Democracy vs. dictatorship

Comparing the evolution of economic growth under two political regimes

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Abstract

A democratic society is often regarded as a prerequisite for economic growth and development. Yet, most empirical studies are not capable of identifying a positive link between GDP growth and democracy indexes. In addition, it is a stylized empirical fact that: (i) most developing countries are dictatorships; and (ii) many poor dictatorships have experienced high growth performances and emerged from poverty such as South Korea, China and Egypt. Against this background, it is of interest to analyse in which ways the growth performance between autocratic and democratic economies may differ, in particular among low-income countries. To answer this question, we compare the endogenous growth paths of two economies that differ only in their political regimes in the context of an overlapping generations model. The key features of the model are: (i) a positive bequest motive in the form of investments in education or productive public capital (infrastructure); (ii) a higher marginal (inter-temporal) utility of consumption today versus consumption tomorrow in low-income countries (for example, subsistence level of consumption); and (iii) a dictator that cares about her income or the income of her dynasty tomorrow. In this framework, we demonstrate that poor but large and stable dictator-
ships exhibit a higher equilibrium growth rate than comparable (equally poor) democracies. Moreover, there exists a particular threshold value in income such that the growth-reducing impact of dictatorial consumption (corruption) outweighs the higher (initial) public investments. Above this, the growth rate under democracy dominates the one in dictatorship.

**JEL classifications:** D72, D74, O12, P16.

**Keywords:** Dictatorship, democracy, political transition, economic growth.

1. **Introduction**

Does democracy spur growth? Or to put it another way: does political freedom imply economic freedom? A democratic society is in fact often regarded as a prerequisite for economic growth and development. Yet, most empirical studies are not capable of identifying a positive link between GDP growth and democracy indexes (for example, Barro, 1996; Tavares and Wacziarg, 2001). Furthermore, it is an empirically stylized fact that: (i) most developing countries are dictatorships, whereas most developed countries are democratic; and (ii) some poor dictatorships have experienced high growth performances and emerged from poverty such as Vietnam, Egypt or China and South Korea, Taiwan, Mexico, or Ecuador before their democratization (compare Table 1). Against this background, it is of interest to analyse under what conditions a democracy outperforms a dictatorship in terms of higher economic growth? Therefore, we contrast the endogenous growth paths of two economies that only differ in their political regimes in the context of an overlapping generations model.

As for the relationship between political institutions and economic growth, the empirical literature mainly relies on three institutional indices: (i) the International Country Risk guide (Knack and Keefer, 1995 or Hall and Jones, 1999); (ii) an aggregate index of survey assessments of government effectiveness from the World Bank (Kaufmann et al., 2003); and (iii) the Polity dataset collected by Jaggers and Marshall (2000). However, all of these measures are endogenous with respect to growth and development. Glaeser *et al.* (2004) document that the first two indices in particular measure political outcomes instead of constraints. That is, they are highly volatile and uncorrelated with direct measures of political constraints on government coming from either electoral rules or courts. Moreover, the authors reveal that the indicators are constructed in such a way that dictators choosing good policies also receive high evaluations. To address the problem of endogeneity, Acemoglu *et al.* (2001) exploit historical information on, for example, settler mortality in the 18th and 19th centuries to instrument for institutions. The authors detect a positive correlation between the historical instruments and the International Country Risk

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2 The indices are highly volatile and hence cannot represent permanent deep institutions.
Table 1. Average growth 10 years before and after (sustained) democratization in 24 countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of dem.</th>
<th>Average growth before</th>
<th>Average growth after</th>
<th>Average growth difference</th>
<th>Real GDP in PPP year of dem.</th>
<th>Av. increase in public spending and public services in % of GDP after dem.</th>
<th>Av. increase in public spending, transportation &amp; communication in % of GDP after dem.</th>
<th>Av. increase in public spending, social security &amp; welfare in % of GDP after dem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mali</td>
<td>1991</td>
<td>0.50 (29y)</td>
<td>2.52 (13y)</td>
<td>2.03</td>
<td>872</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Madagascar</td>
<td>1991</td>
<td>-1.02 (30y)</td>
<td>-1.59 (13y)</td>
<td>-0.58</td>
<td>937</td>
<td>-42.9</td>
<td>-15.2</td>
<td>-72.4</td>
</tr>
<tr>
<td>Nepal</td>
<td>1990</td>
<td>2.81 (8y)</td>
<td>2.67 (10y)</td>
<td>-0.14</td>
<td>1106</td>
<td>-59.1</td>
<td>-16.9</td>
<td>313.6</td>
</tr>
<tr>
<td>Benin</td>
<td>1990</td>
<td>0.60 (25y)</td>
<td>1.66 (12y)</td>
<td>1.06</td>
<td>1086</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1991</td>
<td>1.62 (15y)</td>
<td>1.52 (12y)</td>
<td>0.90</td>
<td>1606</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Honduras</td>
<td>1980</td>
<td>1.08 (28y)</td>
<td>0.06 (23y)</td>
<td>-1.03</td>
<td>2306</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bolivia</td>
<td>1982</td>
<td>1.18 (21y)</td>
<td>0.21 (18y)</td>
<td>-0.97</td>
<td>2896</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Philippines</td>
<td>1986</td>
<td>1.20 (14y)</td>
<td>1.58 (16y)</td>
<td>0.38</td>
<td>3016</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1978</td>
<td>3.64 (11y)</td>
<td>2.75 (24y)</td>
<td>-0.89</td>
<td>3562</td>
<td>-32.5</td>
<td>-13.9</td>
<td>-8.8</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>1990</td>
<td>0.60 (27y)</td>
<td>-0.87 (13y)</td>
<td>-1.47</td>
<td>3908</td>
<td>11.8</td>
<td>-12.0</td>
<td>121.6</td>
</tr>
<tr>
<td>El Salvador</td>
<td>1979</td>
<td>2.01 (27y)</td>
<td>0.46 (23y)</td>
<td>-1.56</td>
<td>4301</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Peru</td>
<td>1978</td>
<td>1.91 (9y)</td>
<td>-2.03 (12y)</td>
<td>-3.95</td>
<td>4748</td>
<td>-47.2</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Ecuador</td>
<td>1979</td>
<td>6.48 (9y)</td>
<td>-0.28 (24y)</td>
<td>-6.76</td>
<td>4901</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Paraguay</td>
<td>1989</td>
<td>2.00 (37y)</td>
<td>0.65 (13y)</td>
<td>-2.64</td>
<td>5175</td>
<td>12.7</td>
<td>-48.3</td>
<td>-22.8</td>
</tr>
<tr>
<td>Panama</td>
<td>1989</td>
<td>2.64 (20y)</td>
<td>2.36 (14y)</td>
<td>-0.27</td>
<td>5876</td>
<td>-64.4</td>
<td>-64.7</td>
<td>60.8</td>
</tr>
<tr>
<td>Romania</td>
<td>1989</td>
<td>6.21 (27y)</td>
<td>0.75 (14y)</td>
<td>-5.46</td>
<td>6060</td>
<td>275.6</td>
<td>-32.3</td>
<td>35.9</td>
</tr>
<tr>
<td>Poland</td>
<td>1989</td>
<td>2.80 (17y)</td>
<td>2.76 (14y)</td>
<td>-0.04</td>
<td>6289</td>
<td>–</td>
<td>–</td>
<td>–</td>
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</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>1989</td>
<td>0.43 (15y)</td>
<td>4.33 (14y)</td>
<td>3.90</td>
<td>6472</td>
<td>−72.9</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Brazil</td>
<td>1985</td>
<td>3.49 (24y)</td>
<td>0.59 (17y)</td>
<td>−2.90</td>
<td>6531</td>
<td>26.1</td>
<td>10.0</td>
<td>20.3</td>
</tr>
<tr>
<td>Uruguay</td>
<td>1985</td>
<td>0.97 (11y)</td>
<td>2.20 (18y)</td>
<td>1.23</td>
<td>6781</td>
<td>−43.0</td>
<td>−0.4</td>
<td>34.9</td>
</tr>
<tr>
<td>South Korea</td>
<td>1987</td>
<td>6.27 (14y)</td>
<td>5.63 (16y)</td>
<td>−0.64</td>
<td>7375</td>
<td>−21.5</td>
<td>12.2</td>
<td>64.4</td>
</tr>
<tr>
<td>Portugal</td>
<td>1974</td>
<td>5.95 (23y)</td>
<td>2.65 (29y)</td>
<td>−3.30</td>
<td>8982</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Hungary</td>
<td>1989</td>
<td>3.36 (17y)</td>
<td>1.98 (14y)</td>
<td>−1.38</td>
<td>10 304</td>
<td>−68.2</td>
<td>−40.4</td>
<td>35.1</td>
</tr>
<tr>
<td>Spain</td>
<td>1975</td>
<td>6.04 (23y)</td>
<td>2.12 (25y)</td>
<td>−3.92</td>
<td>11 614</td>
<td>9.5</td>
<td>34.5</td>
<td>49.4</td>
</tr>
</tbody>
</table>

Sources: Polity IV (2002), Heston et al. (2006) and IMF Government Financial Statistics. We obtain almost identical results if we restrict the number of years to being identical before and after democratization. The corresponding table is available from the authors upon request.
guide or current levels of GDP. Yet, their work is criticized by Engerman and Sokoloff (2003) and Glaeser et al. (2004) who show that their historical institutional instruments also strongly correlated with alternative growth determinants (schooling, for example). In sum, the relevant empirical growth literature is based on political outcomes instead of constraints. This observation is important because good political outcomes appear to be consistent with autocratic regimes in some countries. Glaeser et al. (2004, p. 286) conclude, ‘it is crucial to understand what makes a successful dictatorship’. In the following, we analyse under what circumstances dictatorships are successful and potentially outperform comparable democratic regimes in terms of economic growth.

The model we put forward is consistent with the empirical results on democracy (political constraints) and growth, because both democratic and autocratic societies create distortions. Successful economic performances stem from democracies and dictatorships that feature relatively high investments in future generations, represented by investments in education and infrastructure, relative to current consumption (redistribution). In the economy developed below, it turns out that relatively rich democracies and relatively poor but stable dictatorships choose less distortional public policies. By contrast, poor but unstable dictatorships generate the worst outcome. In this regard, we show that poor dictatorships are more likely to be stable if: (i) the economy is large; and (ii) the dictator has a higher survival probability or lower enforcement costs, due, for example, to a lower degree of ethnic diversity in the economy.

The model is based on three key ingredients. First, there exists a positive bequest motive in the form of investments in education or productive public capital (infrastructure). This assumption involves a trade-off between consumption and productive investments in future generations and is standard in theories of economic development (for example, Aghion and Bolton, 1997). Second, we suppose a higher marginal (inter-temporal) utility of current consumption versus consumption of the next generation in low-income countries (due, for example, to a subsistence level of consumption). This reasoning follows Galor and Weil (2000) and Greenwood and Jovanovic (1990), among others, and implies that the optimal inter-generational consumption decision may be constrained in poor economies. Third, we assume, in accordance with McGuire and Olson (1996) and Shen (2007) that a dictator cares about her own consumption and the income of her direct offspring. In this framework, we demonstrate that poor democracies exhibit a lower equilibrium balanced growth rate than equally poor but stable dictatorships as the median voter under-invests in productive capital. By contrast, under specific conditions which we outline below, the dictator of a poor economy invests in infrastructure capital to spur economic growth and hence the income of her offspring tomorrow.

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3 Steger (2000) analyses the performance of growth models with subsistence consumption with respect to empirically stylized facts of economic development.

4 McGuire and Olson (1996) and Shen (2007) examine the incentives of a dictator to spur economic growth.
Intuitively, the low income of the median voter in a poor democracy involves a relatively low marginal inter-generational utility which constrains productive investments in future generations. On the other hand, the higher income level (from expropriation) of a dictator, in an otherwise identical economy, implies a higher marginal inter-generational utility of the decision maker and hence enhanced public investments. If the economy is relatively poor, this effect outweighs the growth-retarding impact of corruption in dictatorship (dictator’s consumption). Thus, the dictator of a less developed country may invest in infrastructure, whereas the median voter calls for redistributive policies to achieve a higher current consumption share. This redistribution versus public investments policy trade-off in democratic regimes has been informally stressed by Barro (1996) and others.\(^5\) In addition, our model involves a particular threshold value in income such that the growth-reducing impact of dictatorial consumption (corruption) outweighs the higher (initial) infrastructure investment. Thereafter, the growth rate under democracy strictly dominates the one in dictatorship.

Barro (1996) employs cross-country growth regressions to investigate the democracy growth nexus. He reports a weakly negative effect of democracy on economic growth once the effect of rule of law, free markets, human capital and initial GDP are controlled for. Acemoglu \textit{et al.} (2005) argue that there is no causal effect of income on democracy after controlling for country fixed effects. Tavares and Wacziarg (2001) examine the importance of different potential transmission channels for the effect of democracy on growth applying panel data for 65 countries.\(^6\) The former is measured by the Freedom House indicator which is based on information on political procedures instead of political outcomes. More specifically, the authors estimate the impact of democracy on different determinants of economic growth via a system of simultaneous equations. They find that democracy fosters growth by enhancing educational attainments, whereas it hinders growth by reducing the rate of physical capital accumulation. These results are consistent with the specific trade-off highlighted by our model: the median voter (in relatively poor countries) forgoes public capital investments in favour of redistributive policies.\(^7\)

The theoretical part of the literature analyses both directions of causality between democracy and growth. Acemoglu and Robinson (2000) develop a model of political transition: economic growth initially leads to higher income inequality which in turn puts pressure on the autocratic elites to introduce democracy in order to prevent social unrest. Bourguignon and Verdier (2000) assume that education

\(^5\) Barro (1996, p. 1): ‘These (growth retarding) features (of democracy) involve the tendency to enact rich-to-poor-redistribution of income in systems of majority voting and the enhanced role of interest groups in systems with representative legislatures’.

\(^6\) The authors report an insignificant bivariate correlation between democracy and growth. Hence, they conclude that positive and negative growth effects from democracy cancel each other out in the sample.

\(^7\) Our study is also related to the literature on income inequality and economic growth, for example Barro (2000). In contrast to Barro, however, the opportunity to expropriate future income provides incentives for a dictator to invest in infrastructure.
not only affects economic growth but also political participation. Cervellati et al. (2005) consider an endogenous evolution of economic and political institutions in the form of a state of law. On the other hand, McGuire and Olson (1996) and Shen (2007) characterize initial conditions in such a way that it is optimal for an income-maximizing dictator to introduce growth-promoting policies. In particular, they establish that the initial capital stocks of the citizens must not fall below a certain threshold. To the best of our knowledge, the only additional study that compares economic performances of different political regimes within a unified endogenous growth framework is that of Acemoglu (2003). However, his study focuses on the choice of property rights by oligarchic and democratic regimes instead of a trade-off between redistribution and public investments in relatively less developed democracies.

In the succeeding section, we outline the model and develop the theoretical results. Section 3 lists some stylized empirical facts concerning the economic performance of the different political regimes. The final section outlines the conclusion.

2. The model

In the following, we outline the dynamic overlapping generations model. First, we illustrate the democratic economy, and then we introduce dictatorship. The model economy is identical for both political regimes apart from: (i) the determination of public policies consisting of a tax rule and the public provision of infrastructure capital; (ii) a survival probability for the dictator; and (iii) differences in enforcement costs between the two political regimes. We define, for convenience, that each individual runs her own firm to produce a homogeneous final good \( y_{i,t} \). A separation between entrepreneurs and households would yield identical results as long as goods and labour markets are competitive and production is deterministic. Moreover, we abstract from modelling the dynamics of a heterogeneous income distribution in order to keep the comparison between both political regimes tractable. This is less restrictive than it might at first appear. First, the dictator’s optimization problem is supposed to be independent of the distribution of income as her ‘tax base’ exclusively depends on the aggregate income level (compare Section 2.2). Second, in the case of democracy, we need to impose an additional assumption on the initial income distribution to generalize our main result; this is outlined in Remark 1.

2.1 Democracy

In each period \( t \), a generation consists of a population \( N \) of identical, risk averse individuals. We abstract from population growth in that we assume that each individual \( i \) has a single parent so that \( N \) is constant over time. Members of generation \( t \) live for two periods. In the first period of life (childhood), \( t-1 \), the individual exclusively consumes education. In the second period, she produces a single homo-
geneous final good \((y_{i,t})\), receives the pay-offs from her production, consumes, pays for the education of her child \((b_{i,t})\) and votes for public policy rules. Individual production occurs according to a constant return to scale technology:

\[
y_{i,t} = A h_{i,t}^x G_{i,t}^{1-x}
\]

(1)

where \(A\) is a constant technology parameter, \(h_{i,t}\) the individual’s human capital stock and \(G_{i,t}\) the public provision of non-excludable, non-rival infrastructure capital. The final good can be used for consumption or bequest. The bequest comprises investments in the education of the child \((b_{i,t})\) or investments in public infrastructure capital \((I_{i})\) as we assume that the latter is not productive until the following period. The stock of human and infrastructure capital follows the difference equations:

\[
h_{i,t} = h_{i,t-1} + b_{i,t-1}, \quad h_{i0} > 0
\]

(2)

\[
G_{i,t} = G_{i,t-1} + I_{i,t-1}, \quad G_{0} > 0
\]

(3)

where \(h_{i0} > 0\) implies that individuals are productive even in the absence of formal education.

The preferences of members of generation \(t\) are defined over consumption as well as the potential individual income of their children. However, we assume that a subsistence consumption constraint is binding for a sufficiently low level of income. In particular, we define the subsistence level of consumption \((\tilde{c})\) as the level that induces an individual to consume all of her (net) income instead of leaving a positive bequest for her children (for example, by investing in the education of her children). We follow Galor and Weil (2000) in modelling the subsistence consumption level. That is, we assume that the utility is strictly monotonically increasing and strictly quasi-concave for a sufficiently high-income level and satisfies the conventional boundary conditions that ensure the existence of an interior solution for the utility maximization problem. Yet, if the income level is sufficiently low, the consumption constraint is binding involving a corner solution with respect to the

---

8 We do not introduce an individual capital stock explicitly, but \(h_i\) can be thought of as a composite of private and human capital as long as capital/financial markets are complete.

9 This assumption is justified, for example, if the construction of infrastructure capital lasts for one time period. We note that our qualitative results do not hinge on the time-to-build assumption of infrastructure capital. Yet, this assumption simplifies the analysis.

10 We introduce \(h_{i0} > 0\) to rule out corner solutions of zero production.

11 This component of the utility function may represent either inter-generational altruism or implicit concern about potential support from children in old age (see Galor and Weil, 2000).

12 Alternatively, a qualitatively similar result can be derived by assuming a Stone–Geary utility function of the form \(U = \beta \ln(c_t - \tilde{c}) + (1 - \beta) \ln(y_{i,t+1})\). However, the adoption of this formulation would increase the dimensionality of our model.
consumption/bequest decision. In this case, the income level is so low that an individual is not capable of or willing to save part of her income for investments in her offspring’s education. Accordingly, she spends all of her net income on basic needs like food, shelter and clothing. These preferences are defined by the following log-linear utility function:\(^{13}\)

\[
U = \beta \ln(c_{i,t}) + (1 - \beta) \ln(y_{i,t+1}), \quad \begin{cases} 
0 < \beta < 1, & \text{if } c_{i,t} \geq \tilde{c} \\
\beta = 1, & \text{if } c_{i,t} < \tilde{c} 
\end{cases}
\] (4)

where preferences over current consumption and future income are assumed to be additively separable and exogenously weighted by \(\beta\).\(^{14}\) We show in the Appendix that the utility function in eqn (4) can be derived directly from the utility function of Galor and Moav (2006) who assume the following preferences: \(U = \beta \ln(c_{i,t}) + (1 - \beta) \ln(y_{i,t} + \theta)\), where \(\theta\) denotes the subsistence consumption level. Furthermore, the individual budget constraint is given by

\[
b_{i,t} = (1 - \tau_t)y_{i,t} - c_{i,t}
\] (5)

where \(\tau_t\) is a tax rate.

The tax rate and the public investment in infrastructure are determined by the government.\(^{15}\) Note that a redistributive policy, in the form of contemporaneous income transfers between individuals is redundant as we assume that income is equally distributed across individuals.\(^{16}\) Consequently, redistribution at the cost of public infrastructure investment is equivalent to a lower tax rate. That is, we reduce the three-dimensional trade-off between higher taxes, redistributive policies and infrastructure investments to a two-dimensional trade-off between taxes and

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\(^{13}\) This assumption is commonly used in the development literature in order to model a higher marginal utility from contemporaneous versus future consumption for low levels of income which is typically found in the data. In addition to Galor and Weil (2000), who apply an analogous definition of the subsistence consumption level, we show in the Appendix that our utility function can also be derived from that of Galor and Moav (2006).

\(^{14}\) The dependence on the income of the next generation instead of consumption means that parents care about the income of their children, but not the way it is spent (for example, split between consumption and bequest to the second next generation). We note that \(U = \beta \ln(c_{i,t}) + (1 - \beta) \ln(c_{i,t+1})\) would yield analogous results.

\(^{15}\) Infrastructure capital cannot be provided privately in this setting due to a free-rider problem stemming from the non-excludability of \(G\).

\(^{16}\) However, such effects are potentially important as redistributive policies in the democratic regime influence the income of the majority voter. We discuss the robustness of our results with respect to an endogenous income distribution in Remark 1. Yet, we already note that an average equilibrium income level below the subsistence consumption level is sufficient to ensure a poverty trap in democracy even in the case of a right-skewed endogenous income distribution as the equilibrium income of the median voter can at most be equal to the average individual income level.
infrastructure provision. The assumption of a homogenous income distribution simplifies the aggregation problem of individual production to

\[ Y_t = \int_0^N y_{it} \, di = N y_{it}. \]

Hence, the government budget constraint amounts to

\[ I_t = \tau_t Y_t = \tau_t N y_{it}. \]  \hspace{1cm} (6)

In a democratic society, \( \tau \) is determined by majority voting which characterizes the democratic regime.

The maximization problem for an individual in the case of democracy is given as follows:

\[ \max_{c_{it}, \tau_t} U_i, \quad \text{s.t. (1), (2), (3), (5), (6)} \]

whereby the interior solutions for the first-order conditions amount to:

\[ \frac{\partial U_i}{\partial c_{it}} = \frac{\beta}{c_{it}} \left( 1 - \beta \right) \frac{y_{it+1}}{y_{it+1}} \frac{h_{it+1}}{h_{it+1}} \]  \hspace{1cm} (7)

\[ \frac{\partial U_i}{\partial \tau_t} = 0 = \frac{(1 - \beta)}{y_{it+1}} \left( \frac{y_{it+1}}{h_{it+1}} (-y_{it}) + \frac{(1 - x) y_{it+1}}{G_{t+1}} N y_{it} \right). \]  \hspace{1cm} (8)

We solve eqn (7) for the optimal (unconstrained) level of consumption, which is a positive function of net income:

\[ c^*_i = \frac{\beta [h_i + (1 - \tau_i) y_i]}{\beta + (1 - \beta) x}. \]  \hspace{1cm} (9)

The individual budget constraint, the utility function (4) and the solution for \( c^*_i \) define the optimal rule for investments in education of the next generation:

\[ b_{it} = \begin{cases} 0, & \text{if } (1 - \tau_i) y_{it} \leq \hat{c}, \\ (1 - \tau_i) y_{it} - \hat{c}, & \text{if } c^*_i < \hat{c} < (1 - \tau_i) y_{it}, \\ \frac{x(1 - \beta)(1 - \tau_i) y_{it} - \beta h_i}{x + \beta - 2x}, & \text{if } c^*_i \geq \hat{c}. \end{cases} \]  \hspace{1cm} (10)

It follows from the non-linearity in eqn (4) that we have to distinguish three different cases for an individual’s bequest decision depending on her net income. First, she consumes all of her net income if it is below the subsistence level. In the second case, net income exceeds the subsistence consumption level, but the optimal unconstrained consumption level given in eqn (9) falls below it. In this case, an individual
invests a constraint-optimal, but positive part of her net income in the education of her offspring. Third, each individual invests the optimal amount of her net income in the education of her offspring if the optimal consumption level exceeds the subsistence consumption level. The optimal taxation rule can be computed from eqn (8). As all individuals are the same the individual tax decision complies with that of the median voter:

\[
\tau_t^* = \frac{[(1 - z)/z]N(h_{it} + b_{it}) - G_t}{Ny_{it}}.
\] (11)

The optimal tax rate is a positive function of the investment in human capital \((b_{it})\) which is in turn determined by the three different investment rules defined in eqn (10). Thus, we have to distinguish between three different cases depending on the individual contemporaneous income level. In the following, we derive the threshold levels of income which determine the corresponding investments in human and infrastructure capital.

**Case 1:** \(y_{it} \leq \tilde{c}\):

In the first case, where \((1 - \tau_t)y_{it} \leq \tilde{c}\), the individual consumes all of her net income so that \(b_{it} = 0\). Hence, the aggregate human capital stock remains constant. Moreover, we infer from eqn (4) that the median voter chooses zero infrastructure investments \((\tau_t = 0)\) so that the above condition simplifies to \(y_{it} \leq \tilde{c}\). In this case, the predetermined levels of infrastructure and aggregate human capital are equal to their initial values: \(G_t = G_0\) and \(N_{hit} = N_{hi0}\). Intuitively, the individual income level is so low that utility is maximized by spending all of the income on subsistence consumption needs; this implies zero investment (bequest) in future generations. It follows that the democratic society suffers from the absence of long-run economic growth. The urgent consumption needs today prevent individuals from growth-promoting investments in future generations.

**Proposition 1.** Given the preferences and production specifications defined in eqns (1)–(5), it follows that a democratic economy, characterized by majority voting, is kept in a long-run zero-growth trap if the initial income of the median voter falls below the subsistence consumption level \(y_{i0} \leq \tilde{c}\).

Proof: The proof follows directly from eqns (1), (4), (10) and (11) as \(b_{it} = 0\) and \(\tau_t = 0\) if \(y_{it} \leq \tilde{c}\).

We demonstrate in the Appendix that the implementation of the alternative individual preferences defined in Galor and Moav (2006) lead to equivalent results in our model. In particular, Galor and Moav (2006) assume the analogous preferences: 

\[ U = \beta \ln(c_{it}) + (1 - \beta) \ln(y_{it} + \theta), \]

where \(\theta\) denotes the subsistence consumption level. Their preference specification yields an explicit threshold for the subsistent income level; however, the adoption increases the dimensionality of the model. As
we are not interested in the explicit value of subsistent income as a function of \( \theta \), we do not implement these alternative preferences.

Moreover, note that the specifications in eqns (1)–(5) involve the existence of an individual bequest motive and an exogenous income distribution. However, the latter assumption is less restrictive than one might guess as redistributive policies in the case of a heterogeneous symmetric or left-skewed income distribution would not alter the median voter’s equilibrium income level (the average individual income is below the median).\(^{17}\) Moreover, the above condition can be extended to ensure the existence of a democratic poverty trap in the case of a right-skewed distribution. That is, one needs to assume that the average equilibrium income level of an individual is below the subsistence consumption level as the income level of the median voter can at most amount to the average individual income after redistribution.

**Remark 1:** Additionally, to generalize Proposition 1 to the case of an endogenous (heterogeneous) income distribution we need to assume that the initial average equilibrium income level is below the subsistence consumption level \( \bar{y}_{0} \leq \bar{c} \). To understand this condition, note that some individuals, whose income levels are above the subsistence consumption level, invest in education in this case. This raises aggregate human capital and income in the next period. Yet, diminishing returns in individual human capital investment eventually lead to constant aggregate human capital and income levels in equilibrium. The income distribution that corresponds to the equilibrium income level is constant if it is symmetric or left skewed. If it is right skewed, the median voter votes for redistributive policies to augment her income. However, the income level of the median voter after redistribution can never exceed the average income level. Thus, in the case of an endogenous (right-skewed) income distribution, it is sufficient to assume that the initial average equilibrium income level is below the subsistence consumption level in order to ensure the existence of a democratic poverty trap analogous to Proposition 1.

**Case 2:** \( y_{it} > \bar{c} > c_{it} \)

This case includes two sub-cases. First, it is optimal for an individual to choose \( c_{it} = \bar{c} \), that is \( b_{it} = (1 - \tau_{i})y_{it} - \bar{c} > 0 \), if \( c_{it} < \bar{c} < (1 - \tau_{i})y_{it} \). Second, the individual chooses \( c_{it} = (1 - \tau_{i})y_{it} \), that is \( b_{it} = 0 \) if \( (1 - \tau_{i})y_{it} \leq \bar{c} \). The distinction of cases depends on the ratio of the initial infrastructure capital stock to the aggregate human capital stock.

\(^{17}\) The equilibrium income level refers to the level that is installed after the aggregate human capital stock adjusted to its equilibrium level relative to the infrastructure capital stock. That is, some individuals with \( y_{0} > \bar{c} \) would initially invest in education. Yet, an income of the median voter below the subsistence consumption level ensures the absence of infrastructure investments which would eventually prevent further individual human capital investments.
If the predetermined aggregate human capital stock is abundant relative to the infrastructure capital stock, the median voter chooses a positive tax rate even if educational investment is zero. From eqn (11) it follows that:
\[
\tau_t(b_{it} = 0) = \frac{((1 - \alpha)/\alpha)Nh_{it} - G_t}{Ny_{it}} > 0 \iff G_t < \frac{1 - \alpha}{\alpha} Nh_{it}.
\] (12)

This initial increase in infrastructure capital causes a temporary rise in individual income. If the new equilibrium income level does not exceed the above condition, both stocks are balanced: \(G_t = [(1 - \alpha)/\alpha]Nh_{it}\). Not surprisingly, the optimal ratio of the two input factors depends on the shares of both input factors in the individual production functions.

On the other hand, if the initial capital stocks satisfy \(G_t > [(1 - \alpha)/\alpha]Nh_{it}\), the optimal tax rate equals zero. In this intermediate case, there are no contemporaneous infrastructure investments. Still, individual income grows over time as investment in human capital is positive. In this sub-case, \(b_{it}\) declines over time because \(\tau_t = 0\) due to diminishing returns, but it always remains positive as by definition \(b_{it}\) is strictly positive if \(y_{it} \geq \check{c} > c^*_it\) holds. That is, the economy will eventually satisfy condition \(G_t = [(1 - \alpha)/\alpha]Nh_{it}\). Thus, we infer from both subcases that the increase in human capital (or infrastructure) will cause condition \(G_t = [(1 - \alpha)/\alpha]Nh_{it}\) to be satisfied over time so that eventually the growth rate increases until it reaches the unconstrained growth path defined below (Case 3).

Consequently, there exists no balanced growth equilibrium as long as \(y_{it} \geq \check{c} > c^*_it\) (Case 2). Economic growth is restricted initially but always converges to the unconstrained growth path in this intermediate case. The economy may still experience different growth performances during this transitional phase: (i) the growth rate declines over time if the ratio of the initial human capital stock relative to the infrastructure stock is relatively unbalanced (for example, if condition (12) holds), (ii) it accelerates otherwise as the restriction on future investments \((b_{it}, \tau_t)\) alleviates as \(y_{it}\) is growing while \(\check{c}\) is constant. In other words, democracies that feature an initial intermediate aggregate income level, such that the individual consumption of the median voter is above the subsistence level but below the unconstrained, experience a relatively low but strictly positive GDP growth rate in the beginning. The growth rate may initially decrease or increase, but will eventually accelerate at some point in the future until it reaches the long-run unconstrained balanced growth path.

**Case 3: \(c^*_it > \check{c}\)**

If the optimal consumption level is above the subsistence level \((c^*_it > \check{c})\), the optimal tax and bequest decisions amount to:
Investments in infrastructure and aggregate human capital are balanced if
\[ G_t = \left( \frac{1}{\alpha} \right) N \left( h_{it} + y_{it} \right) - (\alpha + \beta - \alpha \beta) G_t. \]

Henceforth, we define
\[ Z_{\text{dem}} = \frac{G_t}{h_{it}} = \frac{1 - \alpha}{\alpha} N. \]

If the predetermined input levels are unbalanced more resources are invested in
the scarce input factor until the endowments of both levels are balanced. Thus, in
the long-run the economy sustains positive endogenous balanced GDP growth and
the ratio of infrastructure to individual human capital is characterized by \( Z_{\text{dem}} \). In
particular, the balanced growth rate amounts to:
\[
g_{\text{dem}} = \frac{N y_{it+1}}{N y_{it}} - 1 = \phi \left( A + \frac{(Z_{\text{dem}})^{\alpha}}{N} + (Z_{\text{dem}})^{\alpha - 1} \right) - 1
= (1 - \alpha)(1 - \beta) \left( \frac{\alpha}{1 - \alpha} \right)^{\alpha} \left[ AN^{(1-\alpha)} + \frac{1}{1 - \alpha} \left( \frac{1 - \alpha}{\alpha} \right)^{\alpha} \right] - 1 \equiv \hat{g}_{\text{dem}} > 0 \quad (15)
\]

where
\[
\phi = [\alpha(1 - \beta)]^\alpha [N(1 - \alpha)(1 - \beta)]^{(1-\alpha)}
\]

and
\[ Z_{\text{dem}}^* = \frac{G_t}{h_{it}} = \frac{1 - \alpha}{\alpha} N. \]

### 2.2 Dictatorship

In the case of dictatorship one of the otherwise identical individuals determines
the expropriation (tax) rate and the public provision of infrastructure capital.
Hence, this agent whom we refer to as the dictator acts according to the same
preferences as the other individuals.\(^{18}\) She maximizes her utility function which
depends on her current consumption and the income of the next generation, her
direct offspring. There are two key differences with respect to other households in

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\(^{18}\) The variables referring to the dictator are marked with the subscript ‘r’.
that she: (i) is potentially richer due to the opportunity to expropriate private income and (ii) could have no offspring because of a revolution. The introduction of such a dictator potentially curtails the utility of all other individuals. In particular, a necessary condition for a reduction in the contemporaneous welfare of individuals due to dictatorship in our framework is a higher tax (expropriation) rate relative to democracy. This condition is satisfied if the subsistent consumption constraint is binding: the tax rate is set to zero in democracy, whereas it is always strictly positive in dictatorship. Nevertheless, economic growth can be positive in dictatorship as opposed to democracy if the ruler invests a positive fraction of the expropriated income in the economy to increase the income (expropriation base) of her offspring. In the following, we derive the necessary condition for this scenario to come true.19

The dictator simultaneously determines the tax rate, her consumption level and her bequest in the form of investments in infrastructure in order to maximize her utility function:

\[
\max_{c_t, \tau_t} U' = \beta \ln(c_t^\tau) + (1 - \beta) \psi \ln(y_{t+1}), \quad \begin{cases} 0 < \beta < 1, & \text{if } c_t^\tau \geq \check{c}, \\ \beta = 1, & \text{if } c_t^\tau < \check{c}, \end{cases}
\] (16)

where \( \psi \) is the probability of survival of dictatorship, subject to eqns (1), (2), (3) and (5), the budget constraint of the dictator

\[ y_t^\prime = \psi \tau_t N y_{it} = c_t^\tau + b_t^\tau \] (17)

and the citizen’s utility function \((U_i)\):

\[ U_i = \beta \ln c_{it} + (1 - \beta) \ln[(1 - \tau_{it+1}) y_{it+1}], \quad \begin{cases} 0 < \beta < 1, & \text{if } c_{it} \geq \check{c}, \\ \beta = 1, & \text{if } c_{it} < \check{c}. \end{cases} \] (18)

The parameter \( 0 < \check{\vartheta} < 1 \) in the dictator’s budget constraint represents the enforcement costs of expropriation in dictatorship. We suppose that dictators have to spend greater resources than democratic authorities to enforce their tax revenues \( (\check{\vartheta} < 1) \); this reduces the fraction of enforceable revenues. Moreover, the citizen’s utility function is amended to account for the fact that part of the individual future income is expropriated by the future dictator and hence partly lost to dictatorial consumption (corruption). The corresponding first-order conditions amount to:

19 We emphasize that our model is not appropriate for a comparative welfare analysis between dictatorship and democracy as we do not account for, for example, the utility from unrestricted property rights or political freedom. Instead, we exclusively focus on the comparison of the evolution of economic growth under both political regimes.
\[
\frac{\partial U^r}{\partial c_t} = 0: \quad \beta_t = \frac{(1 - \alpha)(1 - \beta)\psi}{G_{t+1}} \\
\frac{\partial U^r}{\partial \tau_t} = \frac{(1 - \beta)\psi}{y_{t+1}^r} \vartheta_{\tau_{t+1}}N \left[ z y_{it+1} \frac{\partial b_{it}}{\partial \tau_t} + \frac{(1 - \alpha)y_{it+1}}{G_{t+1}} \vartheta N y_{it} \right].
\]

Condition (19) determines the optimal level of infrastructure investments by the dictator:

\[
b_t^* = \frac{(1 - \alpha)(1 - \beta)\psi y_t^r - \beta G_t}{(1 - \alpha)(1 - \beta)\psi + \beta}.
\]

Note that \(b_t^*\) is independent of \(b_{it}\) as the dictator does not care about contemporaneous consumption decisions of her citizens.\(^{20}\) In fact, the dictator always invests in infrastructure (\(b_t^* > 0\)) if:

\[
y_{it} > \frac{\beta G_t}{(1 - \alpha)(1 - \beta)\psi \vartheta \tau_t N} \equiv \bar{y}_{\text{good}}.
\]

This condition defines ‘when the dictator will be good’. In this case it is optimal for the (inter-temporal) income-maximizing dictator to invest in infrastructure if the individual income of citizens exceeds this threshold value. We can infer from eqn (22) that the probability of growth-promoting infrastructure investments by the dictator increases in the size of the population, whereas it decreases in the predetermined (initial) level of the infrastructure capital stock. Moreover, the probability of a ‘good dictator’ is increasing in \(\psi\) and \(\vartheta\). Thus, a decline in the survival probability of the dictator raises her incentives for corruption. This result is consistent with the analogous findings of McGuire and Olson (1996) or Shen (2007). In particular, dictators become ‘roving bandits’ if \(\psi \to 0\). Similarly, higher enforcement costs (a decline in \(\vartheta\)) lead to higher corruption and hence lower infrastructure investments in dictatorship.

Following, Easterley and Levine (1997), we expect that \(\psi\) and \(\vartheta\) are decreasing in the degree of a country’s ethnic diversity. That is, the higher a country’s degree of ethnic diversity, the lower is a dictator’s probability of survival and the higher is her enforcement cost due to a more intense contest for political power among different ethnic groups.

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\(^{20}\) Yet, the investment decision of the dictator is a positive function of the predetermined aggregate stock of human capital and hence of past individual investment decisions.
Condition (20) demonstrates that the change in the marginal utility of the dictator due to marginal changes in the expropriation rate \( (\partial U_r^\prime/\partial \tau_t) \) depends on the optimal bequest behaviour of the citizens \( (\partial b_{it}/\partial \tau_t) \). \( \partial b_{it}/\partial \tau_t \) depends, in turn, on the stage of development of the economy (compare eqn 10). Hence, we need to consider the three different cases defined in eqn (10) in order to compute \( \partial U_r^\prime/\partial \tau_t \). 

**Case 1:** \( y_{it} \leq \bar{c} \)

In the first case we know from eqn (10) that \( b_{it} = 0 \). It follows that \( \partial b_{it}/\partial \tau_t = 0 \) and hence \( \partial U_r^\prime/\partial \tau_t > 0 \). Thus, the marginal utility of the dictator is strictly increasing in the expropriation rate. An interior solution for \( \tau \) does not exist in this case. It follows that the dictator expropriates the highest possible value. However, we suppose that the dictator cannot expropriate all of the individuals’ income \( (\tau < 1) \) due to the existence of backyard production (black market) which cannot be taxed.\(^{21}\) It follows that the optimal expropriation rate is equal to: \( 0 < \tau_t = \bar{\tau} < 1 \).

We assume that the dictator can expropriate the income of her citizens even if their consumption is below the subsistence level. In this regard, it is important to keep the definition of the subsistence consumption level in mind: if \( c_{it} < \bar{c} \) an individual spends all of her net income on basic needs like food, shelter and clothing, whereas investment in her children’s education is neglected.

Consequently, the dictator always invests in infrastructure even if the economy is ‘relatively poor’ as long as condition (22), which determines the existence of a ‘good dictator’ is satisfied. A comparison of the two individual income levels which define subsistent consumption \( (y_{it} \leq \bar{c}) \) and the existence of a good dictator \( (y_{it} \geq \bar{y}^{\text{good}}) \) reveals the characteristics of an economy in which both income levels overlap. In particular, the threshold level in individual income that ensures positive economic growth in dictatorship is strictly lower than the corresponding threshold level in democracy if \( N \) and/or \( \psi \) is large:

\[
\bar{y}^{\text{good}} < \bar{c} \Rightarrow N > \frac{\beta G_t}{(1 - \alpha)(1 - \beta)\psi \bar{c} \bar{\tau}c} \quad \text{or} \quad \psi > \frac{\beta G_t}{(1 - \alpha)(1 - \beta)N \bar{c} \bar{\tau}c}
\]

\[
\Rightarrow 1 > \bar{\tau} > \frac{\beta G_t}{(1 - \alpha)(1 - \beta)\psi \bar{c} Nc} > 0. \tag{23}
\]

Thus, a poor democracy that is kept in a zero-growth trap (Case 1) would sustain positive endogenous growth in dictatorship if: (i) the size of the population \( N \) is large relative to the predetermined (initial) infrastructure capital stock, and/or (ii) the dictatorial regime is relatively stable (implied by a greater \( \psi \)). The introduction of a dictator would lead to positive growth in this case. The economy overcomes

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\(^{21}\) Compare Acemoglu and Robinson (2000).
the zero-growth trap, even though the utility of individuals initially declines. Note, however, that the dictator becomes a ‘roving bandit’ if condition (23) is violated either because her survival probability would be too low or the size of the population too small.

Hence, we obtain a range of individual income levels which are below the subsistence level such that the democracy features zero growth in the long run, whereas a ‘good dictatorship’, defined in eqn (22), exhibits positive economic growth. Moreover, we know from the conditions \( G_t > [(1 - \tau)/2]NH_t \) and \( \tau_t = \bar{\tau} < 1 \) that individuals in the autocratic regime invest in human capital of the next generation \( b_{it} > 0 \) \( (y_{it} > \bar{c}) \) before diminishing returns in infrastructure capital constrain further investments. This result is summarized in Proposition 2.

**Proposition 2.** Given the preferences and production specifications defined in eqns (1)–(5) and (16)–(18), it follows that the long-run equilibrium growth rate of a relatively poor dictatorship \( (\bar{y}_{it}^{good} < y_{it} < \bar{c}) \) exceeds that of an equally poor democracy if the condition for a ‘good dictatorship’ \( (y_{it} > \bar{y}_{it}^{good}) \), which is defined in eqn (22) is satisfied. That is, the threshold level in individual income that ensures positive long-run economic growth in dictatorship is strictly lower than the corresponding threshold level in democracy \( (\bar{y}_{it}^{good} < y_{it} < \bar{c}) \) if, according to eqn (23), the size of the population is relatively large and/or the dictatorial regime is relatively stable.

It follows that a country can experience strictly positive economic growth in dictatorship, even though it would be locked in a zero-growth trap in democracy. Intuitively, the result follows from two features of the model: (i) the dictator obtains a positive utility from the income of her offspring; and (ii) her income is always above the subsistence level. Hence, she might always invest in the economy (infrastructure) if it is large enough and stable enough in order to expropriate more (aggregate) income in the next period. The positive infrastructure investments generate transitional growth and hence a higher marginal utility from individual human capital investments. This finally generates private investments in human capital \( (b_{it} > 0) \) and hence positive endogenous growth. The result is consistent with the relatively good past performance of some poor autocratic economies (compare Section 3).

Thus, a relatively poor dictatorship, which satisfies condition (22), initially experiences slow but stable economic growth until individual net income exceeds the subsistence consumption level \( \bar{c} \) (Cases 2 and 3).

**Case 2:** \( y_{it} \geq \bar{c} > c_{it}^{*} \)

Again, we have to distinguish two sub-cases. First, the individual chooses \( c_{it} = (1 - \tau_t)y_{it} \) and \( b_{it} = 0 \) if \( (1 - \tau_t)y_{it} \leq \bar{c} \). In this case, the dictator imposes \( \tau_t = \bar{\tau} \) as her marginal utility from a marginal tax increase is strictly positive \( (\partial U' / \partial \tau_t > 0) \). This implies a positive growth rate due to public infrastructure investments. The temporary rise in individual incomes eventually leads to the second sub-case:
\(c_t^i < \bar{c} < (1 - \tau_t) y_t^i\) which involves \(c_t^i = \bar{c}\) and \(b_t^i = (1 - \tau_t) y_t^i - \bar{c} > 0\). In this case, it follows from condition (10) that:

\[
\frac{\partial U^{*}}{\partial \eta_t} = \begin{cases} 
0, & \text{if } \frac{G_{t+1}}{y_{t+1}} < \frac{1}{s}N \Rightarrow Z_{\text{dic}} < Z_{\text{dem}} \eta, \\
>0, & \text{if } \frac{G_{t+1}}{y_{t+1}} = \frac{1}{s}N \Rightarrow Z_{\text{dic}} = Z_{\text{dem}} \eta, \\
<0, & \text{if } \frac{G_{t+1}}{y_{t+1}} > \frac{1}{s}N \Rightarrow Z_{\text{dic}} > Z_{\text{dem}} \eta, 
\end{cases}
\]

(24)

and

\[
\tau = \begin{cases} 
\tau^*, & \text{if } Z_{\text{dic}} < Z_{\text{dem}} \eta, \\
(\bar{\tau}, \bar{\tau}), & \text{if } Z_{\text{dic}} = Z_{\text{dem}} \eta, \\
\bar{\tau}, & \text{if } Z_{\text{dic}} > Z_{\text{dem}} \eta,
\end{cases}
\]

(25)

where \(\tau\) is the lowest possible expropriation rate which is defined by the subsistence consumption level of the dictator ensuring that \(\eta \tau N y_t^i \geq \bar{c}\). We assume that the size of the population (\(N\)) is relatively large such that the latter condition holds for \(\tau\) close to zero. In this case, it follows from eqn (25) and the above threshold level of initial income (\(y_t^i \geq \bar{c}\)) that the individual net income \([(1 - \tau) y_t^i]\) never falls below the subsistence consumption level \(\bar{c}\). Intuitively, it is never optimal for the dictator to erode initial individual investments in human capital. By contrast, the dictator optimally reduces the expropriation rate to a minimum to stimulate private investment (in human capital) as the latter is a scarce production input.\(^{22}\)

If we combine the results of the first two cases, we know that a dictatorship, which is initially poor (\(y_t^i \leq \bar{c}\)) grows at a slow and decreasing rate due to positive infrastructure investments until the threshold value for private investments is finally exceeded (\(c_t^i > \bar{c}\)). At this stage the dictatorship is characterized by a relatively high level of infrastructure capital compared with human capital (\(Z_{\text{dic}} > Z_{\text{dem}} \eta\)) if the ratio was initially relatively balanced. It follows that the dictator reduces the expropriation rate as soon as the private investment threshold is exceeded to promote scarce and productive private investments instead of relatively unproductive and abundant public infrastructure investments. As a consequence, the growth rate temporarily accelerates in dictatorship as soon as \(c_t^i > \bar{c}\).

The model predictions of high infrastructure investments and unbalanced growth in poor but stable dictatorial regimes are consistent with the development paths of several (former) autocratic countries (China, Vietnam, South Korea, Singapore and others; see Section 3). Autocratic authorities in these countries invested in

\(^{22}\) The Chinese economic reforms in the 1980s and 1990s comply with this specific prediction of our model. That is, the ratio of the Chinese government’s financial income relative to GDP decreased tremendously in the 1980s and 1990s: from 31 percent in 1978 to 10 percent in 1995 according to China Statistical Yearbook 2007.
large scale infrastructure projects, even though the major part of their populations experienced minimal consumption levels.

**Case 3: \( c^*_d > \hat{c} \)**

We infer from condition (10) that

\[
\frac{\partial b_{it}}{\partial \tau_t} = -\frac{\alpha(1 - \beta)}{\alpha(1 - \beta) + \beta y_{it}}
\]

so that:

\[
\begin{align*}
\frac{\partial U'}{\partial \tau_t} > 0, & \quad \text{if } Z_{dic} < \hat{Z}_{dic}, \\
= 0, & \quad \text{if } Z_{dic} = \hat{Z}_{dic}, \\
< 0, & \quad \text{if } Z_{dic} > \hat{Z}_{dic} > Z_{dem},
\end{align*}
\]

(26)

where

\[
Z_{dic} = \frac{G_{t+1}}{h_{t+1}}, \quad \hat{Z}_{dic} = \frac{(1 - \alpha)N \alpha(1 - \beta) + \beta}{\alpha(1 - \beta)} > Z_{dem}
\]

and

\[
\tau = \begin{cases} 
\bar{\xi}, & \text{if } Z_{dic} < \hat{Z}_{dic} \\
(\bar{\xi}, \bar{\tau}), & \text{if } Z_{dic} = \hat{Z}_{dic} \\
\bar{\xi}, & \text{if } Z_{dic} > \hat{Z}_{dic}.
\end{cases}
\]

(27)

We are now capable of defining the long-run expropriation rate (\( \bar{\tau} \)) as the rate that involves the optimal unique ratio \( \hat{Z}_{dic} \) which maximizes the dictator’s utility function (\( U' \)) for a given amount of private investments. This rate is uniquely defined as the decisions of the dictator over \( \tau \) (and implicitly \( b' \)) determine a unique infrastructure capital stock in the next period and hence the optimal unique ratio \( \hat{Z}_{dic} \) in the long run. In particular, if \( Z_{dic} < \hat{Z}_{dic} \) the dictator chooses the highest possible expropriation rate (\( \bar{\tau} \)) which entails the highest rate of infrastructure investments. On the other hand, if \( Z_{dic} > \hat{Z}_{dic} \) she determines the lowest possible expropriation rate (\( \bar{\tau} \)) entailing zero infrastructure investments. It follows that the ratio of infrastructure over aggregate human capital adjusts until it amounts to the long-run equilibrium level \( \hat{Z}_{dic} \). The dictator then sets the expropriation rate to maximize her utility by influencing the optimal ratio of public-to-private capital.

If we combine the results from all three cases, we conclude that the ‘good dictatorship’ is characterized by a long-run balanced ratio of the infrastructure relative to the aggregate human capital stock. Hence, GDP growth follows a unique, positive long-run balanced growth path as long as the condition for a ‘good dictatorship’ defined in eqn (22) is satisfied. Moreover, we know from eqn (26) that the balanced growth path features a higher public-to-private capital ratio in dictatorship than in democracy (\( \hat{Z}_{dic} > Z_{dem} \)). Thus, the model involves the additional empirical hypothesis summarized in Proposition 3.
Proposition 3. Given the preferences and production specifications defined in eqns (1)–(5) and (16)–(18) and a relatively high initial individual income level \( y_{it} > \bar{c} \), it follows from eqn (26) that the long-run equilibrium public provision of infrastructure capital is higher in dictatorship than in democracy \( Z_{dem} < Z_{dic} \).23

This result is consistent, for example, with the observed higher infrastructure capital investments in China relative to India during the last 50 years (compare Section 3).

Finally, we combine eqns (1), (10), (21) and (27) to compute the long-run balanced growth rate in dictatorship:

\[
g_{dic} = \frac{(1 - x)(1 - \beta)\psi}{[(1 - x)(1 - \beta)\psi + \beta]} \left[ 1 + \bar{\tau} \delta (\hat{Z}_{dic})^{-x} \right] - 1. \tag{28}
\]

2.3 Comparison of the long-run balanced GDP growth rates between the two political regimes

The previous analysis allows us to compare the two long-run equilibrium balanced growth paths of the two different political regimes for different aggregate income levels. In contrast to the unique long-run balanced growth rate in dictatorship, the democratic regime features two possible long-run growth rates. We already know from Proposition 2 that the growth rate in dictatorship outperforms the one of the democratic zero-growth equilibrium if condition (23) is satisfied. In the following, we compare the two positive long-run balanced growth rates of the two political regimes. That is, from eqns (15) and (28), we obtain:

\[
g_{dem} > g_{dic} \Rightarrow \bar{\tau} < \frac{\omega}{\delta} \left[ \frac{\beta}{\psi} + (1 - x)(1 - \beta) + \frac{1}{\psi} - (1 - x) \right] \frac{x^{-2} \beta}{AN^{1-x}(1 - x)^{1-x}} \tag{29}
\]

where

\[
\omega = \left( \frac{\beta(1 - \beta) + \beta}{\beta(1 - \beta)} \right)^{\frac{x}{a}} > 1.
\]

This condition is satisfied as long as

\[
\frac{\omega}{\delta} \left( \frac{\beta}{\psi} + (1 - x)(1 - \beta) \right) > 1.
\]

First, note that the ‘roving bandits’ type of dictatorship (implied by \( \psi_{fi} < 0 \)) satisfies the above condition and thus experiences an inferior long-run growth rate. Second,

23 Note that the ratio always remains at the initial level in the democratic zero-growth equilibrium. Hence, a relatively high initial ratio in democracy would trivially exceed the one in dictatorship.
we are interested in analysing whether the ‘best possible’ type of dictatorship, which is defined by $\psi = 1$ and $\vartheta = 1$, might violate the above condition. In this case, the (political) survival of the dictator’s offspring is certain and she faces the same enforcement costs as democratic authorities. Accordingly, the sufficient condition simplifies to $\omega(1 - \alpha + \alpha \beta) > 1$. The parameter $\alpha$ reflects the weight of human capital in the Cobb–Douglas production function, whereas $\beta$ measures the importance of an individual’s current consumption relative to the next generation’s income. Assuming a labour share of $\alpha = 2/3$, the growth rate of a democracy outperforms that of the ‘best possible’ dictatorship if $\beta > 0.42$. Note that when $\beta < 0.42$, individuals receive a higher utility from the income of their offspring than from their own consumption. In other words, she would invest more than half of her income in the education of her children. This parameter restriction appears to be quite implausible for the utility function of the median voter. Thus, the unrestricted positive long-run balanced growth rate of a relatively rich democratic economy, which features an income level of the median voter that ensures an interior solution for eqn (6), exceeds the long-run balanced growth rate of an autocratic economy for reasonable parameter values.\footnote{We note that for the special case of a single input factor of a constant return-to-scale production function ($\alpha = 1$), condition (29) reduces to $\tilde{\tau} < [\beta/(1 - \beta)]$. Hence, in this case the growth rate in dictatorship could potentially outweigh the one in democracy if the weight of current consumption preferences relative to future is relatively small.}

The result is summarized in Proposition 4.

**Proposition 4.** Given the preferences and production specifications defined in eqns (1)–(5) and (16)–(18), it follows from eqn (29) that: (i) the long-run growth rate of a relatively poor dictatorship outperforms the one of a poor democracy if the income of the median voter is below the subsistence level of consumption ($y_{it} \leq \bar{c}$) and condition (23) is satisfied for the dictatorship, whereas (ii) even the long-run balanced growth rate of the best performing dictatorship falls below the one of an equally rich democracy if $\omega(1 - \alpha + \alpha \beta) > 1$.

Thus, a comparison between the growth performance of dictatorial and democratic economies depends crucially on the country’s stage of development. The long-run growth rate in a democratic regime which is characterized by a relatively high average income level exceeds the one of a dictatorship of a comparable income level. On the other hand, economies that feature low average income levels, according to the income of the median voter, may experience higher growth in a dictatorial regime. In particular, relatively poor but large and stable economies, in terms of their population size and their degree of ethnic diversity experience higher growth in a dictatorial regime. This result potentially explains the ambiguous empirical findings associated with the democracy–growth nexus outlined above. It suggests that the corresponding relation is non-linear depending on a country’s income level and additional country-specific characteristics like population size and ethnic diversity.\footnote{Indeed, Barro (1996) reports some preliminary empirical results which support this non-linear relationship which depends on a country’s income level.}
The dependence of the potential growth paths of the two political regimes are illustrated in Figure 1. The first income level \((Y(1))\), defined in eqns (22) and (23), corresponds to the level that entails a ‘good dictator’ and the second to the income level that ensures positive investments in education according to eqn (10). Once the latter is exceeded, the democratic economy converges to its unique long-run balanced growth rate, whereas the specific convergence path between \(Y(1)\) and \(Y(3)\) depends on the initial ratio \(Z_0 = G_0/h_0\). The increase in the growth rate is higher as soon as \(Y(2)\) is exceeded and the more unbalanced this ratio is initially. Proposition 4 states that the growth rate in a dictatorial economy outperforms the one in democracy if the income level of the median voter falls between \(Y(1)\) and \(Y(2)\), which are defined in eqns (10), (22) and (23). The converse holds if both economies reached their long-run balanced growth path. As the income level of the median voter is increasing for \(Y > Y(2)\), there exists a specific income level in between such that economic growth in a democratic society starts to outperform the one in dictatorship.

3. Democracy vs. dictatorship: what do the data say?

In the following, we compare the economic performance of different political regimes based on international (country-) panel data. We identify political regimes using the Polity IV (2002) codes. We compare the GDP growth rate as well as the provision of public capital and social security payments in democracies with their counterparts in dictatorships of comparable income levels. The aim of this data analysis is to draw a comparison between the performance of different political regimes across regions and time periods in order to check for a consistency between
our theoretical approach and systematic variations in the data. We note that, given the limitations of the available data on developing countries, Tables 1–3 represent a rather tentative inspection of potential pivotal differences across the two regimes.

Table 1 contrasts the average growth rates and the pattern of public expenditures in a country before and after democratization. We restrict our attention to countries where the only experience with regime change over the period under consideration was a major democratization. These are countries that underwent major democratic transitions according to Polity IV. We also require at least 9 years of data before and after democratization in order to conduct meaningful comparisons of average growth rates. Twenty-four countries in our sample satisfy these criteria, and are listed in Table 1. We consider information on the entire duration of a certain political regime. We use the updated (PPP-adjusted) income data from Heston et al. (2006) and provide supplementary information on the structure of a country’s government expenditures from the IMF Government Financial Statistics in order to shed some light on a potential source of growth differences. That is, we report the percentage changes in a country’s public spending to GDP ratio on general public services, transportation and communication equipment (infrastructure), and social security and welfare after democratization relative to the previous autocratic era. Unfortunately, these time series do not start until 1972. The data exclusively cover low- or medium-income countries by the time of democratization as all regime shifts took place in developing or transition countries.

Table 1 shows that 18 of 24 countries experienced higher average GDP growth rates in the dictatorial regime when compared with the democratic. Moreover, 11 of 15 countries with a (real) GDP level below 6,000 in the year of democratization achieved a higher growth rate in dictatorship. This descriptive finding supports the theoretical result summarized in Proposition 2 of our model. The last three columns of Table 1 report variations in public spending on infrastructure and redistribution across the two political regimes. Our theoretical analysis suggests that democratic regimes invest less in infrastructure capital, but spend more money on social security and welfare (redistribution). Indeed, expenditures for general public services relative to GDP fell below previous ratios after democratization in nine of 14 countries with available data. If we focus on investments in transportation and communication infrastructure relative to GDP, nine of 12 countries exhibited a higher ratio in the dictatorial regime. In particular, all six countries with available data, which have a level of real GDP below 6,000, reduce their public investments.

26 The information on countries that experienced a transition from a democracy to a dictatorship is very limited as most political regime shifts represent democratization during the last 30 years, whereas the time series of the IMF Government Financial Statistics start in 1972.
27 The analysis is based on Rodrik and Wacziarg (2005) (Table 3). The authors analyse the transitional within-country effects of democratization on economic growth.
28 In an extended version of Table 1, we also compare the differences in public spending on education. However, the results are very similar to the changes in the spending on general public services.
# Table 2. Democracy vs. dictatorship: cross-country growth performances

<table>
<thead>
<tr>
<th>Dictatorship country</th>
<th>Decade</th>
<th>Av. growth (%)</th>
<th>Av. real GDP</th>
<th>Democracy country</th>
<th>Decade</th>
<th>Av. growth (%)</th>
<th>Av. real GDP</th>
</tr>
</thead>
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<tr>
<td>Bhutan</td>
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<td>4.44</td>
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<td>Gambia</td>
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<td>786</td>
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<td>481</td>
<td>Gambia</td>
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<td>-0.20</td>
<td>921</td>
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<tr>
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<td>673</td>
<td>India</td>
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<td>1.41</td>
<td>816</td>
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<td>Chad</td>
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<td>-1.75</td>
<td>1112</td>
<td>India</td>
<td>60</td>
<td>2.99</td>
<td>996</td>
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<td>China</td>
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<td>4.82</td>
<td>382</td>
<td>India</td>
<td>70</td>
<td>1.12</td>
<td>1203</td>
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<tr>
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<td>0.55</td>
<td>427</td>
<td>Mongolia</td>
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<td>Zambia</td>
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<td>1366</td>
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<td></td>
<td>1.09</td>
<td>1031</td>
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</tbody>
</table>

*Sources:* Polity IV (2002) and Heston *et al.* (2006). We refer to a democratic (autocratic) country if the Polity index exceeds 7 (−7). We exclude decades with periods of interregnum of at least 2 years, during which there is a complete collapse of central political authority or if a country is occupied by foreign powers during wartime. Excluded countries: democratic: Madagascar 1990s (−1.58%); autocratic: Afghanistan 1990s (−6.85%), Congo 1990s (−7.01%), Ethiopia 1970s (0.25%), South Korea 1980s (6.6%) and Zambia 1970s (3.23%).
Table 3. Infrastructure capital: China vs. India

<table>
<thead>
<tr>
<th>Decade</th>
<th>Average growth (%)</th>
<th>Average real GDP</th>
<th>Telephone lines and mobile phones per 1,000 workers</th>
<th>Power-generating capacity, GW per 1,000 workers</th>
<th>1 – share of transmission and distribution losses in total electricity output</th>
<th>Length of total road network km/km² land</th>
<th>Share of paved roads in total roads</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>China</strong></td>
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<td>1960s</td>
<td>0.55</td>
<td>427</td>
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<td>1970s</td>
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<tr>
<td>1960s</td>
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<td>996</td>
<td>2.59</td>
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<td>12.40</td>
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<td>0.81</td>
<td>0.44</td>
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</table>

in infrastructure substantially (up to 65 percent) after democratization.\textsuperscript{29} Finally, public spending on social security and welfare display the opposite pattern across political regimes. That is, in nine of 12 cases redistributive spending relative to GDP increased after democratization. These systematic variations in infrastructure investments and redistributive policies are consistent with the predictions of Proposition 3 which are specific to our model: the median voter calls for higher social transfers by the government at the expense of lower investments in infrastructure capital in democracy relative to an income-maximizing ‘good dictator’.

In Table 2, we compare the long-run growth performances of different countries during the last 50 years. We restrict our attention to relatively less developed countries and 10-year growth intervals. That is, we exclusively analyse countries whose average real GDP during a decade is in the fourth quartile of the overall income distribution based on the Heston et al. (2006) data. Moreover, we refer to a democracy/dictatorship if the polity index exceeds 7/–7 and exclude decades with periods of complete collapse of central political authority or occupation by foreign powers during wartime of at least 2 years.\textsuperscript{30} Unfortunately, most poor countries are ruled by autocratic leaders so that we are left with merely six observations for democratic regimes. Nevertheless, Table 2 reveals that the average (decade) growth rates of the least developed dictatorships outperform the ones of the least developed democracies. The average growth rate amounts to 2.54 percent in the former subset, but only 1.09 percent in the latter. This result is in line with Table 1 and supports the hypothesis that poor dictatorships often outperform poor democracies in terms of average long-run GDP growth.

The comparison of government expenditures or direct measures of infrastructure capital between least developed countries is very limited due to the absence of appropriate data. Therefore, we exemplify pivotal differences in the public provision of infrastructure by comparing corresponding measures from India and China which represent a stable poor democracy and poor dictatorship respectively. In addition, the two regions feature comparable initial income levels.\textsuperscript{31} The findings are summarized in Table 3. The average real GDP in India from 1960 and 2000 amounts to 1,338 in PPP-adjusted $ and exceeds that of China (1,025). Nevertheless, indicators for the infrastructure capital stock in China outweigh Indian stocks. In particular, the number of main telephone lines and mobile phones per 1,000 workers was on average 21.04 in China versus 12.40 in India starting from similar initial

\textsuperscript{29} We emphasize that transportation or telecommunication services have not been privatized in any of these six countries. In fact, telecommunication services were, for example privatized in Spain after democratization; however, overall public investments in transportation and telecommunication increased.

\textsuperscript{30} In particular, we drop the performance of Madagascar in the 1990s (democratic) and of Afghanistan in the 1990s, Congo in the 1990s, Ethiopia in the 1970s, South Korea in the 1980s and Zambia in the 1970s (all autocratic).

\textsuperscript{31} Moreover, some country characteristics, for example the population size, are comparable among the two economies. However, there are also important differences, such as the fact that the degree of ethnic diversification is higher in India than in China.
rates in the 1960s. Moreover, the power-generating capacity amounted to 0.37 GW per 1,000 workers in the former but only 0.12 in the latter region. By contrast, the average power capacity was the same in both countries in the 1970s. A qualitative index of the provision of electrical power, the share of transmission and distribution losses in total electricity output, confirms this result: the loss ratio amounts to merely 0.08 in China, but 0.19 in India. Yet, the average Indian transportation infrastructure capital stock outperforms the Chinese: the average length of the total road network is 0.44 km/km² of land area in India but only 0.09 km/km² in China. Apart from differences in country size most of this difference is due to different initial conditions (British colonial policy) as 97 percent of the average percentage deviations in the relative road stocks between both countries are explained by deviations in initial conditions in the 1960s. Furthermore, the share of paved roads in total roads, a qualitative index of roads services, was remarkably high in India in the 1960s (40 percent), but increases only by 9 percent since then. By contrast, it was historically very low in China (9 percent) but increases by 14 percent since then.

Summing up, these descriptive statistics suggest that many poor dictatorships outperform democratic counterparts with respect to average long-run GDP growth which is predicted by Proposition 2 of our model. The IMF Government Financial Statistics data and the comparison of infrastructure indices for China and India illustrate that differences in (incentives for) infrastructure investments and redistributive policies under the two political regimes play an important role in this context. These findings are consistent with our theoretical explanation of growth differences between democratic and dictatorial regimes, Propositions 2–4, which are presented in the previous section.

4. Conclusions

In this paper, we compare the long-run growth performances of two economies that only differ in their political regime in an overlapping generations framework. The model features the following key elements. First, individual preferences over contemporaneous consumption and the income of the next generation allow for the existence of a corner solution for relatively low individual income levels due to the existence of a subsistence consumption level. Second, individual productivity depends on the individual human capital stock and the overall amount of public capital (infrastructure) in the economy. Both inputs can only be affected dynamically via investments that pay off in the next generation. In this framework, we demonstrate that poor democracies exhibit a lower equilibrium balanced growth rate than equally poor but stable dictatorships as the median voter in the case of democracy under-invests in productive capital. Intuitively, the low income of the median voter in a poor democracy is characterized by a relatively low marginal inter-generational utility which
constrains productive investments in future generations. On the other hand, the higher income level of a dictator, in an otherwise identical economy, implies a higher marginal inter-generational utility of the decision maker and hence enhanced productive investments. If the economy is relatively poor this effect outweighs the growth-retarding impact of corruption in dictatorship (dictator’s consumption). Thus, the dictator of a less developed country may invest in infrastructure, whereas the median voter calls for redistributive policies to achieve a higher current consumption share. This redistribution versus public investments policy trade-off in democratic regimes has been informally stressed by Barro (1996) and others. In addition, our model involves a particular threshold value in income such that the growth-reducing impact of dictatorial consumption (corruption) outweighs the higher (initial) infrastructure investment. Thereafter, it is shown that the growth rate under democracy strictly dominates the one in dictatorship. Hence, there exists an intermediate income level such that economic growth in a democratic society starts to outperform the one in dictatorship. Although the results are at first derived for a homogenous time-invariant (exogenous) income distribution to keep the dynamic overlapping generations framework tractable, we also discuss their robustness towards heterogeneous time-variant (endogenous) income distributions. We are able to generate some analogous results depending on the skewness of an economy’s income distribution.

Moreover, we provide descriptive empirical statistics that suggest that many poor dictatorships outperform democratic counterparts with respect to average long-run GDP growth which is predicted by Proposition 2 of our model. In addition, the IMF Government Financial Statistics data and the comparison of infrastructure indices for China and India illustrate that differences in (incentives for) infrastructure investments and redistributive policies under the two political regimes play an important role in this context. These findings are consistent with our theoretical explanation of growth differences between democratic and dictatorial regimes as presented in the previous section (Propositions 2–4). Summing up, this model shows that dictatorships, under certain economic conditions, might also provide good economic (institutional) outcomes. In particular, the absence of a redistribution versus productive public investment trade-off might outweigh disadvantages from corruption in relatively poor economies. The comparison between the growth performance of dictatorial and democratic economies depends crucially on the country’s stage of development, the size of its population, and its degree of ethnic diversity. This result potentially explains the ambiguous empirical findings associated with the democracy–growth nexus outlined above. It suggests that the corresponding relation is non-linear depending on a country’s income level. In fact, Barro (1996) reports some preliminary empirical results which support this non-linear relationship with respect to a country’s income level.
References


Appendix

In the following, we employ the alternative individual preferences of Galor and Moav (2006) in our model. We show that their alternative preference specification leads to equivalent results in our model. In particular, these preferences involve an explicit solution for the subsistent income level which entails a poverty trap in democracy. Galor and Moav (2006) assume the following log-linear utility function:

\[ U = \beta \ln(c_{it}) + (1 - \beta) \ln(\theta + y_{it+1}), \]

where \( Y_{it} = A h_{it}^{\frac{\alpha}{\gamma(1 - \gamma)}} \), \( h_{it} = h_{it-1} + b_{it}, \) \( h_{i0} > 0, \) \( G_{it} = G_{it-1} + I_{it-1}, \) \( G_{i0} > 0, \) \( \beta = (1 - \tau_t)y_{it} - c_{it} \) and \( I_{it} = \tau_i Y_{it} = \tau_i N y_{it}. \) This results in the following first-order conditions:

\[ \frac{\partial U_i}{\partial c_{it}} = \frac{\beta}{c_{it}} = \left( \frac{1 - \beta}{\theta + y_{it+1}} \right) \frac{\tau_i y_{it+1}}{h_{it+1}}, \]  

\[ \frac{\partial U_i}{\partial y_{it}} = 0 = \frac{1 - \beta}{y_{it+1}} \left[ \frac{\tau_i y_{it+1}}{h_{it+1}} (-y_{it}) + \frac{(1 - \alpha) y_{it+1}}{G_{it+1}} N y_{it} \right]. \]

Equation (A1) can be transformed into the following expression:

\[ b_{it} \left[ \frac{\beta + \alpha(1 - \beta)}{\beta} + \frac{\theta}{y_{it+1}} \right] = \frac{\alpha(1 - \beta)(1 - \tau_t) y_{it}}{\beta} - h_{it} - \frac{\theta}{y_{it+1}} h_{it}. \]

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The above utility function implies that individuals might not invest in future generations if their income level falls below a certain threshold. The existence of such a threshold can be checked by setting $b_{it} = 0$ and $\tau_t = 0$. In particular, setting $b_{it} = 0$ and $\tau_t = 0$, eqn (A3) must satisfy $\partial / \partial c|_{c=y} \geq 0$ which results in the following condition:

$$x(1 - \beta)y_{it} - h_{it}\left(1 + \frac{\theta}{y_{it}}\right)\beta \leq 0. \quad (A4)$$

Equation (A4) is a quadratic expression in $y_{it}$. It can be solved for $y_{it}$ in order to compute the threshold level of income which involves a poverty trap in democracy (defined by $b_{it} = 0$ and $\tau_t = 0$):

$$0 < y_{it} < \frac{\beta h_{it}}{2x(1 - \beta)} + \sqrt{\left(\frac{\beta h_{it}}{2x(1 - \beta)}\right)^2 + \frac{\theta\beta h_{it}}{x(1 - \beta)}}. \quad (A5)$$

Hence, the Galor and Moav (2006) preferences lead to an explicit threshold level for income which implies a poverty trap in democracy. The democratic economy is kept in a poverty trap if the income level of the median voter satisfies the inequality in eqn (A5). For the initial period, $t = 0$, the poverty trap condition changes to:

$$Ah_{i0}G_{0}^{1-x} = y_{i0} < \frac{\beta h_{i0}}{2x(1 - \beta)} + \sqrt{\left(\frac{\beta h_{i0}}{2x(1 - \beta)}\right)^2 + \frac{\theta\beta h_{i0}}{x(1 - \beta)}}. \quad (A6)$$

Thus, our utility function in eqn (4) can be derived from the utility function of Galor and Moav (2006) by setting

$$\hat{c} = \frac{\beta h_{it}}{2x(1 - \beta)} + \sqrt{\left(\frac{\beta h_{it}}{2x(1 - \beta)}\right)^2 + \frac{\theta\beta h_{it}}{x(1 - \beta)}};$$

$$U = \beta \ln(c_{it}) + (1 - \beta)\ln(y_{it+1}), \quad \left\{ \begin{array}{ll} 0 < \beta < 1, & \text{if } c_{it} \geq \hat{c}, \\ \beta = 1, & \text{if } c_{it} < \hat{c}, \end{array} \right.$$