{\beta}{1+\beta}(1-\overline{\tau})(1+\widetilde{r}(K_t, G_t))\left\{(1-\overline{\tau})(1-z)-\rho\right\} w_{t-1}\right] \tag{26}$$

$$V^b(K_t, G_t) := \beta \ln\left(\widetilde{b}(K_t, G_t)\right) \tag{27}$$

[8] As mentioned in Section 2.2, the labor market also clears due to the inelastic supply schedule.

[9] Although it is possible to include the welfare of younger individuals in the objective function, it is deliberately excluded for two reasons here. Theoretically, young agents (i.e., young savers and hand-to-mouth individuals) share the same preferences as older savers, as they both benefit from increases in G_t and leave the policy-making process unchanged. Practically, including young agents' weights shifts the equilibrium policy toward $G_t^{\star k}$, limiting benefits for older hand-to-mouth individuals, which is inconsistent with empirical data.

where

$$\widetilde{b}(K_t, G_t) = \frac{2(1-\theta)}{N(1-\mu_{t-1})} \left\{ R_t + \overline{\tau}\widetilde{w}(K_t, G_t)L_t + \overline{\tau}(1+\widetilde{r}(K_t, G_t))S_{t-1} - G_t - \widetilde{w}(K_t, G_t)M_t^I \right\}.$$

We can then obtain the following lemma:

Lemma 2 *Given K_t and e, all older individuals exhibit a single-peaked preference over G_t in the competitive equilibrium, ensuring that both $V^k(K_t, \cdot)$ and $V^k(K_t, \cdot)$ are concave. The bliss point (i.e., preferred policy) of savers is thus given by*

$$G_t^{\star k} = \overline{\tau} w_t L_t + \overline{\tau} r_t S_{t-1} + R_t - w_t M_t^I$$

whereas the bliss point of the hand-to-mouth $G_t^{\star b}$ satisfies

$$\left.\frac{\partial V^b}{\partial G_t}\right|_{G_t = G_t^{\star b}} = 0.$$

See Appendix D for the proof. This result shows that savers consistently prefer higher levels of public infrastructure to maximize the return on their savings, with their most favorable policy allocating all available resources, minus military expenditures, to public goods. In contrast, hand-to-mouth individuals favor public goods only up to their bliss point $G_t^{\star b}$, beyond which additional investments reduce their benefits due to diminishing returns. Lemma 2 allows us to immediately establish the following proposition:

Proposition 1 *Assuming K_t is given, the welfare maximization problem yields a unique policy, G_t^*, that ensures $\eta_t^* := K_t/(\Psi G_t^*)$ satisfies the following first-order condition:*

$$\int_0^{1-\mu_{t-1}} \left.\frac{\partial V^k}{\partial G_t}\right|_{G_t = G_t^*} dz + (1-\mu_{t-1}) \left.\frac{\partial V^b}{\partial G_t}\right|_{G_t = G_t^*} = 0$$

2.7.2 Military conflict

Each group chooses a level of investment in political violence while accounting the anticipated response of the other group. The payoff function of the incumbent group is given by

$$W^I\left(K_t, M_t^I; M_t^A\right) := \frac{N}{2}\left[(1-\mu_t)W^{I,o'}(K_t, M_t^I) + (1-\mu_{t-1})W^{I,o}(K_t, M_t^I)\right]$$

where $W^{I,o'}(K_t, \cdot)$ is the next period payoff of the current young hand-to-mouth group, and $W^{I,o}(K_t, \cdot)$ is the current period payoff of the old hand-to-mouth group. The indirect utility functions are

$$W^{I,o'}(K_t, M_t^I) = \beta \left\{ \ln(b_{t+1}^I) + \widetilde{\gamma}(M_t^I; M_t^A) \ln \sigma \right\}$$

$$W^{I,o}(K_t, M_t^I) = \beta \ln \widetilde{b}(K_t, M_t^I)$$

The welfare of other agents, irrelevant to M_t^I, is disregarded. Further derivation details are provided in Appendix E. From this payoff function, we can derive the following lemma:

Lemma 3 *Given K_t and G_t, every incumbent hand-to-mouth exhibits a single-peaked preference over M_t^I in the competitive equilibrium, ensuring that both $W^{I,o'}(K_t, \cdot)$ and $W^{I,o}(K_t, \cdot)$ are concave. The bliss points are given by*

$$M_t^{\star o'} = \frac{\overline{\tau} w_t L_t + \overline{\tau} r_t S_{t-1} + R_t - G_t}{w_t}.$$
$$M_t^{\star o} = 0$$

See Appendix F for the proof. This result indicates that future old hand-to-mouth agents prefer higher military spending to increase the likelihood of retaining power, whereas current old agents oppose any military expenditure as it diminishes their immediate welfare. In relevant to Lemma 3, we can establish the following:

Lemma 4 *Given K_t and G_t, the payoff function $W_t^I(K_t, \cdot)$ possesses a unique bliss point, $M_t^{I\star}$. Specifically, the following conditions must be satisfied:*

$$\text{for } M_t^{I\star} > 0, \quad \left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I = M_t^{I\star}} = 0$$
$$\text{for } M_t^{I\star} = 0 \quad \frac{\partial W^I}{\partial M_t^I} < 0 \quad \forall M_t^I \geq 0$$

The anti-incumbent leader focuses exclusively on increasing the likelihood of political turnover, aiming to secure greater benefits for the currently young hand-to-mouth. The payoff function of the anti-incumbent group is given by

$$W^A\left(K_t, M_t^A; M_t^I\right) := (1-\mu_t)\ln\left[\left(1 - \overline{\tau} - \frac{2M_t^A}{L_t}\right) w_t\right] + (1-\mu_t)\beta\left\{\ln(\sigma b_{t+1}) + \widetilde{\gamma}(M_t^A; M_t^I)\ln\left(\frac{1}{\sigma}\right)\right\} \tag{28}$$

The payoff is essentially the lifetime welfare of the current young hand-to-mouth. Analogous to the incumbent strategy, we can establish the following lemma:

Lemma 5 *Given K_t and G_t, the payoff function, $W_t^A(K_t, \cdot)$, possesses a unique bliss point, $M_t^{A\star}$. Specifically, the following conditions must be satisfied:*

$$\text{for } M_t^{A\star} > 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^A = M_t^{A\star}} = 0$$
$$\text{for } M_t^{A\star} = 0 \quad \frac{\partial W^A}{\partial M_t^A} < 0 \quad \forall M_t^A \geq 0$$

See Appendix G for the proof. Using Lemmas 4 and 5, we can characterize the Nash equilibrium:

Proposition 2 *Assuming K_t and G_t are given, the conflict game yields a Nash equilibrium, (M_t^{I*}, M_t^{A*}), satisfying the following first-order conditions:*

$$\left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I = M_t^{I*}, M_t^A = M_t^{A*}} \leq 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^I = M_t^{I*}, M_t^A = M_t^{A*}} \leq 0$$

More specifically,

1. *For* $M_t^{I*} = M_t^{A*} = 0$ *where there is a peace,*

$$\left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I=0, M_t^A=0} < 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^I=0, M_t^A=0} < 0$$

2. *For* $M_t^{I*} > 0, M_t^{A*} = 0$ *where there is a repression,*

$$\left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I=M_t^{I*}, M_t^A=0} = 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^I=M_t^{I*}, M_t^A=0} < 0$$

3. *For* $M_t^{I*} > 0, M_t^{A*} > 0$ *where there is a civil war,*

$$\left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I=M_t^{I*}, M_t^A=M_t^{A*}} = 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^I=M_t^{I*}, M_t^A=M_t^{A*}} = 0$$

4. *For* $M_t^{I*} = 0, M_t^{A*} > 0$ *where there is a one-sided attack,*

$$\left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I=0, M_t^A=M_t^{A*}} < 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^I=0, M_t^A=M_t^{A*}} = 0.$$

The labelling of conflict status is conducted same as Besley and Persson (2011a). Concerning the fourth scenario (i.e., a one-sided attack by the anti-incumbent group), we add a caveat. Besley and Persson (2011a) argued that such scenarios are infrequent in real-world contexts; however, such a Nash equilibrium arises in their theoretical framework. In our model, we include this scenario because it facilitates an unambiguous interpretation of the equilibrium dynamics.

2.8 Timing of events

The timing of events is delineated as follows:

1. At the beginning of period t, the state variable, K_t, is realized.
2. A new generation is born, and individuals decide whether to become savers or hand-to-mouth based on their ability endowment, e. Then, the distribution of agent types $\{\mu_t, 1-\mu_t\}$ is determined.
3. Individuals are assigned a political group identity by nature and join their respective political groups.
4. The incumbent chooses the size of public good G_t.
5. Political groups simultaneously choose the size of their forces, $\{M_t^I, M_t^A\}$, and benefit policies $\{b_t^I, b_t^A\}$ are residually determined.
6. All markets clear, and the old generation dies.
7. The triumphant group becomes a new incumbent.

2.9 Steady state

Given the equilibrium policies, we establish the following definitions:

Definition 2 *A political equilibrium is a sequence of prices (i.e., $\{w_t, r_t\}_{t=0}^{\infty}$), consumption and savings (i.e., $\left\{c_t^{y,k}, c_t^{y,b}, c_t^{o,k}, c_t^{o,b}, s_t\right\}_{t=0}^{\infty}$), capital stock (i.e., $\{K_{t+1}\}_{t=0}^{\infty}$), distribution of agents (i.e., $\{\mu_t\}_{t=0}^{\infty}$), and sequence of public policies (i.e., $\left\{G_t, b_t^I, b_t^A, b_t^I, M_t^I, M_t^A, R_t\right\}_{t=0}^{\infty}$, given the initial capital stocks K_0, constant tax rates $\overline{\tau}$, and the initial distribution of old agents, μ_0^o), such that*

(i) Individuals rationally choose agent types and maximize utility,

(ii) Firms maximize profits,

(iii) All markets clear,

(iv) The government budget is balanced,

(v) The incumbent maximizes the welfare of their own group members by choosing the size of public good,

(vi) The conflict game is in Nash equilibrium.

Definition 3 *A steady state equilibrium is a political equilibrium path along which consumption and savings (i.e., $c_t^{y,k}, c_t^{y,b}, c_t^{o,k}, c_t^{o,b}, s_t$), capital K_t, productive public good G_t and military expenditures, $M_t^I w_t, M_t^A w_t$, grow at a constant rate.*

The steady-state growth rate is given by

$$\nu := -\delta + \frac{N\beta\mu}{1+\beta}\left\{\left(1-\overline{\tau}-\frac{M^A}{L}\right)\left(1-\frac{\mu}{2}\right)-\rho\right\}(1-\alpha)L^{-\alpha}\eta^{\alpha-1}, \tag{29}$$

where all time subscripts are omitted. From Lemma 1, the distribution of agents μ is characterized by

$$\mathbb{E}\left[U^k(K_t,\mu)\right] = \mathbb{E}\left[U^b(K_t)\right]. \tag{30}$$

The capital-public good ratio, η, is recast as

$$\int_0^{1-\mu} \left.\frac{\partial V^k}{\partial G_t}\right|_{G_t=\eta K_t} dz + (1-\mu)\left.\frac{\partial V^b}{\partial G_t}\right|_{G_t=\eta K_t} = 0. \tag{31}$$

Military investments M^I, M^A are characterized by

$$\left.\frac{\partial W^I}{\partial M_t^I}\right|_{M_t^I=M^I, M_t^A=M^A} \leq 0, \quad \left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^I=M^I, M_t^A=M^A} \leq 0. \tag{32}$$

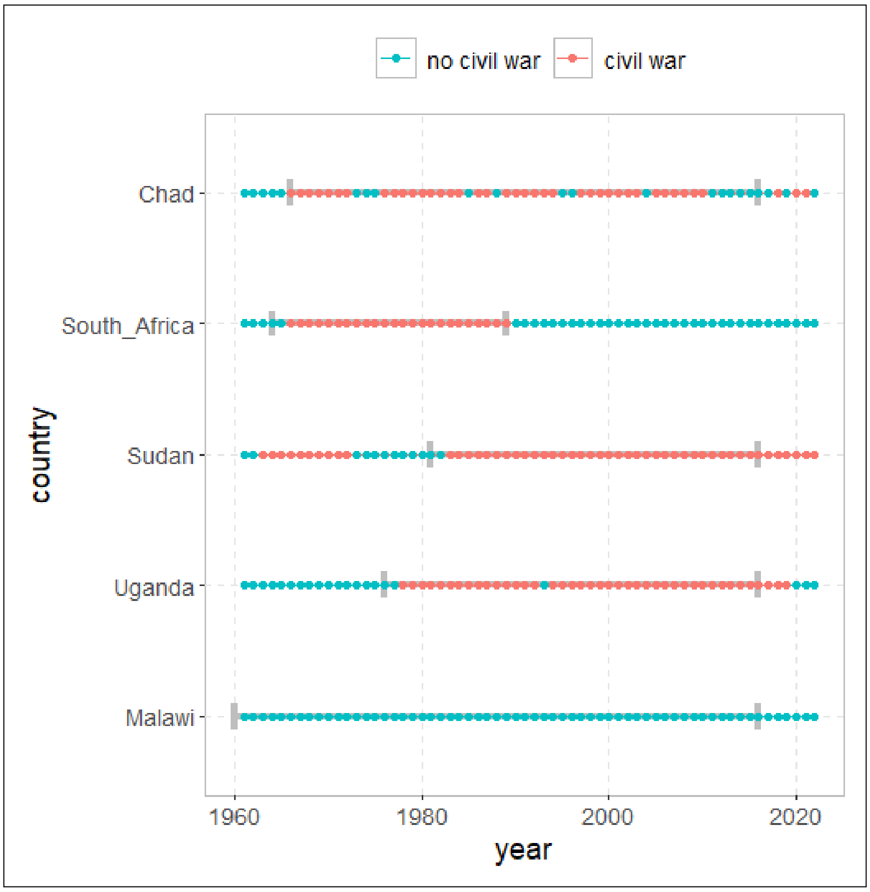
Finally, equilibrium labor allocation is given by

$$L = N\mu\left(1-\frac{\mu}{2}\right) + N(1-\mu). \tag{33}$$

Proposition 3 *The balanced-growth equilibrium has a constant growth rate of output, ν, capital-to-public good ratio, η, military investment, M^I, M^A, distribution of agents, μ, and, total labor allocation, L, that satisfy the system of non-linear equations:* (29), (30), (31), (32) *and* (33).

3 Setup for numerical illustrations

Because we lack analytical solutions for the balanced-growth equilibrium, we rely on numerical solutions. We selected five African countries and calibrated their parameter values



* Grey ticks indicate the initial and final periods used for calibration

Figure 2: Political violence in selected countries

by fitting the model to observed data from each country.

3.1 Identification of violence and timeframes

First, we verify the state of domestic security using the *UCDP/PRIO Armed Conflict Dataset version 23.1*. Following the approach of Besley and Persson (2011b), we construct a variable for civil war occurrence by examining the entire episode of internal conflicts, classified as Type 3 or 5 in the UCDP). This classification requires that, at some point during its duration, the conflict resulted in more than 1,000 battle-related deaths in a single year. Figure 2 shows the histories of violence in each country. Notably, violence persisted fairly consistently throughout the calibrated periods, which allows us to set the model period to five years to ensure that each period contains at least one civil war incident. As a result, we identified four countries as being under the civil war regime: Chad, Sudan, South Africa, and Uganda. We also included Malawi as a contrasting peaceful regime counterpart.[10]

Figure 3 shows the trajectory of GDP per capita over the focus periods, where we can see that each nation experienced positive growth, even under political violence conditions. We assume that individuals enter the workforce at age 20, become old at 35, and die at 50, an age that closely aligns with the average life expectancy in the African region. Hence, agents are active for six

[10] Although Malawi experienced a repression incident in 1976, as indicated by the purges variable of Banks and Wilson (2023), we added it to the peaceful regime in this exercise.

model periods where the first half of their lives are young, and the latter half is old. The data span approximately the same length as the individual's lifespan, with the exception of South Africa, where the coverage is half.

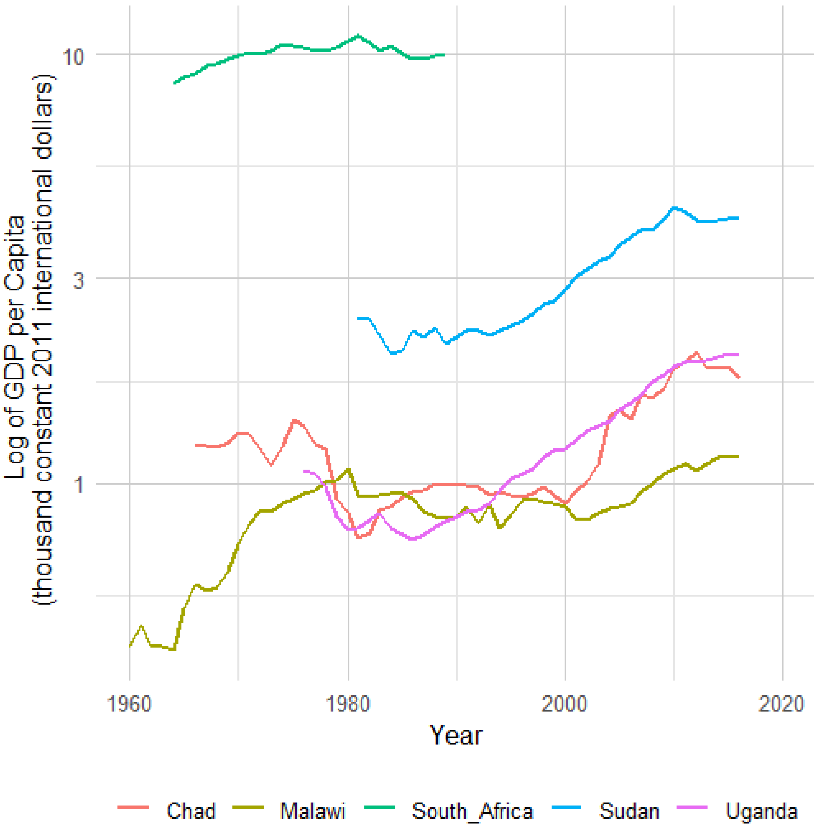


Figure 3: GDP per capita of selected countries

Table 1: Calibrated political equilibria

Country	Years	Growth rate ν (annual)	Military size M^I	Military size M^A	Security situation	K-G ratio η	Rental rate of capital r (annual)	Fraction of wealth holders μ
Chad	1966 - 2016	0.52%	0.0061	0.22	CIVIL WAR	1.19	22.2%	0.20
South Africa	1964 - 1989	0.57%	0.0011	0.13	CIVIL WAR	0.58	15.4%	0.27
Sudan	1981 - 2016	1.24%	0.0023	0.25	CIVIL WAR	0.83	22.2%	0.23
Uganda	1976 - 2016	1.21%	0.0029	0.010	CIVIL WAR	0.71	22.2%	0.22
Malawi	1960 - 2016	1.26%	0	0	PEACE	0.24	29.8%	0.12

3.2 Calibration of parameters

Table 1 summarizes the equilibrium outcomes across countries. Growth rates are matched with the *IMF Investment and Capital Stock Dataset, 2019* (ICSD).[11] Rental rates of capital are determined by fitting the annual averages of the output-capital ratios derived from ICSD data[12] The sizes of military forces, M^I and M^A, agent fraction, μ, and capital-public good ratio, η, represent the computed equilibrium values. The aggregate labor, L, is normalized to one for all economies.

4 Impacts of politico-economic channels

Based on the calibrated models, we investigate the characteristics of the balanced-growth equilibrium. Although we utilized the most appropriate data available for calibration, some proxies were employed, and the accuracy of a measurement may not necessarily be sufficient for establishing its validity. Therefore, we must stress that the aim of our numerical exercise is to obtain qualitative implications rather than provide precise quantitative estimates. Next, we illustrate the marginal contributions of key channels in Uganda under its civil war regime and Malawi under its peaceful regime.[13] Figures 4 - 18 present the results. In each figure, most variables on the vertical axis are standardized relative to the default solution. More details of the calibration process are shown in Appendix I.

Institution

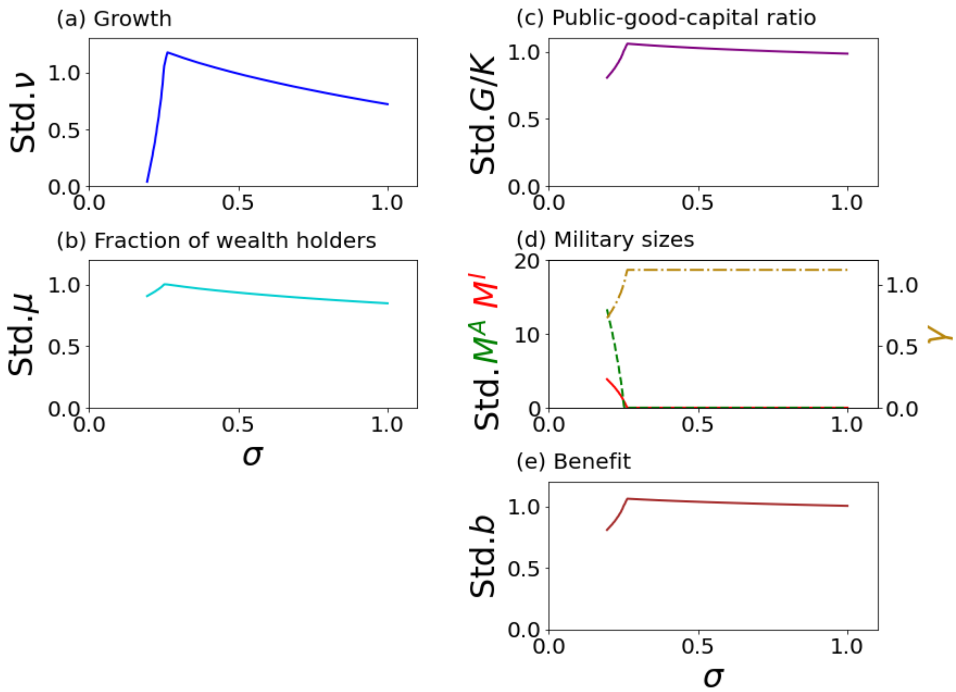
Figure 4 summarizes the impacts of marginal changes in σ for Uganda. In the panels of the figure, each curve exhibits kinks at points where the first-order conditions of the conflict game are binding. Recalling that a larger value of this parameter indicates that the incumbent distributes benefits more equally across groups, which, in turn, should reduce the incentive for violence.

[11] Associated methodological manuals for these estimates can be accessed at `http://www.imf.org/external/np/fad/publicinvestment/data/info122216.pdf` and `http://www.imf.org/external/pp/longres.aspx?id=4959`.

[12] For Chad and Sudan, the output-capital ratio yields extraordinarily high values for the rental rates, which failed to calibrate the model. Consequently, we adopted the values used for Uganda.

[13] Results for the other countries are omitted as their numerical solutions yield similar interpretations.

In panel (d), as expected, we can see that as σ increases, the sizes of the military forces, M^I and M^A, drastically decrease, eventually reaching zero. Considering other variables in the domain for which both M^I and M^A are zero, a marginal increase in σ expands the total benefits. This creates fiscal pressure on the government and hampers infrastructure development (see panel (c)). It also reduces the return on capital, leading more individuals to choose to be hand-to-mouth (see panel (b)). As a result of these complex behavioral changes, the growth rate decreases moderately (see panel (a)). In contrast, when σ is sufficiently small, the incentive for violence is accelerated, worsening economic performance. In summary, our model predicts that although institutional improvements, all else being equal, facilitate the elimination of violence; they do not necessarily boost economic growth. Our interpretations remain unchanged for the case of Malawi, whose results are shown in Appendix J.



* Std. X indicates values of variable X normalized by the default solution.

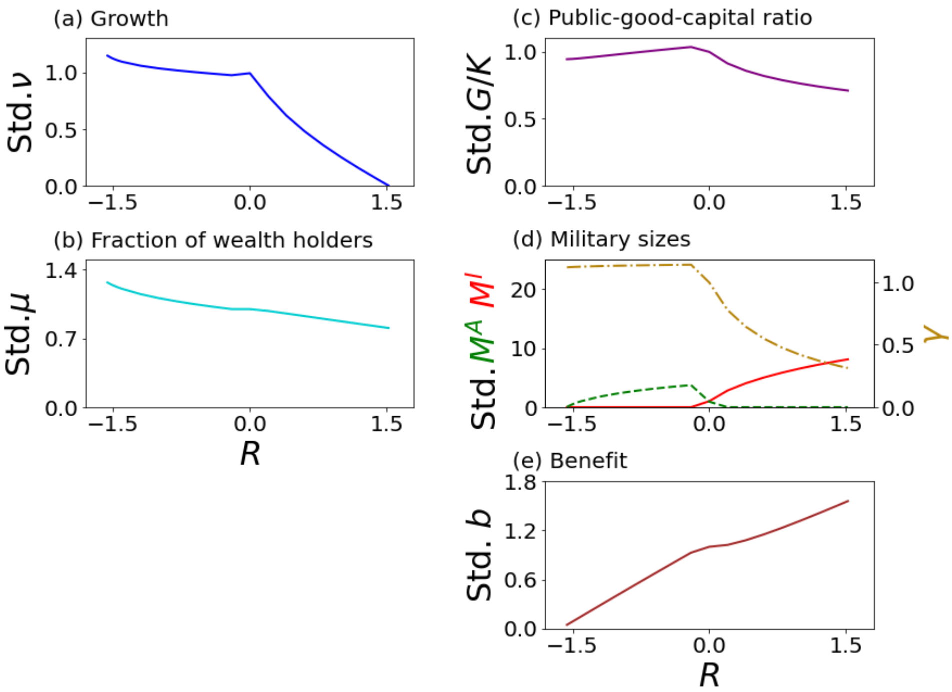
Figure 4: Effects of σ for Uganda

External resource

Parameter R represents the external revenue flow in terms of capital (i.e., $R = R_t/K_t$). In the default calibration, its value is assigned to zero. Hence, an exogenous change in the available resources alters the portfolio of government expenditures. Figure 5 summarizes the impacts of marginal changes in R for Uganda. Because the results appear complex, we discuss the marginal changes separately for domains $R > 0$ and $R < 0$.

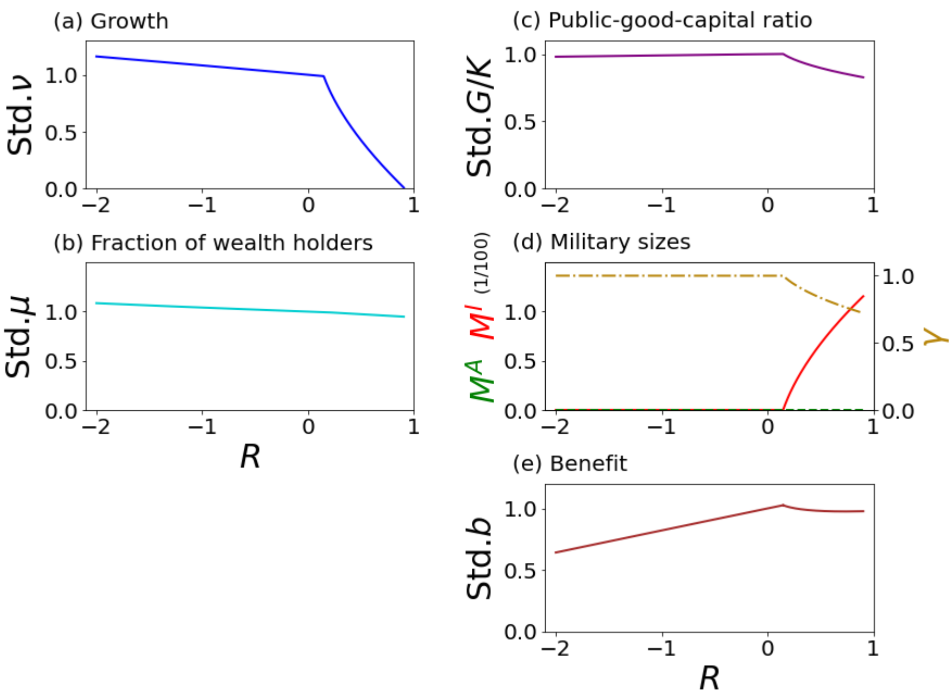
Focusing on $R > 0$, where the government obtains extra funds from external sources, we can see in panel (d) that a marginal increase in R enhances the military spending of the incumbent while reducing that of the anti-incumbent. This implies that the incumbent intensifies its attacks, taking advantage of the extra funds, whereas the anti-incumbent group decelerates their counterattacks, ultimately ceasing their armament. Simultaneously, the government reduces spending on infrastructure and increases the level of benefits (see panels (c) and (e)). This indicates that in this situation, the government allocates more resources to violence than to infrastructure development. Unsurprisingly, this shift toward improved benefits attracts more individuals to become hand-to-mouth, and economic growth is not fostered (see panels (b) and (a)).

Focusing on $R < 0$, where a part of the government revenue is used for payments to external entities, a marginal decrease in R tightens the budget, causing spending on all expenditure items to diminish (see panels (c), (d), and (e)). Given the reduced strength of the incumbent's force, the anti-incumbent group enlarges its military if they can afford it (see panel (d)). However, the anti-incumbent group eventually must reduce its military as their own financial resources also diminish. As social benefits deteriorate, more individuals choose to become savers instead of relying on welfare (see panel (b)). However, this shift ultimately enhances the growth rate as the overall spending on non-productive items (i.e., benefits and military expenditures) shrinks (see panel (a)). Figure 6 shows the results for Malawi. The interpretation of results is essentially the same as for Uganda, but the benefit slightly decreases as M^I increases. Because M^I is zero in the default setting, a marginal increase can sufficiently raise the probability of maintaining power, offsetting the welfare loss resulting from benefit reductions (see panel (e)). From these results, we can conclude that when the costs of armament are sufficiently low, an increase in external resources is more likely to lead to an increase in violence, holding all else constant. This insight is consistent with the theoretical prediction of Besley and Persson (2011a).



* Std. X indicates values of X normalized by the default solution.

Figure 5: External resources for Uganda

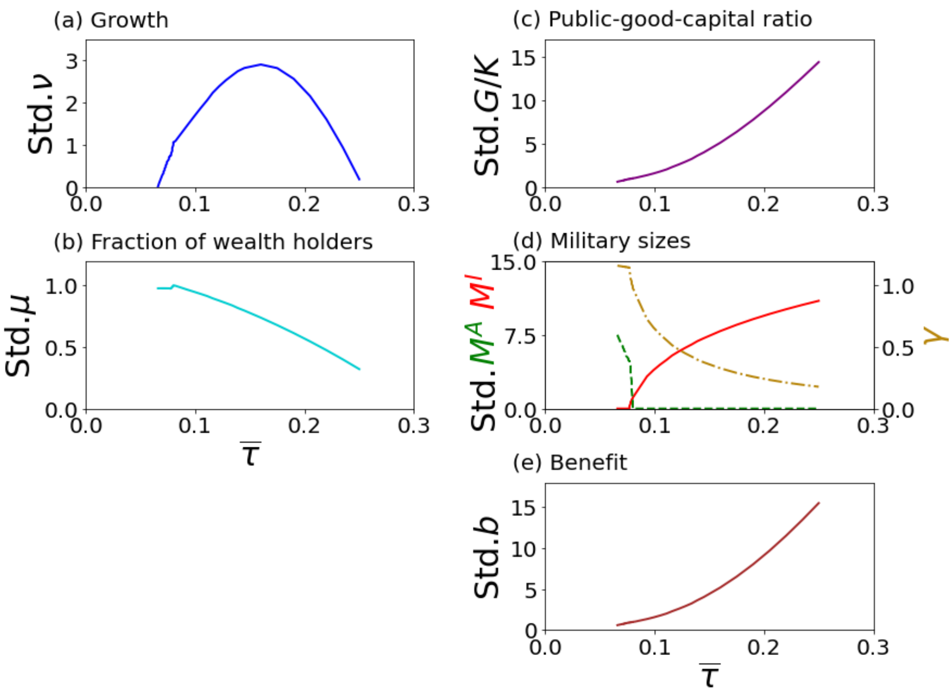


* Std. X indicates values of X normalized by the default solution.

Figure 6: External resources for Malawi

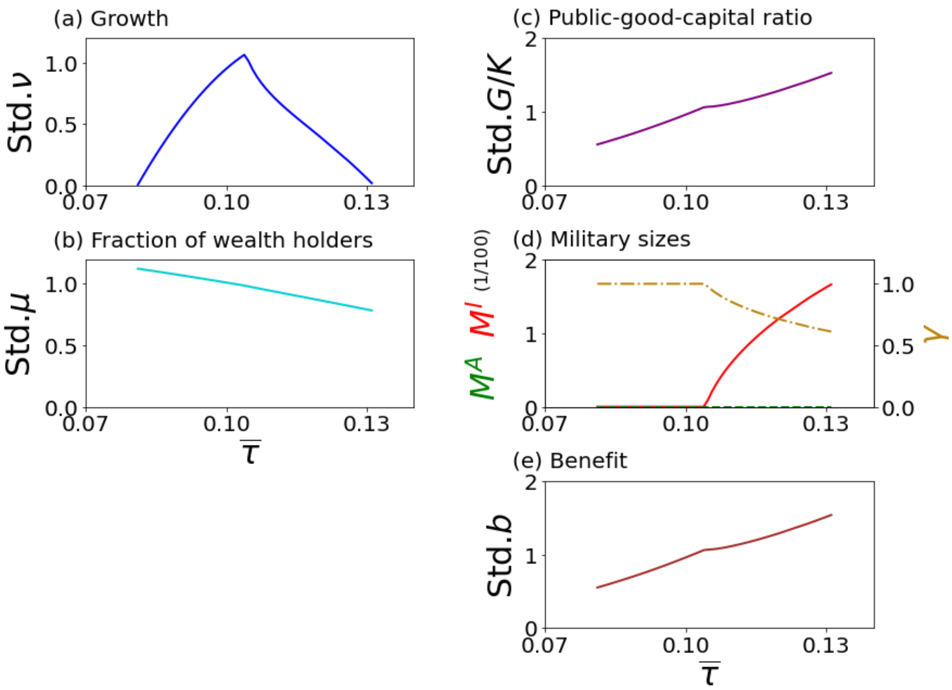
Fiscal capacity

Parameter $\overline{\tau}$ represents the income tax rate, for which a marginal change influences the tax base, altering government expenditures and growth in a complex manner. Figure 7 shows the results for Uganda. Unsurprisingly, a marginal increase in the tax rate raises all expenditure items (see panels (c), (d), and (e)). The incumbent group accelerates military attacks, and the anti-incumbent group responds by reducing the size of their military force. Obviously, an increase in the tax burden reduces the disposable income of households. Hence, for savers, the reduction in income directly impacts their lifetime utility, whereas for hand-to-mouth individuals, the tax burden is offset by increased benefits. These welfare changes eventually lower the fraction of savers (see panel (b)). As the marginal tax rate rises, growth is initially boosted by infrastructure development. However, this positive effect is eventually neutralized and diminished by worsening violence and a decline in capital accumulation. Thus, the graph of the growth rate shows a hump-shaped pattern (see panel (a)). Figure 8 shows the results for Malawi. The intuitions for economic behavior behind each graph are similar to the Uganda case, but the hump-shaped curve is rather sharp at its peak (see panel (a)). This sharpness reflects the transition from a peaceful regime to a repression regime, which severely damaged growth due to the onset of violence.



* Std. X indicates values variable X normalized by the default solution.

Figure 7: Fiscal capacity for Uganda

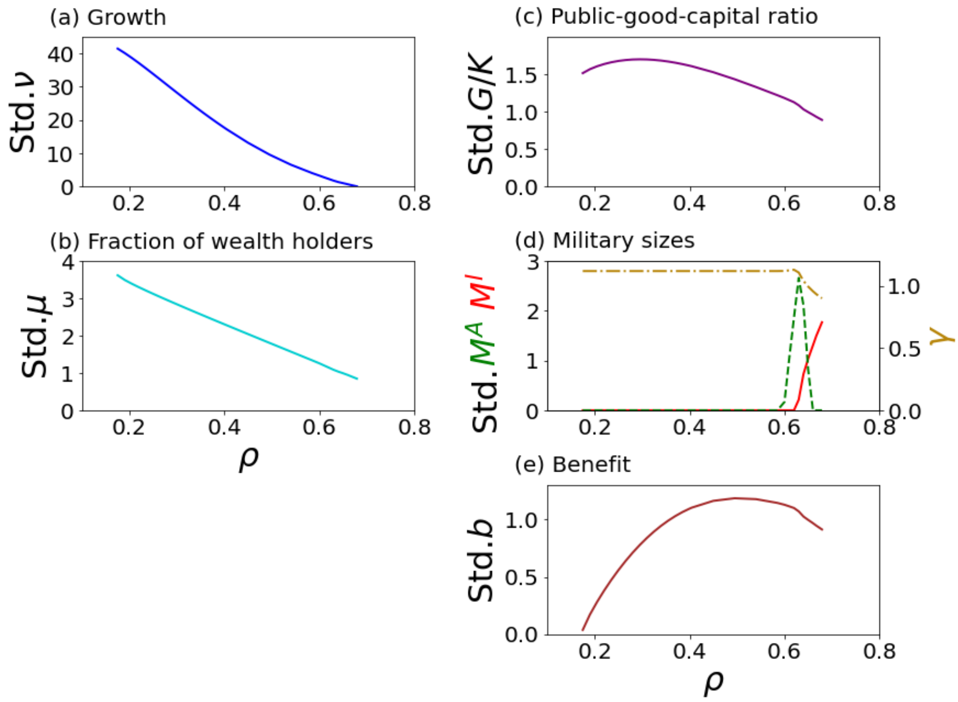


* Std. X indicates values of X normalized by the default solution.

Figure 8: Fiscal capacity for Malawi

Capital market accessibility

A reduction in the access costs to the capital market should have positive impacts for growth. Figure 9 shows the results for Uganda. A marginal decrease in ρ drastically improves the lifetime welfare of savers, thereby stimulating an increase in the saver population (see panel(b)). Capital accumulation is then promoted, and the policy shifts towards more aggressive infrastructure development rather than enhancing benefits (see panels (c) and (e)). Such changes lead to accelerated growth (see panel (a)). Moreover, the boost in growth raises the costs of military formation (i.e., wages) thus diminishing the incentives for political conflicts (see panel (d)). We must stress that this economic channel could serve as another trigger for achieving a state of non-violence. In the Malawian case, growth was also promoted as the access costs decreased, but it remained under peaceful status. See Appendix J for details. We also investigated the impacts of other two channels, χ and Ψ. See details in Appendix J.



* Std. X indicates values of X normalized by the default solution.

Figure 9: Market accessibility for Uganda

Growth and welfare under hypothetical peace

We evaluated the impacts of civil war on long-run economic performance. As noted earlier, the data used in our calibrations were subject to certain imperfections. Therefore, although the numerical results are informative, they should not be interpreted as precise quantitative estimates. Rather, our aim is to highlight the qualitative distortions that civil war imposes on growth and welfare.

In this exercise, we calculate the steady-state outcomes under a peaceful scenario (i.e., $M^I = M^A = 0$), which is ensured by setting both the private militarization parameter, χ, and the offensive advantage parameter, ξ, to values close to the minimum of one while keeping the default parameter values constant. Table 2 summarizes the results. There, variations in growth and welfare are denoted as $\Delta\nu = (\nu_{peace} - \nu)/\nu$ and $\Delta\mathbb{E}[c] = (\mathbb{E}[c_{peace}] - \mathbb{E}[c])/\mathbb{E}[c]$, respectively, where subscript *peace* refers to the benchmark outcome of the peaceful regime. We can see that in all economies, growth and welfare improve considerably under the peaceful scenario.

Table 2: Economic distortions by violence

	$\Delta\nu$	$\Delta\mathbb{E}[c^k]$	$\Delta\mathbb{E}[c^b]$
Chad	+790%	+78%	+38%
South Africa	+279%	+49%	+26%
Sudan	+96%	+8%	+5%
Uganda	+19%	+8%	+4%

5 Conclusion

Stagnant economic development and persistent civil conflicts have long been observed in developing countries. In this study, we sought to understand what drives these phenomena and how they interconnect. We proposed a politico-economic growth model to investigate the endogenous mechanisms that shape the macroeconomic performance and security stability. The model incorporates two types of households: savers, who accumulate assets, and hand-to-mouth individuals, who rely on social benefits. Economic growth is driven by capital and productive public goods, and political violence is modeled as a conflict game between incumbent and anti-incumbent groups, driven by the unequal allocation of social benefits. As such, the model allows for the characterization of economic growth and political stability together through various explicit channels.

We calibrated our model using African data and provided numerical solutions, revealing that institutional improvements in benefit allocations can eliminate violence, whereas fiscal measures alone, including increased taxation and external aid, do not necessarily promote growth or achieve peace. The findings also highlight the critical role of capital market accessibility in resolving violence, as reducing access costs fosters capital accumulation and increases the marginal cost of conflict, ultimately suppressing violence.

Although our model provides theoretically valuable insights into growth and violence, it is not without its limitations. For example, institutional parameters were treated as static and exogenous. Future research should explore the evolution of institutions within this specific context, applying concepts such as the evolution of political institutions proposed by Bisin and Verdier (2024). Additionally, external geopolitical factors (e.g., natural resource-driven conflicts, commonly referred to as the "resource curse") were excluded from our framework. Incorporating a natural resource channel would offer a more comprehensive understanding of the interplay between growth and violence. Furthermore, our numerical exercises relied on imperfect data, which clearly indicates the need for more robust empirical validation. Moreover, country-specific indicators of capital market development, efficiency of infrastructure investment, and detailed information on military sizes related to internal conflicts would support a more compelling counterfactual analysis.

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Appendix A Proof of Lemma 1

Using Eqs. (4) and (5), the first-order derivatives of $c_t^{y,k}$ and $c_{t+1}^{o,k}$ with respect to e are given by

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

Therefore,

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

This holds true for any tax policy, τ. Given the stochastic nature for political identity, the expected utility of a saver is given by

$$\mathbb{E}\left[U^k(K_t,e)\right] = \frac{1}{2}U^k(K_t,e;\tau^I) + \frac{1}{2}U^k(K_t,e;\tau^A) \tag{A.1}$$

Using the above result, it is clear that Function (A.1) is strictly decreasing on $[0,1]$. Meanwhile, the expected utility of a hand-to-mouth is given by

$$\begin{aligned}
\mathbb{E}\left[U^b(K_t)\right] &= \mathbb{E}\left[\frac{1}{2}U^b(K_t;\tau^I) + \frac{1}{2}U^b(K_t;\tau^A)\right] \\
&= \frac{1}{2}u(c_t^{y,b};\tau^I) + \frac{1}{2}u(c_t^{y,b};\tau^A) \\
&+ \beta\left[\frac{1}{2}(1-\gamma)u(c_{t+1}^{o,b};b_{t+1}^I) + \frac{1}{2}\gamma u(c_{t+1}^{o,b};b_{t+1}^A) + \frac{1}{2}(1-\gamma)u(c_{t+1}^{o,b};b_{t+1}^A) + \frac{1}{2}\gamma u(c_{t+1}^{o,b};b_{t+1}^I)\right] \\
&= \frac{1}{2}u(c_t^{y,b};\tau^I) + \frac{1}{2}u(c_t^{y,b};\tau^A) + \beta\left[\frac{1}{2}u(c_{t+1}^{o,b};b_{t+1}^I) + \frac{1}{2}u(c_{t+1}^{o,b};b_{t+1}^A)\right] \qquad \text{(A.2)}
\end{aligned}$$

Unlike the case for a saver, Function (A.2) is independent of e. Therefore, the graphs of Functions (A.1) and (A.2) have an obvious unique intersection when $e = e^*$. Figure 10 depicts the unique $e^* \in (0,1)$. ■

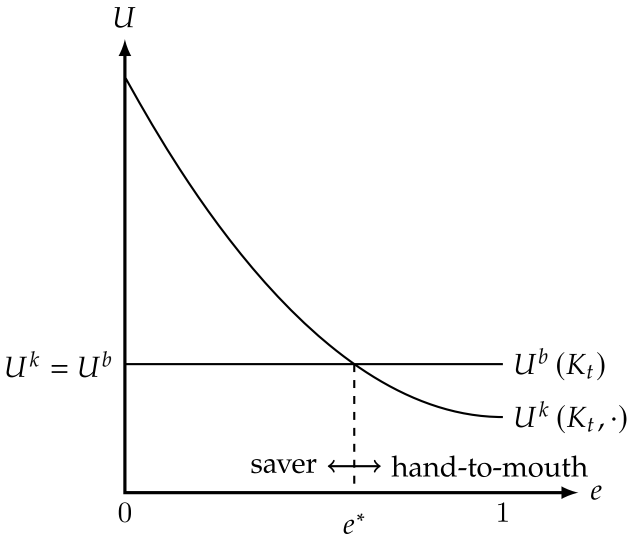


Figure 10: *Ex ante* choice

Appendix B Reformulation of budget constraints

Given the group-specific policy instruments outlined in Sections 2.3 and 2.4, we reformulate individual budget constraints (1a), (1b), (7a), and (7b) as follows:

Incumbent group

Regarding savers,

$$s_t + c_t^{y,k} = \left\{(1-\overline{\tau})(1-e) - \rho\right\} w_t,$$
$$c_{t+1}^{o,k} = (1-\overline{\tau})(1+r_{t+1})s_t.$$

Regarding hand-to-mouth individuals,

$$c_t^{y,b} = (1-\overline{\tau})w_t,$$
$$c_{t+1}^{o,b} = b_{t+1}.$$

Anti-incumbent group

As for savers,

$$s_t + c_t^{y,k} = \left\{(1-\overline{\tau}-\tau^A)(1-e) - \rho\right\} w_t,$$
$$c_{t+1}^{o,k} = (1-\overline{\tau})(1+r_{t+1})s_t.$$

Regarding hand-to-mouth individuals,

$$c_t^{y,b} = (1-\overline{\tau}-\tau^A)w_t,$$
$$c_{t+1}^{o,b} = b_{t+1}.$$

where $\tau^A = \frac{2\chi M_t^A}{L_t}$.

Appendix C Contest function

Figure 11 presents graphs of the contest function with $\xi = 1, 5, 20$. A greater value of ξ reduces the probability of political turnover for a given military size, M^I, of the incumbent group, although differences across ξ diminish as M^I becomes sufficiently large and the probability approaches zero. Additionally, when ξ is larger, marginal increases in M^I lead to more substantial decreases in the probability of turnover. This demonstrates how ξ amplifies the effectiveness of military investment for the incumbent group.

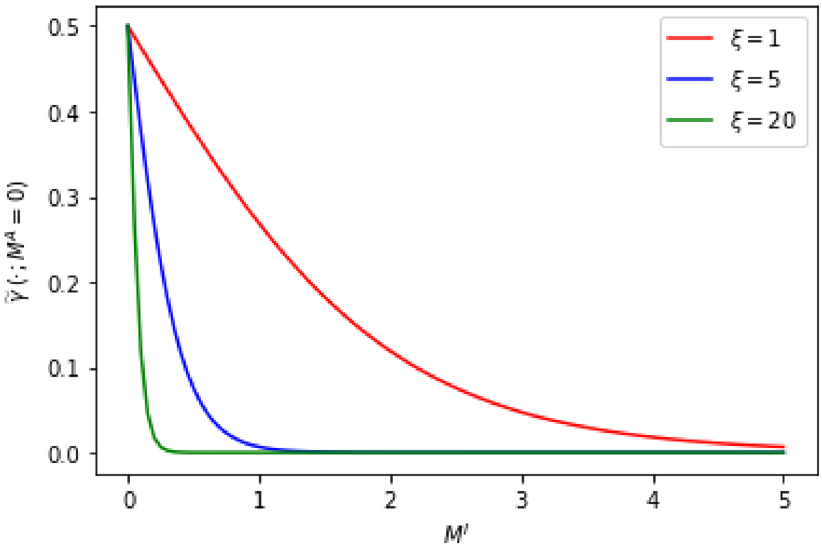


Figure 11: Illustration of contest function $\gamma = \tilde{\gamma}(\cdot; \xi, M^A = 0)$

Appendix D Proof of lemma 2

First, we derive the pertinent derivatives of prices.

$$\frac{\partial \widetilde{r}}{\partial G_t} = \alpha(1-\alpha)\Lambda L_t^{1-\alpha}\left(\frac{K_t}{\Psi G_t}\right)^{\alpha}\frac{\Psi}{K_t} > 0$$

$$\frac{\partial^2 \widetilde{r}}{\partial G_t^2} = -\alpha^2(1-\alpha^2)\Lambda L_t^{1-\alpha}\left(\frac{K_t}{\Psi G_t}\right)^{\alpha+1}\frac{\Psi^2}{K_t^2} < 0$$

$$\frac{\partial \widetilde{w}}{\partial G_t} = \alpha(1-\alpha)^2\Lambda L_t^{-\alpha}\left(\frac{K_t}{\Psi G_t}\right)^{\alpha}\Psi > 0$$

$$\frac{\partial^2 \widetilde{w}}{\partial G_t^2} = -\alpha(1-\alpha^2)\Lambda L_t^{-\alpha}\left(\frac{K_t}{\Psi G_t}\right)^{\alpha+1}\frac{\Psi^2}{K_t} < 0.$$

Let m denote either k or b. The first-order derivative of $V^m(K_t, \cdot)$ with respect to G_t is given by

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

where

$$
\begin{aligned}
\frac{\partial c_t^{o,k}}{\partial G_t} &= \frac{\beta}{1+\beta}(1-\overline{\tau})\left\{(1-\overline{\tau}(1-e)-\rho\right\} w_{t-1}\frac{\partial \widetilde{r}}{\partial G_t} > 0, \\
\frac{\partial c_t^{o,b}}{\partial G_t} &= \frac{2(1-\theta)}{N(1-\mu_{t-1})}\left[(\overline{\tau}L_t - M_t^I)\frac{\partial \widetilde{w}}{\partial G_t} + \overline{\tau}S_{t-1}\frac{\partial \widetilde{r}}{\partial G_t} - 1\right] \\
&= \frac{2(1-\theta)}{N(1-\mu_{t-1})}\left[(\overline{\tau}L_t - M_t^I)\frac{\partial \widetilde{w}}{\partial G_t} + \overline{\tau}\left\{\frac{\partial \widetilde{r}}{\partial G_t}K_t + \rho N\mu_t\frac{\partial \widetilde{w}}{\partial G_t}\right\} - 1\right] \\
&\qquad (\because \text{ The market clearing condition (24)})
\end{aligned}
$$

The second-order derivatives are then given by

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

where

$$
\begin{aligned}
\frac{\partial^2 c_t^{o,k}}{\partial G_t^2} &= \frac{\beta}{1+\beta}(1-\overline{\tau})\left\{(1-\overline{\tau}(1-e)-\rho\right\} w_{t-1}\frac{\partial^2 \widetilde{r}}{\partial G_t^2} < 0, \\
\frac{\partial^2 c_t^{o,b}}{\partial G_t^2} &= \frac{2(1-\theta)}{N(1-\mu_{t-1})}\left[(\overline{\tau}L_t - M_t^I)\frac{\partial^2 \widetilde{w}}{\partial G_t^2} + \overline{\tau}\left\{\frac{\partial^2 \widetilde{r}}{\partial G_t^2}K_t + \rho N\mu_t\frac{\partial^2 \widetilde{w}}{\partial G_t^2}\right\}\right] < 0.
\end{aligned}
$$

The first-order derivatives clearly demonstrate that $V^k(K_t,\cdot)$ is monotonically increasing. Furthermore, the second-order derivatives confirm that $V^m(K_t,\cdot)$ are concave functions. The concavity and monotonic increasing property ensures that $V^k(K_t,\cdot)$ is maximized at a corner point given by

$$
G_t^{\star k} = \overline{\tau}w_tL_t + \overline{\tau}r_tS_{t-1} + R_t - w_tM_t^I
$$

Likewise, $V^b(K_t,\cdot)$ is maximized at a unique point given by

$$
\left.\frac{\partial V^b}{\partial G_t}\right|_{G_t=G_t^{\star b}} = 0
$$

■

Appendix E Payoff function of the incumbent group

Given K_t and G_t, the government budget constraint, (17), leaves policy variables M_t^I and b_t^I undetermined. This allows us to express b_t^I as a function of M_t^I and G_t, denoted as $b_t^I = \widetilde{b}(G_t, M_t^I)$, and identify the components relevant to the payoff function. Additionally, the probability of political turnover depends on M_t^I through function $\gamma = \widetilde{\gamma}(M_t^I, M_t^A)$. In the current period, the expected payoff for a young hand-to-mouth individual in the subsequent period is given by

$$
\beta\left[(1-\gamma)\ln(b_{t+1}^I) + \gamma\ln(\sigma b_{t+1}^I)\right] = \beta\left[\ln(b_{t+1}^I) + \gamma\ln(\sigma)\right].
$$

This expression captures the welfare of future old hand-to-mouth individuals and is included in the payoff function of the incumbent group. From Eqs. (4), (5), (7a), and (7b), it is evident that $c_{t+1}^{o,b}$ depends on M_t^I through the transfer channel, b_t^I. Consequently, the welfare of current old hand-to-mouth individuals is also factored into the payoff function. Alternatively, the welfare of other types of agents is irrelevant to policy variables M_t^I and b_t^I and is thus excluded from the analysis.

Appendix F Proof of lemma 3

The relevant derivates are presented as follows:

$$\frac{\partial W^{I,o'}}{\partial M_t^I} = \beta \ln(\sigma) \frac{\partial \widetilde{\gamma}}{\partial M_t^I} > 0$$

$$\frac{\partial^2 W^{I,o'}}{\partial M_t^{I2}} = \beta \ln(\sigma) \frac{\partial^2 \widetilde{\gamma}}{\partial M_t^{I2}} < 0$$

$$\frac{\partial W^{I,o}}{\partial M_t^I} = -\frac{\beta}{\widetilde{b}(M_t^I)} \cdot \frac{2(1-\theta)w_t}{N(1-\mu_{t-1})} < 0$$

$$\frac{\partial^2 W^{I,o}}{\partial M_t^{I2}} = \frac{\beta}{\widetilde{b}(M_t^I)^2} \cdot \left\{ \frac{2(1-\theta)w_t}{N(1-\mu_{t-1})} \right\}^2 > 0$$

As a result, function $W^{I,o'}(K_t, \cdot)$ is monotonically increasing and concave, and $W^{I,o}(K_t, \cdot)$ is monotonically decreasing and concave. ■

Appendix G Proof of lemma 5

For ease of analysis, we decompose $W^(K_t, M_t)$ into

$$W^A(K_t, M_t^A) = f(K_t, M_t^A) + g(K_t, M_t^A)$$

$$f(K_t, M_t^A) := (1-\mu_t) \ln \left[\left(1 - \overline{\tau} - \frac{2\chi M_t^A}{L_t} \right) w_t \right]$$

$$g(K_t, M_t^A) := (1-\mu_t)\beta \left\{ \ln(\sigma b_{t+1}) + \widetilde{\gamma}(M_t^A; M_t^I) \ln\left(\frac{1}{\sigma}\right) \right\}$$

Let $\overline{M_t^A} = \frac{(1-\overline{\tau})L_t}{2\chi}$ represent the upper limit of M_t^A. On the domain, $(0, \overline{M_t^A})$, the relevant derivatives are as follows:

$$\frac{\partial f}{\partial M_t^A} = -(1-\mu_t) \frac{1}{1 - \overline{\tau} - \frac{2\chi M_t^A}{L_t}} \left(\frac{2\chi}{L_t} \right) < 0$$

$$\frac{\partial^2 f}{\partial M_t^{A2}} = -(1-\mu_t) \frac{1}{\left(1 - \overline{\tau} - \frac{2\chi M_t^A}{L_t} \right)^2} \left(\frac{2\chi}{L_t} \right)^2 < 0$$

$$\frac{\partial g}{\partial M_t^A} = (1-\mu_t)\beta \frac{\partial \widetilde{\gamma}}{\partial M_t^A} \ln\left(\frac{1}{\sigma}\right) > 0$$

$$\frac{\partial^2 g}{\partial M_t^{A2}} = (1-\mu_t) \frac{\partial^2 \widetilde{\gamma}}{\partial M_t^{A2}} \ln\left(\frac{1}{\sigma}\right) < 0$$

$$\lim_{M_t^A \to \overline{M_t^A}} \frac{\partial W^A}{\partial M_t^A} = -\infty$$

These results suggest the existence of $M_t^{A\star} > 0$, such that $\left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^A = M_t^{A*}} = 0$ if $\left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^A=0} > 0$.

Moreover, $M_t^{A\star} = 0$ if $\left.\frac{\partial W^A}{\partial M_t^A}\right|_{M_t^A=0} < 0 \; \forall M_t^A \; in(0, \overline{M_t^A})$. ■

Appendix H Extension with conscription

This section introduces an extended framework in which military services are provided by individuals. In this setup, the hand-to-mouth population is divided into two subgroups: workers who retain their original features, and soldiers who are conscripted by group leaders to serve in the military. The classification of workers or soldiers is determined randomly by nature after the ex ante choice between saver and hand-to-mouth types. Workers supply labor during their youth and receive benefits in their old age, with their budget constraints unchanged from the original hand-to-mouth agents. Soldiers, on the other hand, are employed by their group leaders and are paid a wage during their youth, while also receiving benefits in their old age. For the incumbent group, the budget constraints of soldiers are

$$c_t^{y,b} = (1 - \overline{\tau})w_t, \quad c_{t+1}^{o,b} = b_{t+1},$$

where soldiers are paid a wage, w_t, financed by the government. The military manpower supply is given by

$$M_t^I = \frac{N}{2}(1 - \mu_t)(1 - \phi^I).$$

Similarly, for the anti-incumbent group, the budget constraints of soldiers are

$$c_t^{y,b} = (1 - \overline{\tau})\chi w_t, \quad c_{t+1}^{o,b} = b_{t+1},$$

and their military manpower supply is

$$M_t^A = \frac{N}{2}(1 - \mu_t)(1 - \phi^A).$$

The wages for soldiers in the anti-incumbent group are financed by their group members, leading to the following balanced budget condition:

$$\chi w_t M_t^A = \frac{N}{2} w_t \tau^A \left[\mu_t \left(1 - \frac{\mu_t}{2}\right) + (1 - \mu_t)\phi^A\right].$$

In the labor market, the aggregate supply of labor, including savers and workers, is

$$L_t = N\left[\mu_t \left(1 - \frac{\mu_t}{2}\right) + (1 - \mu_t)(\phi^I + \phi^A)\right].$$

Incorporating these changes, the modifications to the key optimization problems for agent type (μ_t) and policy variables (G_t, M_t^I, M_t^A) do not alter the convexity of the respective objective functions, nor do they fundamentally change the equilibrium outcomes. Intuitively, we can argue step by step as follows:

Agent type choice

The ex ante choice of μ_t remains largely unchanged, as the expected utility for workers and soldiers differs only by wage levels in their youth, whereas benefits in old age remain identical.

Public goods

The determination of G_t continues to depend on the welfare of old agents in the incumbent group, preserving the original structure of the equilibrium.

Conflict game

The strategies for M_t^I and M_t^A remain consistent. For the incumbent group, the welfare of young agents determines the best response, as wages for workers and soldiers are the same. Similarly, the anti-incumbent group's strategy is driven by the welfare of young agents, balancing military costs against potential gains from regime change.

As such, although the introduction of conscription modifies the model's mechanics, it does not significantly affect the equilibrium characteristics or the nature of strategic interactions.

Appendix I Calibration process

This section provides more details on the calibration process, starting with the timeframe. Recall that the model period is five years, and agents are alive for 30 years. This configuration divides the population into six cohorts per period, and in every period, a conflict game unfolds between the different cohorts. Figure 12 depicts this cohort structure.

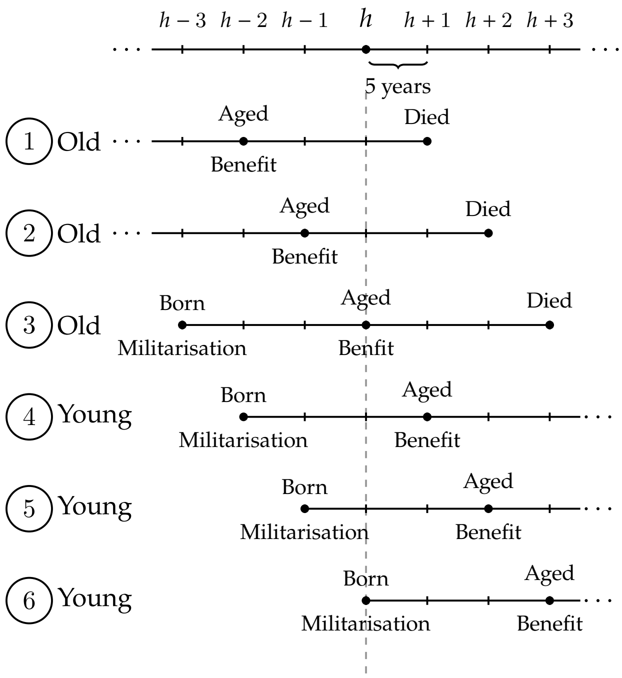


Figure 12: Cohorts at time h

Table 3: Country-common parameters

Parameter	Definition	Value	Reference/ Process
α	capital share	0.36	Cooley and Prescott (1995)
$1-(1-\delta)^{1/15}$	depreciation rate	0.048	Cooley and Prescott (1995)
$\beta^{1/15}$	discount factor	1.011	Hurd (1989)
Ψ	public investment efficiency	0.42	Dabla-Norris et al. (2012)
R	exogenous government revenue	0	set as a benchmark

Table 4: Country-specific parameters

	$\overline{\tau}$	χ	ξ	σ	A	N	ρ
Chad	0.05	0.30	70	0.08	61	1.02	0.64
South Africa	0.23	0.15	32	0.25	16	1.04	0.37
Sudan	0.07	0.28	54	0.09	49	1.03	0.60
Uganda	0.08	0.19	78	0.25	44	1.03	0.65
Malawi	0.10	0.20	49	0.23	55	1.01	0.74

Table 3 shows the common values of parameters across countries. The capital share of output, α, and depreciation rate, δ, were sourced from Cooley and Prescott (1995). The discount factor, β, was taken from an empirical study by Hurd (1989). The efficiency parameter of public infrastructure investment is based on the estimate provided by Dabla-Norris et al. (2012), which is the average value across 71 countries, including 40 low-income countries. Lastly, the parameter for exogenous revenues, $R = R_t/K_t$, is set to zero as the default value. This setup ensures a unique political equilibrium and allows for a straightforward interpretation of the results. If non-zero values are assigned to this parameter, the model could yield multiple equilibria under varying states of violence, thus introducing ambiguity and complexity into the analysis.

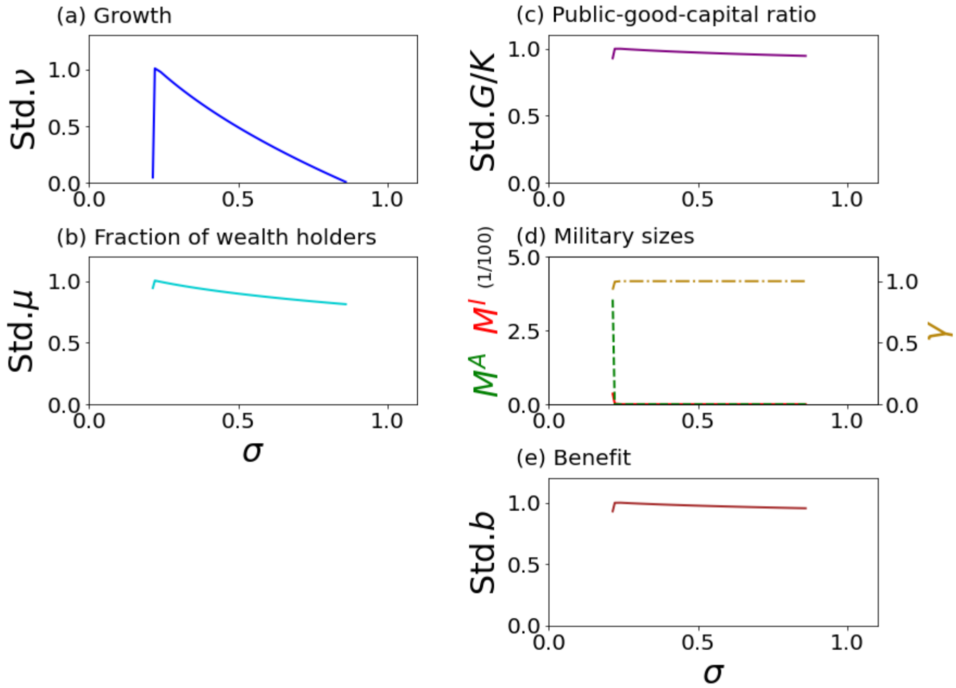
Table 4 presents the calibrated values of country-specific parameters. The income tax rate equals the average share of tax revenues in GDP for the periods extracted from *the International Centre for Taxation and Development (ICTD) Government Revenue Dataset*. The parameters for the cost of private armament, χ, and contest function, ξ, were calibrated to ensure the combination of (M^I, M^A) aligns with the equilibrium state of violence. The institutional parameter, σ, was set at 0.25 as the benchmark for South Africa, ensuring the equilibrium under the civil war regime. For the other countries, we adjusted the parameter values so that their V-Dem democracy index values were proportionally comparable to the South African benchmark. The TFP parameter, A, population size, N, and capital market access cost, ρ, were residually determined under first-order conditions.

Appendix J Additional comparative statics

This section details the results that were not presented in Section 4.

Institution

Figure 13 shows the behavior of the equilibrium solutions for Malawi when there is a marginal change in the σ parameter.

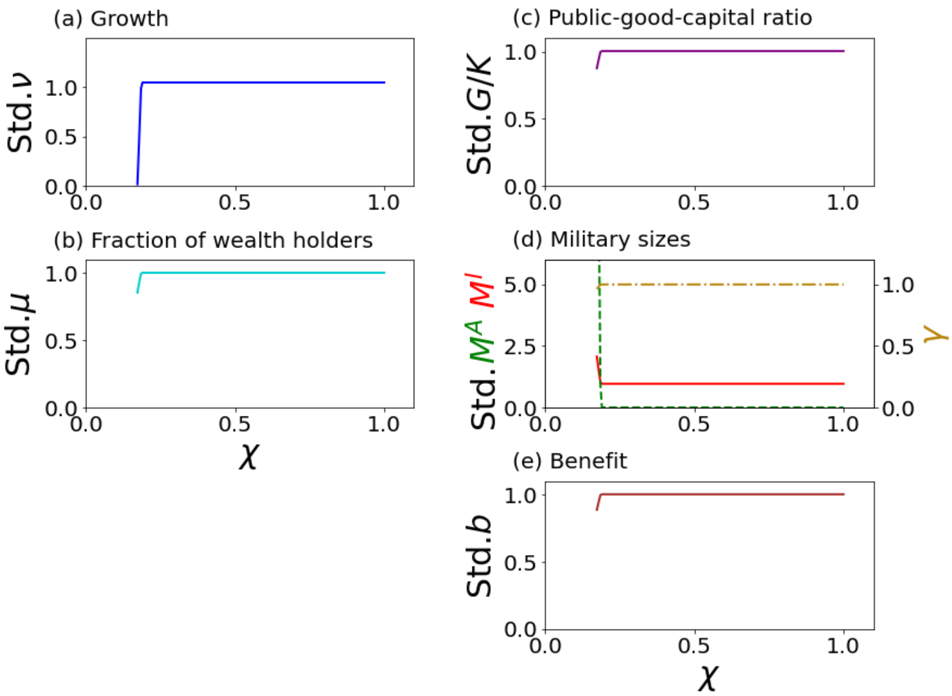


* Std. X indicates values of X normalized by the default solution.

Figure 13: Effects of σ for Malawi

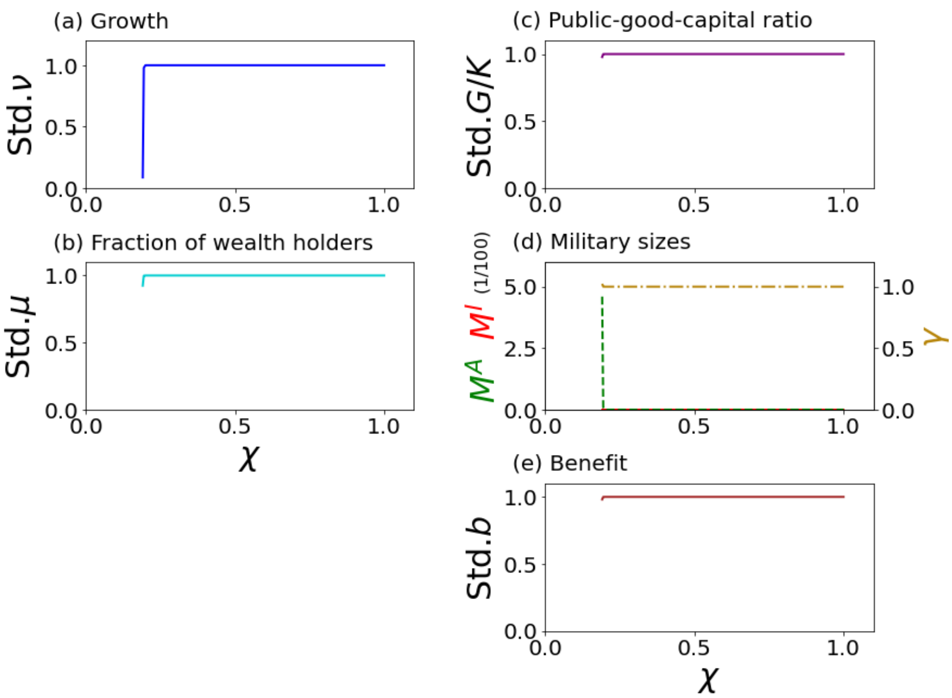
Private armament costs

A marginal decrease in the unit cost of private armament can incentivize the anti-incumbent group to arm, increasing the likelihood of political turnover with violence. Figure 14 shows the results for Uganda. It is observed that when χ is sufficiently large, the anti-incumbent group is unable to initiate armed conflict due to the high costs. When χ is very small, the anti-incumbent group is more inclined to accelerate military attacks, and the incumbent government responds by increasing its military size accordingly (see panel (d)). The escalation of political violence erodes the tax base and consequently impairs infrastructure development and benefits (see panels (c) and (e)). This also leads to a decline in the population of savers, thereby hindering growth (see panels (b) and (a)). Figure 15 shows the results for Malawi. The interpretations of the plots are the same as with Uganda, but in the Malawian case, the incumbent does not pursue militarization, as it is contradictory to maximizing the welfare of its group.



* Std. X indicates values of X normalized by the default solution.

Figure 14: Effects of χ for Uganda

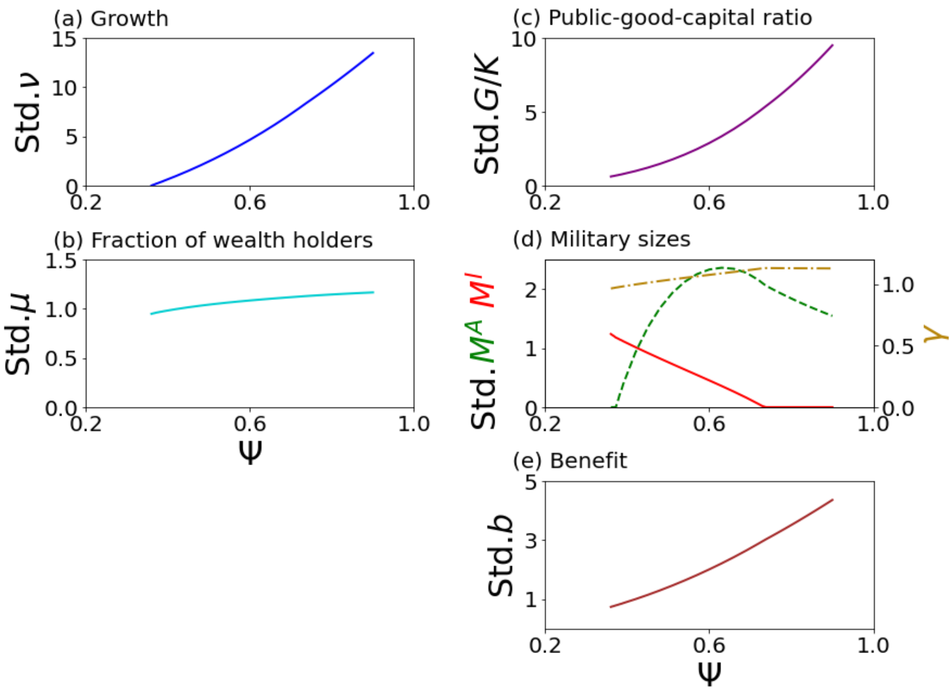


* Std. X indicates values of X normalized by the default solution.

Figure 15: Effects of χ for Malawi

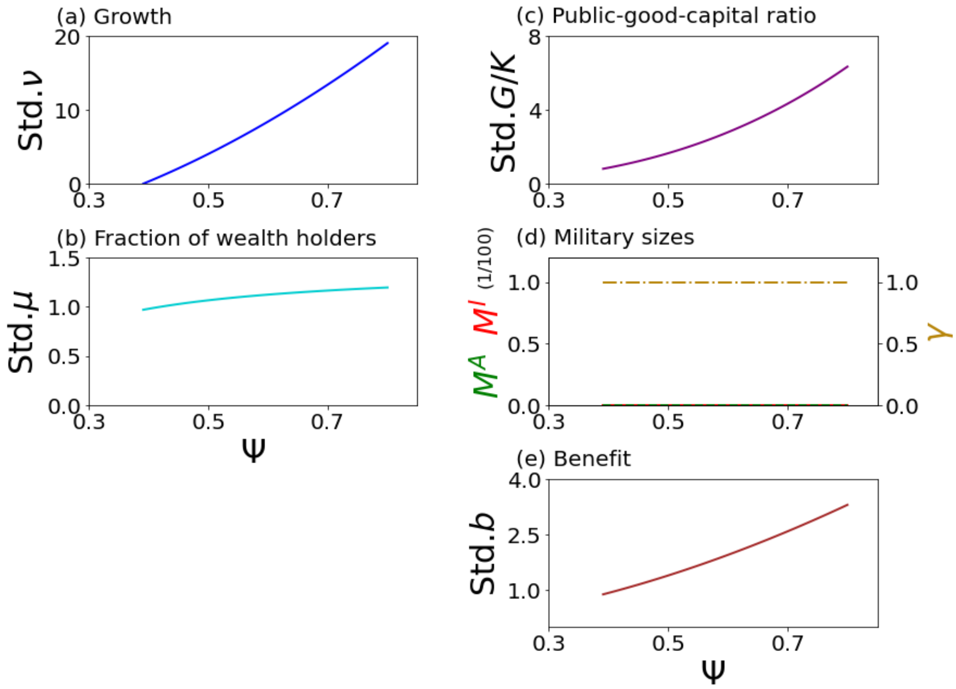
Infrastructure development efficiency

An increment in the efficiency parameter, Ψ, directly affects economic production. The effects of this change are like those observed with improved market accessibility (i.e., a marginal decrease in ρ), but the impact on achieving a state of no violence is more moderate. Figure 16 shows the results for Uganda. A marginal increase in the efficiency fosters infrastructure development (see panel (c)), which is associated with the enhancement of the tax base, and the incumbent government increases the benefits (see panel (e)). This leads to an increase in the population of savers, alongside growth (see panels (a) and (b)). In terms of violence, the incumbent reduces military expenditures, and the anti-incumbent group responds by increasing their own military expenditures. However, this response by the anti-incumbent group is limited, as the marginal benefits diminish, leading to a decrease in their military size. Figure 17 shows the results for Malawi. Our interpretations remain unchanged.



* Std. X indicates values of X normalized by the default solution.

Figure 16: Effects of Ψ for Uganda

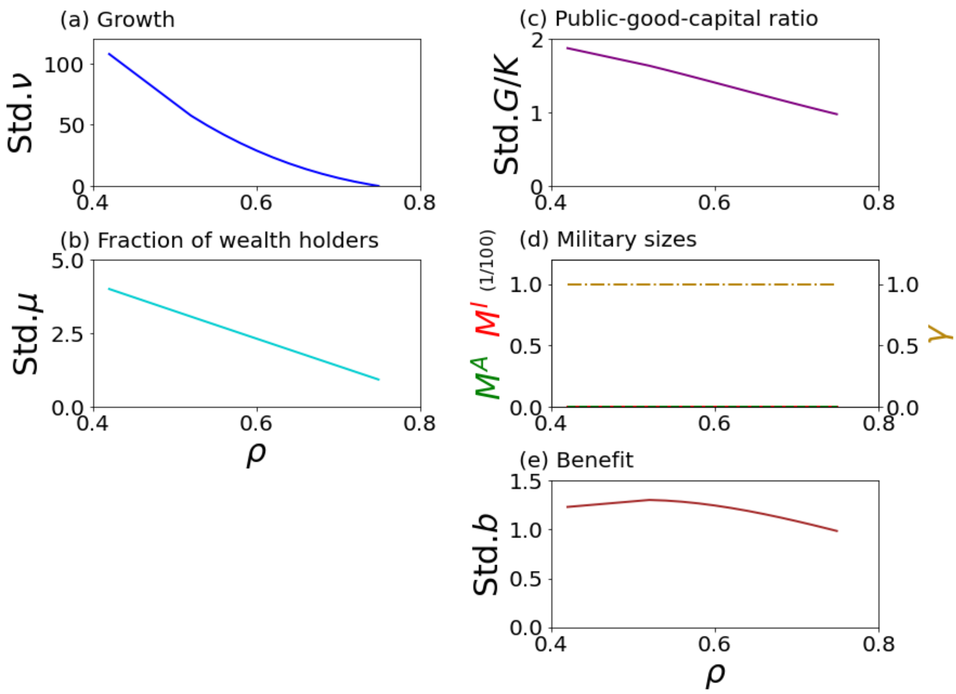


* Std. X indicates values of X normalized by the default solution.

Figure 17: Effects of Ψ for Malawi

Capital market accessibility

Figure 18 shows the behavior of the equilibrium solutions for Malawi when there is a marginal change in the ρ parameter.



* Std. X indicates values of X normalized by the default solution.

Figure 18: Market accessibility for Malawi