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Education, corruption, and the distribution of income

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Abstract We examine how the interaction between education and corruption affects institutional reform and economic development. While corruption reduces average income and education, education increases not only output and hence potential corruption rents, but also produces more informed electorates that better monitor government actions. We find that economies with intermediate levels of education remain in a poverty trap since the level of skills creates sufficient corruption rents but not enough monitoring. Economies with low or high levels of education can escape the poverty trap, and inequality plays a key role in determining whether this occurs through a change in institutions or an expansion of education.

Keywords Inequality · Corruption · Education · Economic development

JEL Classification O1

1 Introduction

The recent empirical growth literature has emphasized the importance of both human capital and good institutions for economic development. An intense debate has emerged about the relative importance of these two factors, and the extent to which institutions cause human capital

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accumulation and growth, or vice versa. Central to the debate are a number of countries, many in East Asia, which experienced rapid growth in the absence of strong economic institutions. Their economic success has been the result of pro-growth policies that favour physical and human capital accumulation; see Glaeser et al. (2004). The evidence seems to point to two disparate development paths, one institution led, the other based on factor accumulation, especially human capital.

This paper presents a model that highlights that either development path may be endogenously determined by a country's initial conditions. Initial conditions, both in terms of average human capital and the distribution of wealth, are shown to determine the endogenous policy choices of a self-interested government. These policy choices then give rise to a number of distinct development paths. Either institution-led or education-led development can generate equilibria with high income, high education, and quality institutions. Our model also allows us to examine the conditions which lock countries in low-income equilibria with poor institutions, low human capital, and high inequality. The multiplicity of development paths may explain the empirical literature's difficulty in identifying whether high quality institutions "cause" education, or whether education "causes" quality institutions. Chong and Gradstein (2007), for example, provide empirical evidence of a correlation between poor institutions and inequality, and Easterly (2007) finds that unequal distributions are major impediments to educational achievement, quality institutions and development.

Our model combines two strands of the literature. First, we base our analysis on Galor and Zeira (1993) approach to education. In their framework credit market imperfections limit agents' human capital investments, and to this we add two policy dimensions. On the one hand, we allow for government corruption (our concept of "bad institutions") that results in the misappropriation of public funds and reduces output and disposable income. On the other hand, governments may use their power of taxation to provide education subsidies, which increase educational attainment.

The second key aspect of our analysis is that we model a new dimension of political participation. While previous models examined the transition from dictatorship to democracy and the extension of franchise,[1] we assume that democracy is established and examine the implications of the fact that education increases the efficacy of political participation. A voluminous political science literature documents that education determines the *effectiveness* of political participation, even in democratic societies (see OCED 2007 for a survey). Specifically, education attainment is associated with more attentive political participation and with "elite-challenging" behavior that identifies and punishes corrupt behavior.[2] This indicates that even in democratic societies, the quality of institutions can vary with the level of education.[3]

Since we are interested in examining the macroeconomic implications of education affecting the effectiveness of political participation, we focus on a particular type of 'grand' corruption that impacts economic outcomes in a democracy.[4] Grand corruption is undertaken

[1] See, for example, Acemoglu and Robinson (2000) and Bourguignon and Verdier (2000).

[2] See Inglehart and Catterberg (2002), American Political Science Association Task Force (2004), and OECD (2007).

[3] Evidence that more educated electorates are more likely to identify and punish corruption is found in Galston (2001), Delli Carpini and Keeter (1996), Popkin and Dimock (1999), Glaeser and Saks (2006), and Nie et al. (1996). An economic application of this concept is developed by Glaeser et al. (2007) who examine the relationship between education, civic activity and the transition from dictatorship to democracy.

[4] We consider grand corruption as opposed to bribes paid by private agents or bureaucratic ("petty") corruption (see Bardhan 1997, and Tanzi (2000)). Jain (2001) argues that it is grand corruption that has the most damaging economic effects. See Alesina and Angeletos (2005) for an analysis of grand corruption.

by political elites that implement policies to foster their own utility, either through misappropriation or distorted allocation of public funds. Corruption tends to reduce education levels since it reduces disposable incomes and the ability to invest in education. On the other hand, education affects corruption. More educated electorates generate higher output and corruption rents, but political participation and elite challenging behavior increase the risk that corrupt incumbents are detected and punished. The threat may be sufficiently large for corrupt governments to find it in their interest to pass institutional reforms that eliminate future corruption.

The equilibrium strategy chosen by the party in power depends on initial conditions. Governments in countries with high initial educational attainment will abstain from corruption since the elite is motivated to behave honestly in order to maintain political power when facing a highly educated electorate. Countries with intermediate levels of education are most likely to be stuck in poverty traps. Human capital is sufficiently high to generate substantial corruption rents, but not high enough to result in efficient monitoring of politicians, resulting in corrupt political regimes and low output. For low levels of education, the initial wealth distribution is the key determinant of policy choices. When there is little education, corrupt behavior is unlikely to be detected but income and corruption rents are also low. To increase its corruption rents, the elite actually foster human capital accumulation and income growth through public education. However, corrupt governments engage in pro-growth policies only if the cost of public education does not exceed future corruption gains.

It is helpful to provide three examples of countries that experienced the different development dynamics implied by the model. Zimbabwe is an example of an economy stuck with mediocre educational attainment and rampant corruption. Ever since International Country Risk Guide has collected institutional data, it has rated Zimbabwe among the most corrupt countries in the world, and, in 2003, as the most corrupt. At the same time, educational attainment in Zimbabwe is respectable: the country was in the 64nd percentile of the world distribution of education at independence and has retained a roughly similar rank since (Barro ans Lee 2001).

When Zimbabwe achieved independence, its educational attainment was greater than Botswana's, a country which would experience a 'reversal of fortunes' based on institutional reform. Botswana started with some of the most dreadful initial conditions in Africa. According to Acemoglu et al. (2003) and Harvey and Lewis (1999), there was no university in Botswana in 1966, and there were only two secondary schools in the country that offered five-year courses. Acemoglu et al. (2003) report that immediately after independence the Botswana Democratic Party (BDP) invested heavily in public infrastructure, education and health. By 1998, educational attainment in Botswana exceeded that of most other African countries, with a secondary enrollment rate of 89%. Although the country has conducted free elections, the BDP has managed to maintain the majority since independence. Meanwhile Transparency International ranks Botswana as the least corrupt country in Africa, with a similar score to those of Portugal and South Korea. It currently features one of the highest per capita income levels in Africa.

Another African economy exhibiting high educational attainment in the late 1990s was Mauritius. At that time, its primary enrollment rate reached 96%, exceeding that of Botswana or Singapore (see Subramanian and Roy 2003). The economic success of Mauritius would have surprised early observers who asserted that terrible initial conditions in Mauritius, including rampant corruption, would hamper subsequent development (see Meade 1961). However, Subramanian and Roy (2003) indicate that Meade overlooked the unusually high level of initial human capital in the country, which then led to strong subsequent institutional reforms. Subramanian and Roy (2003) outline how these reforms are seen as the key

to Mauritius development, and the authors indicate that "Mauritius ranks well above the average African country with respect to all indices of institutional quality, political as well as economic and also above the fast growing economies on most indices." These institutional changes, initiated by high initial educational attainment, thus eradicated the substantial level of corruption that was documented around the time of independence (see Whitehead 2003, p. 214).

Our model is related to several strands of democracy, education, and growth literature. First, our approach is close to the analyses of endogenous institutions in Acemoglu and Robinson (2000) and Bourguignon and Verdier (2000).[5] The political elite in Bourguignon and Verdier faces a similar trade-off as in our model: education increases rents (in their case due to a technological externality) but also electoral participation. Since greater electoral participation leads to more redistribution, Bourguignon and Verdier find a monotonic relationship between education and development which is difficult to ascertain in the data. Our analysis shares with Acemoglu and Robinson (2000) that the political elite may be interested in committing to institutional changes that limit its power in the short run, but which increases their long term payoff. Acemoglu and Robinson focus on the threat of revolution that forces parties to extend the franchise and commit to redistribution. In our model the threat to the elite (and the subsequent institutional change) is due to the well-documented capacity of a more educated electorate to monitor the behavior of the ruling party. Since education not only threatens the reelection, but also increases corruption rents, there is a mitigating factor that is absent in Acemoglu and Robinson. Countries with intermediate levels of education will then exhibit *higher* corruption than those where educational attainment is high or low.

The political economy of education policies has been examined by a number of recent papers, and the distribution of income or wealth often plays a key role. Fernandez and Rogerson (1995) consider a setup in which individuals vote over the size of education subsidies, and show that when income inequality is high, middle-class voters may chose to limit the size of the subsidies in order to exclude poor agents from education and thus obtain "reverse redistribution" through the tax-subsidy system. A closely related result is obtained by De la Croix and Doepke (2009), who find that the quality of public schooling is affected by the degree to which low-income individuals are able to affect the political outcome in a democracy.

Galor et al. (2009) examine the introduction of public schooling in a historical context. Due to a low degree of complementarity between human capital and land, landowners are hurt by the introduction of a tax in order to finance public education, and hence oppose education policies. Since their losses are greater the less dispersed is the distribution of land, greater inequality in land ownership makes it less likely that an economy introduces public education. The interaction between inequality and institutions is also emphasized by Sokoloff and Engerman (2000) in their discussion of the determinants of development in the "New World". They argue that, in the American colonies, early differences in the extent of inequality (themselves caused by a combination of geography, factor endowments, and native population characteristics) have been the key source of differences in institutional development (in particular, education policies) and the resulting economic outcomes.

Our work is also related to the literature on the causes and effects of corruption. One strand of this literature identifies the static incentives for corruption and rent-seeking.[6] Another

[5] See also Aghion et al. (2004), Alesina and Angeletos (2005), Cervellati et al. (2006), and Glaeser et al. (2007). See also Galor and Moav (2004, 2006) for work on the long-run relationship between inequality, education and income levels.

[6] This literature started with Krueger (1974). For surveys see Bardhan (1997) or Tanzi (1998).

strand examines the impact of corruption on growth, following the seminal work of Mauro (1995); OECD (2007) who documents that corruption reduces growth. The relationship between education and corruption has, however, received little attention. Two notable exceptions are Ehrlich and Lui (1999) and De la Croix and Delavallade (2009). Ehrlich and Lui examine how individuals' decisions to allocate their time between human capital investments and rent-seeking activity affects growth. De la Croix and Delavallade explore the idea that corruption affects the diversion of public funds from growth-enhancing human capital accumulation to other types of expenditures where corruption is easier to conceal. They thus present a complementary explanation to ours, in which the "predatory technology" is the key determinant of education and growth. A crucial difference is that De la Croix and Delavallade examine a representative agent model; hence inequality across individuals plays no role in their analysis, while in our framework it is the fundamental driving force that determines development paths.

The paper is organized as follows. Section 2 describes the production sector and education decisions, using the overlapping-generations model with imperfect capital markets developed by Galor and Zeira (1993). It shows how the tax rate affects bequests and the level of human capital, and highlights the role played by initial inequality. Section 3 introduces the political structure of the model, in which the political party in power chooses the tax rate for the provision of a public good. Section 4 examines the strategic behavior of the political elite as a function of education and inequality. Subsequently we examine the dynamics of education and characterize the possible development paths. Section 5 concludes.

2 Production, education and taxation

2.1 Description of the economy

The production and education structures follow Galor and Zeira (1993), to which we add a proportional income tax that is levied in order to finance a public good. We consider a small, open economy populated by a constant number of overlapping-generations dynasties, which we normalize to one. Time is discrete and agents live for two periods. Individuals differ in their initial (inherited) wealth. They will chose whether or not to invest in human capital, and will, accordingly, work in the skilled or the unskilled sector. Both sectors produce the same homogeneous consumption good, whose price is the numeraire. All markets are competitive, except for the domestic credit market. In the original model, monitoring costs implied that the rate at which agents could borrow to invest in human capital was greater than the lending (world) interest rate. For simplicity, we use an extreme version of this assumption and suppose that borrowing in order to invest in education is not possible.

2.1.1 Production

Skilled and unskilled workers, denoted L_{St} and L_{Ut}, respectively, produce output in separate, competitive sectors denoted by j, with $j = u, s$. The production functions are given by

$$Y_{jt} = K_{jt}^{\alpha} \left(A_j L_{jt}\right)^{1-\alpha}, \quad 0 < \alpha < 1 \tag{1a}$$

where K and A represent physical capital and technology, respectively. We assume $A_s > A_u$, implying that technology used by skilled workers is more productive.

Firms borrow at the constant world interest rate, r, and income is taxed at rate τ_t, which is determined endogenously by the political process that is specified in Sect. 3. For now we

take τ_t to be given. Equality between the world interest rate and the domestic after-tax return on capital determines capital-labor ratios, $k_{jt} = A_j (\alpha (1-\tau_t)/r)^{1/(1-\alpha)}$, where $k_{jt} \equiv K_{jt}/L_{jt}$. As a result, wages, w_{jt}, are independent of the labor supply and given by

$$w_{jt} = \lambda_j (1-\tau_t)^{\alpha/(1-\alpha)}, \quad \lambda_j = (1-\alpha) A_j (\alpha/r)^{\alpha/(1-\alpha)}. \tag{2}$$

Note that wages depend negatively on the tax rate, through the effect that the latter has on the capital stock. Using the labor market clearing constraint, $L_{Ut} + L_{St} = 1$, aggregate output can be expressed as

$$Y_t \equiv Y_{ut} + Y_{st} = (1-\tau_t)^{\alpha/(1-\alpha)} \frac{\lambda_u (1-L_{St}) + \lambda_s L_{St}}{1-\alpha}. \tag{1b}$$

Not surprisingly, higher taxes depress output while an increase in the fraction of the labor force that is educated raises it.

We assume that production requires the provision of a public good, which can be thought of as an infrastructure requirement. We follow García-Peñalosa and Turnovsky (2005), and assume that ϕY_t units of the public good are required to produce a level of output Y_t, with $0 < \phi < 1$. The public good has a constant unit cost, c, implying that the total cost is $c\phi Y_t$. The public good is financed through the proportional income tax, implying that the tax rate must be at least $c\phi$, although it may be higher if the party is corrupt or if it subsidizes education.

2.1.2 Education, consumption and bequests

There is a mass 1 of overlapping-generations dynasties indexed by i. Agents live for two periods, implying that the population measure is 2. Agents differ in their initial wealth, with all the skilled workers holding wealth $x_{s,0}$ and all the unskilled $x_{u,0} < x_{s,0}$ at time 0. The timing of education and bequests is as follows. At the beginning of the first period, an individual receives a bequest and decides whether or not to invest in education. Education takes no time. The individual is then employed in the first period, receives a wage corresponding to her skill level, and has an offspring at the end of the period. In the second period, the individual does not work, she consumes and leaves a bequest. There are elections at the beginning of each period, and all agents vote.

We suppose that there is "warm glow" altruism, so that an individual derives utility from the bequest left to her offspring, b_i, as well as from her own consumption, c_i. The utility function is assumed to take the form

$$U_{it} = \left(\frac{c_{it}}{1-\beta}\right)^{1-\beta} \left(\frac{b_{it}}{\beta}\right)^{\beta}, \quad \text{where} \quad \beta < 1. \tag{3}$$

Utility optimization implies that consumption and bequests are constant fractions of per capita output, $c_{it} = (1-\beta) y_{it}$ and $b_{i,t} = \beta y_{i,t} = x_{i,t+1}$, where $x_{i,t+1}$ is the inheritance that a young individual from dynasty i receives from her parents, i.e. her wealth. Substituting for consumption and the bequest, the indirect utility function is given by

$$U_i = y_i. \tag{3'}$$

We employ the common assumption that there exists a fixed education cost, e, and that borrowing to finance education is not possible.[7] The incomes of an unskilled and a skilled agent can then be written as

[7] None of our results would change in the more general case in which borrowing to invest in education is possible but costly due to imperfect capital markets, as in Galor and Zeira (1993).

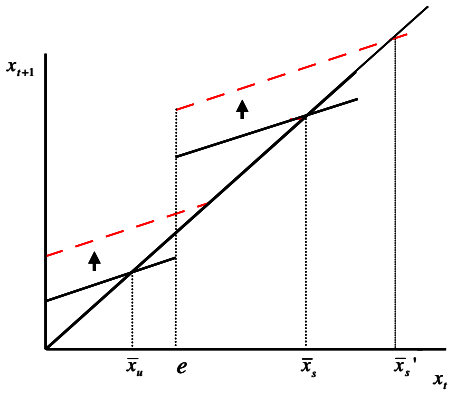

Fig. 1 Bequests, taxation and education

$$y_{ut} = (1+r)\left((1-\tau_t)w_u(\tau_t) + x_t\right), \tag{4a}$$
$$y_{st} = (1+r)\left((1-\tau_t)w_s(\tau_t) + (x_t - e)\right). \tag{4b}$$

After receiving their bequest, young agents decide whether or not to study. A necessary condition to invest in education is that bequests are large enough to cover the cost of education, i.e. $x_{it} \geq e$. Wealthy agents then invest in education if their lifetime income as skilled workers exceeds that of being unskilled, that is, if $y_s > y_u$. This inequality reduces to the condition that the return to education must be greater than the interest an agent could obtain from investing e in physical capital, that is, $(1-\tau_t)\left(w_s(\tau_t) - w_u(\tau_t)\right) = (1-\tau_t)^{1/(1-\alpha)}(\lambda_s - \lambda_u) \geq e$. Note that this equation is independent of the agents' wealth, implying that if it is satisfied, all agents wish to become educated. Furthermore, it implies that a sufficiently low tax rate $\tau_t \leq \hat{\tau}$ is required for agents to wish to invest in education, where $\hat{\tau} \equiv 1 - (e/(\lambda_s - \lambda_u))^{1-\alpha}$.

2.1.3 Dynamics

The dynamics of the model are given by the evolution of bequests, which are characterized by

$$x_{u,t+1} = \beta(1+r)\left(\lambda_u(1-\tau_t)^{1/(1-\alpha)} + x_{u,t}\right), \tag{5a}$$
$$x_{s,t+1} = \beta(1+r)\left(\lambda_s(1-\tau_t)^{1/(1-\alpha)} + x_{s,t} - e\right). \tag{5b}$$

The bequests of all dynasties with wealth $x_t < e$ are governed by Eq. (5a), while those of dynasties with wealth $x_t \geq e$ are governed by (5b). These two functions are depicted in Fig. 1, where the lower line represents the bequest function of the unskilled and the higher one the bequest function of the skilled. Under the assumptions of a constant tax rate and $(1+r)\beta < 1$ (which occurs if the propensity to bequeath is not too large), these two functions intersect the 45° degree line and converge to the steady states $x_{u,t+1} = x_{u,t} = \bar{x}_u$ and $x_{s,t+1} = x_{s,t} = \bar{x}_s$.

Assuming a constant tax rate, the long-run distribution of wealth converges to an invariant distribution that is a function of the initial distribution (see Galor and Zeira 1993). The long-run levels of wealth held by skilled and unskilled can then be expressed as

$$\bar{x}[\tau] = \frac{\beta(1+r)}{1-(1+r)\beta}\lambda_u(1-\tau)^{1/(1-\alpha)}, \tag{6a}$$

$$\bar{x}_s[\tau] = \frac{\beta(1+r)}{1-(1+r)\beta}\left(\lambda_s(1-\tau)^{1/(1-\alpha)} - e\right), \tag{6b}$$

while the steady state fraction of skilled (unskilled) workers is given by the proportion of dynasties whose initial wealth exceeds (falls below) the cost of education.

Galor and Zeira discuss the equilibrium at length. They examine the role of the production function (technology and interest rate), and the initial distribution of wealth in determining the feasible equilibria. Here, we are interested in the political economy of taxation and hence investigate the impact of the tax rate on the education decision.

An equilibrium with inequality requires a tax such that rich dynasties can afford education, while poor dynasties cannot, i.e. $\bar{x}_u[\tau] < e \leq \bar{x}_s[\tau]$. From (6a, 6b) this implies a tax in the interval $\left[\bar{\tau}_u, \hat{\tau}\right]$, where $\bar{\tau}_u = 1 - \left(e\left(1-\beta(1+r)\right)/\beta(1+r)\lambda_u\right)^{1-\alpha}$. Any tax rate lower than $\bar{\tau}_u$ allows a descendent of those currently unskilled to eventually study, while any tax greater than $\hat{\tau}$ implies that the return to education is too low and nobody invests in education.

In our two-class economy, we can define the initial degree of inequality as the distance between the initial wealth of the educated and that of the non-educated, $x_{s,0} - x_{u,0}$. For given levels of education and average wealth, a lower value of $x_{u,0}$ implies greater wealth inequality. In what follows we assume that the initial distribution of wealth is such that the initial equilibrium exhibits inequality. That is, $x_{u,0} < e < x_{s,0}$. The assumption is necessary to focus on the interesting case of initially unequal societies. The analysis of how political corruption and reform affect educational attainment would be irrelevant if all workers could afford education from time t =0.

2.2 Dynamic effects of taxation

We can now analyze the dynamic effects of tax changes on income and bequests, and hence on the distribution of income and educational attainment. Lower taxes have a direct and an indirect effect on individual incomes: for a given wage level, lower taxes increase disposable income, but they also raise the net return to capital, which leads to a capital inflow that raises wages. These two effects shift the bequest functions upwards, which implies higher bequests at $t+1$, as depicted in Fig. 1.

The impact on education depends on the tax level. Any tax that exceeds the threshold $\bar{\tau}_u$ generates an equilibrium with inequality, although income and steady state wealth will be higher for both the skilled and the unskilled due to the inflow of physical capital (see Eq. (6a, 6b)). Tax levels below $\bar{\tau}_u$ shift the bequest function sufficiently upwards to eliminate the fixed point for the unskilled, as depicted in Fig. 1. In this case, all dynasties are skilled in the long-run, i.e. $L_S = 1$. This equilibrium results in higher aggregate output and complete equality.

The transition to such an equilibrium takes time, however, and the duration depends on the initial level of inequality, i.e. on $x_{u,0}$. Figure 2 depicts the dynamic adjustment of the economy in response to a reduction in the tax rate from τ_0 to $\tau_1 < \bar{\tau}_u$. The tax reduction shifts up the bequest schedule, which increases the wealth of the next generation. If the initial wealth level of the unskilled at t is low, for example x_0, their offspring will receive an inheritance of x_1 which is less than the cost of education. They will hence be unable to study and the skilled labor supply at $t+1$ will be equal to that at t. Some descendent of this dynasty will

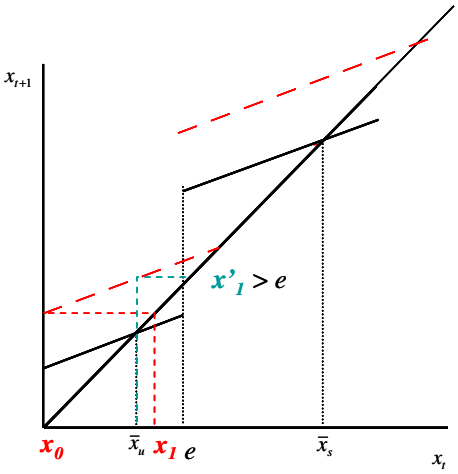

Fig. 2 Dynamic effects taxation on education

eventually be able to study, but it will take time. Now suppose that the initial level of wealth of the unskilled is high, say $\bar{x}_u$. In this circumstance their bequest is $x'_1 > e$, implying that all those born at $t+1$ will be able to afford education and the skilled labor force at $t+1$ will be equal to 1. From Fig. 2, it is clear that the number of periods it takes for unskilled dynasties to be able to afford education, denoted N, is higher the lower $x_{u,0}$ is, i.e. the greater inequality is.

3 Political economy

3.1 The political equilibrium

Having established the relationship between education and the distribution of wealth in response to a change in taxes, we can now examine the effects of inequality and education on corruption via the political process. Assume that there are many (infinitely lived) parties, and that at the beginning of each period an election takes place. A party elected to govern is in power for one period before it faces reelection.

3.1.1 Preferences and possible actions of political parties

We suppose that parties derive utility from corruption rents, π_t, and from ego rents, u. Such ego rents are standard in the political economy literature, where they are introduced as the non-pecuniary benefits from holding office.[8] We assume that ego rents are bounded above in relation to the productivity of the economy in order to rule out that the only dominant strategy is to remain in power and provide competitive taxes (see Appendix I). Specifically, we suppose that

[8] See Downs (1957) on the concept of ego rents, and, for example, Rogoff (1990) and Besley (2006) for recent applications.

$$u < A_u \delta a_0, \tag{A1}$$

$$u < A_s \delta^2 a_0 / (1 + 2\delta), \tag{A2}$$

where δ is the party's subjective discount rate.

A party's expected payoff at time t is then given by

$$V_t = \sum_{n=0}^{\infty} \left(\prod_{j=0}^{n} p_j \frac{u + \pi_{t+n}}{(1+\delta)^n} \right), \tag{7}$$

where p_j denotes the probability of reelection at time j, specified in detail below. Modeling political parties as infinitely-lived is common in the political economy literature, where it is used as a tool to rule out "hit-and-run" strategies when a last period is specified (see, for example, Alesina 1988; Persson et al. 1997). In our context, such hit-and-run incentives would imply a corrupt government in the last period. The assumption of an infinitely-lived party can be interpreted as assuming old politicians that care about the welfare of the next generation of party members.[9] There exists substantial empirical evidence to support this view (see, for example, Brender and Lott 1996; Parker 2005, for a review of the literature).

At any point in time, the party in power can undertake three possible actions. First, it decides whether or not to subsidize education. Second, it chooses the tax rate: it can either be honest and set the 'competitive' tax rate, denoted τ_t^c and which will be defined below, or set a tax above τ_t^c and pocket the difference, i.e. be corrupt. Third, we suppose that the party can also undertake institutional reform. We conceive institutional reform as a set of institutions that guarantees complete transparency regarding c, which identifies τ_t^c as the appropriate tax to voters.[10] This reform could take the form of the creation of an external accounts committee or the requirement that the government budget is approved by parliament. Once institutional reform is undertaken, it remains in place, implying that future ruling parties cannot levy taxes in excess of τ_t^c and hence cannot extract corruption rents. Institutional reform is passed at the end of the period, which renders it a commitment device: a ruling party that passes reform today is "tying its hands" and committing to not be corrupt in the future.

3.1.2 The government budget and corruption

There are two types of public expenditure that the government can finance. The first is the provision of the public good, which has a cost $c\phi Y_t$. The government could also decide to introduce an education subsidy, s_t, that reduces the cost of investing in human capital to $e - s_t$. We examine these in turns.

Define the "competitive" tax τ_t^c, as the tax rate that is sufficient to cover the cost of public expenditure. Since tax revenues are given by $\tau_t Y_t$, the competitive tax rate is $\tau_t^c = c\phi + S_t / Y_t$,

[9] The party's payoff (7) can be derived from first principles by assuming that the utility function of an incumbent politician is $U_{it}^p = (c_{it}/(1-\beta))^{1-\beta} (b_{it}/\beta)^{\beta} + u + \gamma p_{t+1} V_{t+1}$, where γ measures the degree of altruism towards young party members. Given the results from our individual optimization ($c_{it} = (1-\beta) y_{it}, b_{it} = \beta y_{it}$) and since the income of a politician is $y_{it} + \pi_t$, this utility function can be expressed as $U_{it}^p = y_{it} + V_t$, where $V_t \equiv u + \pi_t + \gamma p_{t+1} V_{t+1}$. Through recursive substitution, we can then obtain (7), with $1/(1+\delta) \equiv \gamma$. See Alesina and Spear (1988).

[10] This concept of reform is in line with historical evidence, such as that provided by Wallis (2005). Wallis shows that major transport infrastructure projects in the US were ridden with corruption, which led to a fiscal crisis in the early 1840s. Many states responded by writing new constitutions that increased the transparency of government borrowing and expenditure, which reduced corruption. Cross-country differences in the degree of budget transparency and the possibility of discretionary taxation are large; see Alesina et al. (1999) and the references there cited.

where S_t is the total amount spent in education subsidies. In the absence of education subsidies, the tax rate required to finance infrastructure is $\tau^c = c\phi$. In order to allow for the possibility of corruption, we suppose that the cost of infrastructure, c, is not known to the electorate. The party in power can thus claim that the cost is greater than c and set a tax $\tau_t > \tau_t^c$ in order to appropriate some of the tax revenue. Corruption rents are then given by

$$\pi_t = (\tau_t - c\phi)Y_t - S_t, \tag{8}$$

which increases with aggregate income and falls with the education subsidy. If the elected party engages in corruption, it will choose a tax rate that maximizes these rents, as will be detailed below.

3.1.3 Education subsidies

The expression for the corruption rents in (8) indicates that they increase with the level of income. A corrupt government may then increase its rents by subsidizing education in order to raise the number of skilled individuals and hence output. Note, first, that the optimal subsidy is $s_t = e - x_{u,t-1}$, since any subsidy lower than that will not allow the poor to obtain an education and hence will have no impact on the size of the skilled labor force. The timing of education subsidies is as follows. At the beginning of period t, the government borrows in the international capital market and uses the funds to finance the education subsidy. The offspring of poor dynasties can now invest in education, resulting in $L_{S,t} = 1$. Tax revenues are then collected, and part of them is used to repay the loan and interest.

The government can chose two types of education policy: one is a universal subsidy; the other is a targeted subsidy awarded only to the poor, so that the rich still face a cost of education of e. A universal subsidy implies rents of $\pi_t = (\tau_t - c\phi)Y_t - (1 + r)s_t$, while a targeted subsidy implies generates higher rents of $\pi_t = (\tau_t - c\phi)Y_t - (1 + r)s_t(1 - L_{St})$ and hence depends on the number of poor. Because it generates higher rents, a targeted subsidy is preferred by the party in power, and most of our analysis focuses on the case of targeted subsidies. Section 4.4 show how the results are altered when universal subsidies are introduced.

3.1.4 Election probabilities

In order to relate education to the effectiveness of political participation, we posit that education affects how closely individuals can monitor the behavior of the incumbent party. This can be due, for example, to skilled individuals having better information about the cost of the public good and hence being more able to assess whether the competitive tax level is imposed. The unskilled, on the other hand, are unable to monitor the ruling party. Thus the probability that a corrupt party is caught increases in the number of educated individuals. For simplicity, we assume that the probability of being caught is equal to the fraction of skilled individuals in the population, $L_{S,t}$.

Whether or not a corrupt incumbent is reelected then depends on the composition of the electorate. If the incumbent is shown to be corrupt, voters expect it to be corrupt in the future and will not reelect it; if it has not been proven corrupt (either because it was honest or because it was not caught), it will be reelected. Consequently, when a party is honest, it is reelected with certainty, that is,

$$p_H = 1. \tag{9a}$$

Reelection with certainty in the presence of competitive taxes is assumed for simplicity only; results are robust to the assumption that the probability of reelection for honest parties be less than 1. All that is required is that the reelection probability is independent of the number of skilled workers and greater than the reelection probability for corrupt parties.

Consider now the corrupt party's reelection probability, denoted p_C. Given that the probability of being caught is directly proportional to the number of educated agents, $L_{S,t}$, the reelection probability of a corrupt party is

$$p_C\left[L_{S,t}\right] = 1 - L_{S,t}. \tag{9b}$$

A corrupt party that passes institutional reform instead faces the election probability

$$p_{CR}\left[L_{S,t}\right] = 1 - qL_{S,t}, \quad 0 \leq q < 1 \tag{9c}$$

which indicates that the party is punished for its past corruption but also rewarded for future honest behavior. How important punishment is for past corrupt behavior is given by q. For $q = 0$, voters implement no punishment and a party that reforms (and hence cannot be corrupt in the future) is elected with certainty. For $q = 1$ (full punishment for formerly corrupt parties) there is no gain from the reform strategy and hence it is never implemented.

Institutional reform thus implies that a previously corrupt party increases its reelection probabilities by 'tying its hands' and by committing to competitive taxes in the future. Such reforms are only plausible if a corrupt party perceives the electorate as being sufficiently elite challenging and decides to trade corruption rents for the reelection and the associated ego rents.

3.2 Endogenous corruption

Before we examine dominant political strategies, it is important to determine the optimal degree of corruption, i.e. the tax rate that corrupt parties impose. Recall that corruption rents are given by $\pi_t = (\tau_t - c\phi)Y_t - s_t$, which increases in the tax rate for a given level of output. However, as we saw in Sect. 2, higher tax rates reduce the capital-labor ratio and aggregate output. These two opposing forces imply that corruption rents are a concave function of τ. Using (1b) to substitute for Y_t, we obtain that the level of corruption that maximizes corruption rents

$$\tau^* = 1 - \alpha(1 - c\phi). \tag{10}$$

The analysis of corrupt regimes would be trivial if corruption was associated with equality, hence we assume

$$\tau^c < \bar{\tau}_u < \tau^* < \hat{\tau}, \tag{A3}$$

which implies that the corrupt tax rate τ^* does not affect the level of education, while the competitive tax rate $\tau^c = c\phi$ allows all dynasties to become educated (see Appendix I for the specific parametric restrictions implied by A3). This assumption is satisfied for an intermediate range of the cost of education. If the cost of education is too high, even the competitive tax rate would be too large for the wealthiest individuals to study; if the cost of education is too low, all dynasties can afford education even when $\tau*$ is imposed.[11] In either of these two cases, the level of education would be independent of the tax rate and of the level of corruption.

[11] See Appendix III.

Corruption rents obtained by a corrupt party at time t are then a function of the level of education and the subsidy,

$$\pi_t \left[L_{S,t}, s_t\right] = a\left(1 + \varphi L_{S,t}\right) - (1 + r)s_t(1 - L_{St}), \tag{11}$$

where $\varphi \equiv A_s/A_u - 1, a \equiv a_0 A_u$, and $a_0 \equiv (1-\alpha)^2 \left(\alpha^2/r\right)^{\alpha/(1-\alpha)} (1 - c\phi)^{1/(1-\alpha)}$. Higher levels of education generate higher output and therefore greater corruption rents. Rents also increase in the level of unskilled productivity, A_u, the skill premium, A_s/A_u, and decrease in the world interest rate, r, as well as in the cost of the public good, c.

In order to focus on a set of meaningful equilibria and rule out corner solutions, we assume

$$\varphi > q, \tag{A4}$$

otherwise the effects of reform are too small to affect election probabilities and reform would never pay. In addition, to assure that strategies with public education exist, the cost of education has to be bounded (see the Appendix). We hence assume

$$\frac{\delta a_0 A_s - qu}{(1+\delta)(1+r)} > e > u(1-q)\frac{1+\delta}{\delta(1+r)}. \tag{A5}$$

If the upper bound is not satisfied, public education is so expensive (relative to foregone rents) that it is never implemented. If the lower bound is not satisfied, the cost of education is so cheap that universal education is the only dominant strategy.

4 Party behavior and the dynamics of education

4.1 Corruption, subsidies and reform

The timing of the various actions in the economy is as follows. At time 0, the economy starts with a level of education, $L_{S,0}$, and an incumbent party. The elected party chooses a tax rate (either τ^* or τ_t^c) and whether or not to subsidize education. This determines the level of education in the next period, $L_{S,t+1}$. At the end of t, the political party chooses whether to institute institutional reform or not. In period $t+1$, educated individuals assess whether the previous ruling party was corrupt, an election takes place, and either the incumbent is reelected or a new party takes power. The party in power for period $t+1$ chooses the tax (if reform was not passed). This tax determines savings at $t+1$ and hence the level of education at $t+2$.

Given this timing of events, there are three possible strategies for an incumbent. First, the party can be corrupt at all periods and never pass institutional reform as indicated by strategy V_C. This strategy then implies no changes in education, i.e. $L_{S,t} = L_{S,0} = L_S \forall t$, and constant corruption rents since output is constant. The probability of reelection faced by such a party is $1 - L_S$, implying an expected payoff of

$$V_C\left[L_S\right] = (u + \pi\left[L_S, 0\right]) \sum_{t=0}^{\infty} \left(\frac{1 - L_S}{1+\delta}\right)^t = \frac{(1+\delta)\left(u + a(1+\varphi L_S)\right)}{\delta + L_S} \tag{12a}$$

The payoff indicates that the level of education increases the corruption rent, but lowers the reelection probability.

An alternative strategy for a ruling party is to be corrupt in the first period and then to pass institutional reform, V_{CR}. When this strategy is chosen, corruption is short-lived, and

reforms result in low taxes that eventually allow everyone to invest in education.[12] This strategy provides corruption rents only in period 1 but a higher probability of reelection (and hence higher future ego rents). The expected payoff for a corrupt-reforming party is

$$V_{\mathrm{CR}}[L_S] = u + \pi[L_S, 0] + (1 - qL_S)\sum_{t=1}^{\infty}\frac{u}{(1+\delta)^t} = u + a(1+\varphi L_S) + (1 - qL_S)\frac{u}{\delta}. \tag{12b}$$

This payoff is linear in the level of education, with L_S having two effects as it increases corruption rents but reduces the probability of reelection.

The third strategy is to expand education through subsidies and then reform, V_{SR}. By subsidizing education, the party can increase the level of education, which raises output and hence the corruption rent obtained. The optimal policy is to provide the lowest subsidy that would allow poor dynasties to obtain education, that is, $s_t = e - x_{u,t}$.[13] This subsidy results in $L_{S,t} = 1$. Tax revenues are then collected, a fraction is used to repay the cost of financing the subsidy and the rest is pocketed by the party. Since the entire population is now educated and politically active, institutional reform is passed to hold on to political power. Institutional reform and a fully educated population imply that further corruption is not feasible.

With education subsidies, corruption rents are given by $\pi[1, x_u] = a(1+\varphi) - (1 + r)(e - x_u)(1 - L_s)$. The expression highlights that the trade-off that corrupt parties face. On the one hand, subsidies to education increase human capital, output, and tax revenues thus raising corruption rents; on the other hand, the cost of the subsidy reduces rents for a given level of tax revenues. The payoff to the subsidy-reform strategy can then be expressed as

$$V_{\mathrm{SR}}[L_s, x_u] = \frac{1+\delta}{\delta}u + a(1+\varphi) - \frac{qu}{\delta} - (1+r)(e - x_u)(1 - L_S). \tag{12c}$$

This payoff is increasing in the initial level of education since it implies that fewer poor must be subsidized. The payoff is also affected by the distribution of wealth, since greater inequality (a lower value of x_u) requires a larger education subsidy and hence results in lower corruption rents.

4.2 Corruption in the absence of ego rents

To illustrate the trade-offs faced by the ruling party, we build intuition by deriving the optimal strategy in the absence of ego rents, $u = 0$. In this case, institutional reform is never implemented since it would yield no utility, and the optimal strategy the one that yields the highest expected discounted corruption rents.[14] This yields only pervasive corruption and subsidy as viable strategies. For $u = 0$, (12a) and (12c) can be expressed as

[12] Note that once reform is implemented, the ruling party has no incentive to remove it. Since the only reason why they may wish to do so is to extract corruption rents, and since voters can observe institutional changes, the latter will infer that a party that removes the reform will be corrupt next period and will not reelect it with probability 1. The payoff from removing the reform is hence zero.

[13] There is also the possibility of generating an education expansion by setting the competitive tax rate over a number of periods, which would allow poor dynasties to accumulate sufficient wealth to eventually afford education. As we discuss in the Appendix, this strategy will yield the same predictions as the introduction of public education, and will be preferred over education subsidies when the discount rate is sufficiently low.

[14] Note that in this case, (A1), (A2) and (A5) are always satisfied.

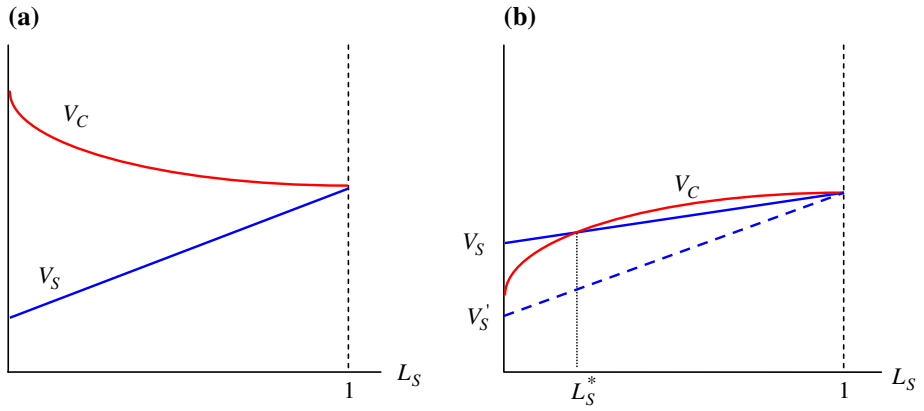

Fig. 3 Political strategies in the absence of ego rents. **a** High productivity. **b** Low productivity

$$V_C[L_S] = \frac{1+\delta}{\delta + Ls}(a_0 A_u + a_0(A_s - A_u)L_S) \tag{13a}$$

$$V_S[L_S, x_u] = a_0 A_s - \frac{qu}{\delta} - (1+r)(e - x_u)(1 - L_S) \tag{13b}$$

The party faces a trade off between extracting low corruption rents over a long period of time or, alternatively, expanding education and obtaining a high corruption rent once. Which of the two strategies delivers the highest payoff depends on the initial level of education, the initial degree of inequality, and parameters such as the discount rate and the production technology.

The level of education plays a crucial role. On the one hand, it reduces the cost of education expansion, making V_S increasing in L_S. On the other, it has two opposing effects on V_C: it increases corruption rents at any point in time but reduces the probability of reelection and thus expected future rents. The level of unskilled productivity determines whether the 'rent effect' dominates the 'reelection effect'. If unskilled productivity is high, the skill premium is low and the rents gained from a more educated population are small, hence the rent effect is unlikely to dominate. Specifically, for $A_u > \delta A_s/(1+\delta)$ the reelection effect dominates making V_C increasing and concave in L_S, while for $A_u < \delta A_s/(1+\delta)$, the V_C schedule is decreasing and convex.

We can then examine graphically which strategy dominates. There are two possible scenarios, depending on whether $A_u > \delta A_s/(1+\delta)$ holds. For high productivity, the $V_C[L_S]$ schedule is decreasing, as depicted in Fig. 3a. In this case, the skill premium, A_s/A_u, is low and hence there is little gain from education expansion, implying that the payoff from corruption is always above that from education subsidies. Figure 3b depicts the case of low unskilled productivity, i.e. $A_u < \delta A_s/(1+\delta)$, so that the skill premium is high and education expansion may result in a large increase in rents. When initial education is low, the increase in rents from education expansion is large. Then, there exists a threshold level of education, L_S^*, such that if $L_S < L_S^*$, then the policy maker opts for education expansion before reaping the corruption rents, while the elected party is permanently corrupt for $L_S > L_S^*$. This implies that economies with *low* initial levels of education are more likely to escape the corruption-poverty trap.

The degree of inequality also affects which strategy is chosen. To see this note that as inequality increases (x_u falls) the V_S schedule tilts downwards, the reason being that greater inequality makes the subsidy more costly and hence reduces corruption rents. When

inequality is low, as is the case for the continuous V_S line in Fig. 3b, education expansion dominates of low values of L_S. The dashed V_S' line represents an economy with high initial inequality: V_S is everywhere below V_C and corruption prevails for all levels of education.

4.3 Education, corruption and institutional reform

The presence of an ego rent provides incentives to simply stay in power and forgo corruption rents. While institutional reform increases the probability of reelection and hence ego rents, it excludes future corruption rents. All three strategies (12a–12c), are now feasible and the payoffs can be expressed as

$$V_C\left[L_S\right] = \frac{1+\delta}{\delta + Ls}\left(u + a_0 A_u + a_0(A_s - A_u)L_S\right) \tag{14a}$$

$$V_{\mathrm{CR}}\left[L_S\right] = \frac{1+\delta}{\delta}u + a_0 A_u + \left(a_0(A_s - A_u) - \frac{qu}{\delta}\right)L_S \tag{14b}$$

$$V_{\mathrm{SR}}\left[L_S, x_u\right] = \frac{1+\delta}{\delta}u + a_0 A_s - \frac{qu}{\delta} - (1+r)(e - x_u)\left(1 - L_S\right) \tag{14c}$$

Clearly V_{SR} is linearly increasing inL_S, and assumptions (A1) and (A4) imply that V_{CR} is also increasing. The payoff from being utterly corrupt maybe increasing or decreasing depending on whether A_u is greater than a threshold $\tilde{A}$, defined in the Appendix. As suggested by the previous section, productivity and the initial degree of inequality are crucial determinants of the dominant equilibrium strategy. Both V_C and V_{CR} shift upwards as $A_u$increases, while V_{SR} tilts upwards as x_u rises. The equilibria resulting from these strategies can be summarized in three broad propositions (that are proven in the Appendix). The propositions assume that assumptions (A1–A5) hold, so that we restrict ourselves to non-trivial equilibria that can be categorized according to a country's unskilled productivity level, A_u.

Proposition 1 *Political equilibria with low productivity, $A_u < \tilde{A}$*

For low levels of productivity of the unskilled, there exist three inequality thresholds, x_u^*, x_u^{**} and x_u^{***},

- (i) *For high levels of inequality, i.e. $x_u < x_u^*$, V_C dominates for low and intermediate levels of education, and V_{CR} dominates for high L_S.*
- (ii) *For intermediate levels of inequality, i.e. $x_u^* \leq x_u \leq x_u^{**}$, V_C dominates for low and intermediate levels of education, and V_{SR} dominates for high L_S.*
- (iii) *For low levels of inequality, i.e. $x_u^{**} < x_u < x_u^{***}$, V_C dominates for intermediate values of L_S, while V_{SR} dominates for low and high levels of education.*
- (iv) *If inequality is sufficiently low, the subsidy-reform strategy, V_{SR}, dominates all other strategies irrespective of initial L_S.*

These three cases, depicted in Fig. 4a, represent countries with low unskilled productivity. In this case the expansion of education may dramatically increase income and rents to incumbents. Case (i) is that of a country with high initial inequality. High inequality implies that the subsidy required for education expansion is large, which renders the payoff to education expansion through subsidies, V_{SR}, unattractive. The party in power then faces a tradeoff between obtaining corruption rents for many periods but risking not being reelected and giving up monetary rents and for certain ego rents though institutional reform. Low and intermediate levels of skilled labor generate pervasive corruption, V_C, and high levels of educated workers L_S, induce corrupt-reform strategies, V_{CR}, because the threat of being caught is high. In this case, the government chooses to 'tie its hands' and introduces reform after one period of corruption.

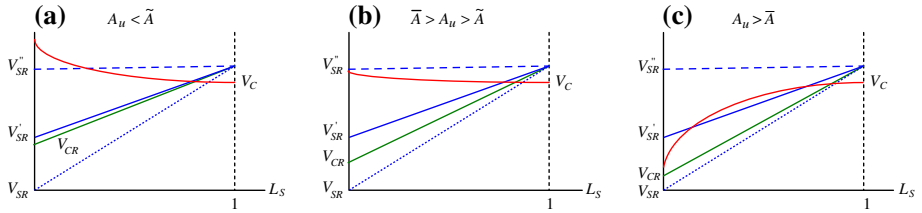

Fig. 4 Political strategies with ego rents and redistributive education subsidies. **a** Low productivity $A_u < \tilde{A}$. **b** Intermediate productivity $\tilde{A} > A_u > \bar{A}$. **c** High productivity $A_u > \bar{A}$. Note: V_{SR}, V'_{SR}, V''_{SR} represented by *dotted, solid* and *dashed lines* are associated with high, medium, and low initial inequality, respectively

For intermediate levels of inequality (case *ii*), corruption rents are still sufficiently large to render education expansion unattractive, while the threat of being caught is not sufficiently strong to make reform desirable. The optimal strategy is hence to maintain the current education level and be corrupt every period. Again, it is only when the level of education is sufficiently high, that the government resorts to reforms in order to stay in power.

For countries with low levels of inequality (case *iii*), corruption rents are low when education is low and the highest payoff is obtained by introducing an education expansion to increase future rents. If in equality is low and initial education is high, then the probability that a corrupt government is caught is so high that it is again optimal to introduce reform in order to increase the probability of reelection. But since reform makes future corruption impossible, the government will want to assure that the current monetary rents as high as possible, and introduce education subsidies to educate the entire population. Economies with intermediate levels of education will, however, be stuck with pervasive corruption. The reason is that the gain in terms of corruption rents from educating the entire population is not sufficiently high, while the threat of not being reelected is not sufficiently strong.

Lastly, if inequality is sufficiently low (case *iv*), the small cost of a potential education subsidy renders education expansion an attractive policy. Hence subsidy-reform, V_{SR}, dominates all other strategies irrespective of the initial level of education and universal education is achieved.

Consider now economies with an intermediate level of unskilled productivity, $\bar{A} > A_u \geq \tilde{A}$, where is a $\bar{A}$ second threshold productivity level, defined in the Appendix. We now have the following proposition:

Proposition 2 *Political equilibria with intermediate productivity,* $\bar{A} > A_u \geq \tilde{A}$

For intermediate levels of productivity of unskilled workers, there exist two inequality thresholds, x_u^* *and* x_u^{**}

- (*i*) *For high levels of inequality, i.e.* $x_u < x_u^*$, V_C *dominates for low and intermediate levels of education, and* V_{CR} *dominates for high* L_S.
- (*ii*) *For intermediate levels of inequality, i.e.* $x_u^* \leq x_u \leq x_u^{**}$, V_C *dominates for low and intermediate levels of education, and* V_{SR} *dominates for high* L_S.
- (*iii*) *For low levels of inequality, i.e.* $x_u > x_u^{**}$, V_{SR} *dominates for all values of* L_S.

For sufficiently high productivities of the unskilled, $A_u \geq \tilde{A}$, the increase in rents that a party may reap by increasing education is small. Instead, the effect of education on reelection probabilities dominates and therefore increasing workers' education reduces the payoff for corrupt parties (i.e. V_C is decreasing and convex as depicted in Fig. 4b). The intuition from proposition 1 carries over directly to Proposition 2 with one important difference: intermediate levels of inequality, depicted by the schedule V'_{SR}, result in corrupt regimes not only

for intermediate levels of education but also for low L_S. Corruption dominates because a high level of A_u implies a low skill premium, and thus reduces the gains from education expansion, which renders corruption as the more attractive option than education subsidies. Note, however, that a sufficiently low degree of inequality, represented by the dashed V''_{SR} schedule, allows both low and middle education countries to escape corruption.

Lastly, we need to consider the case of a country with a high level of unskilled productivity, implying a low skill premium. That is, $A_u \geq \bar{A}$. The possible equilibria in this case are given by the following proposition:

Proposition 3 *Political equilibria with high productivity,* $A_u \geq \bar{A}$

For high levels of productivity one inequality threshold remains, x_u^**, such that*

- (i) *For high levels of inequality, i.e.* $x_u < x_u^*$, V_C *dominates for low and intermediate levels of education, and* V_{CR} *dominates for high* L_S.
- (ii) *For low levels of inequality, i.e.* $x_u \geq x_u^*$, V_C *dominates for low and intermediate levels of education, and* V_{SR} *dominates for high* L_S.

Proposition 3, and the associated Fig. 4c, emphasize that countries with highly productive unskilled workers are unlikely to experience reforms. High productivity of the unskilled could be explained, for example, by the presence of natural resources in the country or by "high-yield" crops such as those that produce illegal drugs. The resulting low skill premium implies that education expansion is not an attractive option. Only when the share of the population that is educated, L_S, is sufficiently large, will the threat of an ouster from power induce a government to reform. As a result, pervasive corruption dominates for all but high levels of L_s. It is important to note that, for certain parameter values, the threshold $\bar{A}$ will be outside the range of possible values of A_u.[15] Hence, Proposition 3 may not apply.

The three propositions highlight that the optimal strategy depends on three elements. First, unskilled productivity is crucial because it determines the magnitude of the rents that can be extracted from an uneducated population, and hence the payoff to education expansion. The greater the productivity of the unskilled is, the higher the incentives for corruption. This implies that the presence of natural resources or international transfer of unskilled technology raises incentives for corruption. Second, initial inequality is the key determinant of the cost of education subsidies and therefore the return to the subsidy-reform strategy, V_{SR}. Lastly, for given levels of inequality and productivity, the initial level of education determines both the rents gained from education expansion as well as the cost in terms of reduced reelection probabilities.

4.4 Universal education subsidies

Many countries have introduced publicly funded education that is equivalent to universal education subsidies. In this case, the cost of the subsidy does not depend on the number of poor individuals and it is given by $(1+r)(e-x_u)$. The payoff from a strategy that involves universal education subsidies is then

$$V_{\text{USR}}[x_u] = \frac{1+\delta}{\delta}u + a(1+\varphi) - \frac{qu}{\delta} - (1+r)(e-x_u). \tag{15}$$

Note that the payoff to this strategy is independent of L_s because neither corruption rents (determined by the level of education *after* the expansion), nor the subsidy costs depend on the level of education.

[15] For example, this will be the case when u=0. See "Appendix".

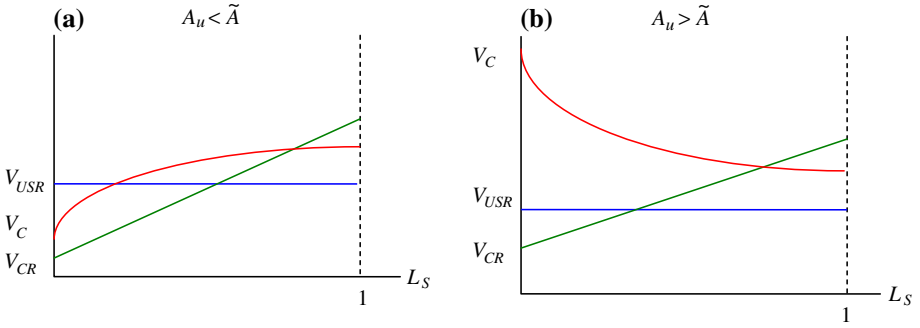

Fig. 5 Political strategies with universal education subsidies. **a** Low productivity. **b** High productivity

In this case the three possible strategies are: pervasive corruption, V_C, corruption-reform, V_{CR}, and universal education-corruption-reform, V_{USR}. Appendix II examines the relative payoffs under these three strategies, and they relative payoffs are given in Fig. 5.

There are two possible configurations of the payoff schedules. Figure 5a considers the case of low unskilled productivity. For low levels of education V_{USR} is preferred, for intermediate levels the ruling party's dominant strategy is to be utterly corrupt, while for highly educated populations V_{CR} dominates. Again the initial level of inequality is important as higher inequality (a downwards shift of V_{USR}) rules out education subsidies, while sufficiently low inequality (an upward shift of V_{USR}) ensures that pervasive corruption is never implemented. The case of high unskilled productivity is depicted in Fig. 5b, where the education subsidy strategy is never viable. If the level of education is low, pure corruption, V_C, is preferred as the threat of not being reelected is small. For high levels of education, corruption-reform, V_{CR}, dominates as the increase in the corruption rent is insufficient to compensate for the reduced reelection probability.

In summary, even under universal subsidies or public education, our results are unchanged for economies with low and intermediate levels of initial education. However, the analysis for economies with high initial levels of education is slightly modified. These countries can never witness the introduction of public education and experience political reform under all parameter configurations.

5 The evolution of wealth

We can now examine the evolution of wealth under the different strategies. If the party is always corrupt, the economy maintains the two class distribution with the same number of skilled and unskilled as there were initially, and their steady state wealth converges to $\bar{x}_u\left[\tau^*\right] < e$ and $\bar{x}_s\left[\tau^*\right] > e$. The resulting output is low for two reasons: first, the high tax rate implies a low capital-labor ratio and, second, because a fraction of the labor force remains uneducated.

If institutional reform is passed at time t, the amount of skilled labor is unchanged for N-1 periods. During these periods the lower tax rate allows unskilled dynasties to increase their bequests, and at N the entire labor force can afford education. In this case, development is fostered by political reforms that also trigger subsequent education expansion. Lastly, when the party in power subsidizes education (either through targeted or universal subsidies) it induces an immediate expansion of human capital. In contrast to the previous case, the expansion of education occurs first and is then followed by institutional change. These results are summarized in Proposition 4:

Proposition 4 *Political strategies and long-run development*

Consider the three possible strategies chosen by the party:

(*i*) *If the party is permanently corrupt the economy remains in a low-education, low-output, high-inequality trap.*

(*ii*) *If the party implements institutional reform, wealth accumulation eventually allows the unskilled to acquire education, leading to high output and an equal distribution of wealth.*

(*iii*) *If the party subsidizes education, the increase in education leads to high output and an equal distribution of wealth. Education expansion will then bring about institutional change.*

6 Discussion and conclusions

Our analysis has allowed for education to affect the efficacy of political participation in democracies and results in various possible patterns of development when education and corruption are endogenous. Three main results emerge. The first one concerns the question of whether high quality institutions "cause" education, or education "causes" quality institutions. We threat both education and institutions as endogenous, emphasizing that their levels are equilibrium outcomes that render notions of causality meaningless. The only causality identified by the model is between initial inequality and human capital and the subsequent development path.

The second key implication of our analysis is the emphasis on two possible development paths. In one case, institutional reform reduces corruption and eventually leads to education expansion. That is, an improvement in institutions brings about education and equality. An alternative development path occurs when education subsidies result in an increase in human capital, which limits future corruption on the part of the government. Institution-led development is only possible in highly educated economies, and will occur when inequality is high. Development will be education-led when the distribution of wealth not too unequal. It can occur both in economies with high and with low initial levels of human capital, though in the latter it can only take place if the productivity of the unskilled is low.

Lastly, although we have postulated a positive relationship between education and political knowledge at the individual level, this does not translate into a monotonic relationship between aggregate education and corruption. This is because education has two opposite effects: it increases income and hence the corruption rent obtained by a corrupt party, but also raises the efficacy of political participation and therefore decreases the reelection probabilities of corrupt parties. The result of these opposing forces is that countries with low levels of education may fare better in the long-run than those with intermediate levels of education. Two conditions are required for the former to escape low levels of development. First, the productivity of the unskilled must be low so that current corruption rents are low. Second, inequality cannot be too high, as otherwise education expansion is too costly to the incumbent. In contrast, resource-rich countries with high unskilled productivity are likely to remain locked in a high-corruption/low-education equilibrium.

These findings are consistent with empirical evidence which indicates that resource abundance may lead not only to low growth rates but also to poor governance.[16] In the introduction we have argued that Botswana, Mauritius and Zimbabwe provide examples of countries in the

[16] See Bulte et al. (2005) for empirical evidence, and Robinson et al. (2006) for an analysis of institutional determinants of the resource curse.

three equilibria we have obtained. Botswana implemented educational expansion, Mauritius experienced institutional reforms, and Zimbabwe—a country with intermediate educational attainment at the time of independence- being caught in a corruption-poverty trap. Similarly, consider the case of Latin America, whose economies have been, to a large extent, characterized by poor institutions and widespread corruption. In the mid-20th century these economies featured intermediate levels of education.[17] Corruption rents were therefore sufficiently large while the efficacy of political participation was insufficiently high to impose sufficient punish for corrupt behavior. As a result, these economies were locked in a bad-institutions/low-output/high-inequality equilibrium.

A final example is provided by East Asia and (most) sub-Saharan African economies. In the mid-20th century, at the end of colonization, many countries in these regions were characterized by extremely low levels of educational attainment. In the 1950s the perception among development economists was that the serious problem was faced by East Asia. African countries were resource rich, and natural resources would bring in the revenues needed to trigger growth (Hance 1956); East Asian economies were uneducated, resource poor, and highly populated, and hence had no way of escaping the poverty trap. Yet, the next few decades witnessed large public education programs and a massive increase in per capita incomes in the Asian economies, and stagnation in most African countries (Temple 1999). At the same time, institutions in the former economies experienced substantial improvements, while the latter remained ridden by corruption (see Glaeser et al. 2004).

Our analysis suggests a possible explanation for these observed disparities. As well as poor, East Asian countries were relatively equal (see the discussions in Benabou 1996, and Aghion et al. 1999). The model predicts that under these conditions the optimal strategy for the party in power is to fund education at a large scale, with the resulting expansion in educational attainment leading to higher output levels and eventually to institutional change. In contrast, in most African economies, abundant natural resources made the productivity of the unskilled high, leading to large potential rents. Corruption prevailed, impeding education and maintaining low output levels.

Appendix I

In this Appendix we examine the payoffs to the party from the possible strategies derived in Sect. 4, and prove the propositions. There are five possible strategies,

$$
\begin{aligned}
V_H &= \frac{1+\delta}{\delta}u, \\
V_C\left[L_S\right] &= \frac{1+\delta}{\delta+Ls}(u+a(1+\varphi L_S)), \\
V_{\mathrm{CR}}\left[L_S\right] &= \frac{1+\delta}{\delta}u+a+\left(a\varphi-\frac{qu}{\delta}\right)L_S, \\
V_{\mathrm{SR}}\left[L_S,x_u\right] &= \frac{1+\delta}{\delta}u+a(1+\varphi)-\frac{qu}{\delta}-(1+r)(e-x_u)(1-L_S), \\
V_{\mathrm{HCR}}[N] &= \frac{1+\delta}{\delta}u+\frac{1}{(1+\delta)^N}\left(a(1+\varphi)-\frac{qu}{\delta}\right).
\end{aligned}
$$

[17] Other arguments that have been put forward for the poor economic performance of Latin American economies include vested interests of landed elites, and social conflict. See, for example, Acemoglu and Robinson (2006, 2008).

The strategies are defined in the text except for the first and the last. V_H is the payoff from being honest in all periods, which is simply the discounted ego rents. $V_{\text{HCR}}[N]$ is the payoff from the following strategy. The party is initially honest, choosing a competitive tax for N-1 periods, which allows poor dynasties to accumulate wealth and become educated in period N. Honesty ensures reelection for N periods. At N, the party sets the corrupt tax rate and obtains rents. Since the entire population is now educated, the party would choose to pass constitutional reform at N in order to have a positive probability of staying in power. That is, there are two alternative ways to induce education expansion: $V_{\text{SR}}[L_S, x_u]$ and $V_{\text{HCR}}[N]$. The strategy $V_{\text{SR}}[L_S, x_u]$ yields lower rents (as the subsidy has to be financed) but the rents are obtained immediately; $V_{\text{HCR}}[N]$ provides a higher rent but requires waiting for N periods before obtaining it. The payoff $V_{\text{HCR}}[N]$ is independent of the level of education, but affected by the distribution of wealth, since a lower x_u increases N.

Note that strategies such as being corrupt for two periods and then introducing reform are not possible, since under corruption, the economy is the same every period. Hence, if at t it were optimal to be corrupt for n periods (say, from t to $t+n-1$) and pass reform at $t+n$, then at $t+1$ it will also be optimal to be corrupt for n periods and then pass reform at $t+n+1$, and so on. This would imply that the party always postpones reform, i.e. that it is permanently corrupt.

Before deriving the propositions, recall our parametric assumptions (A1–A5)

$$A_u > \frac{u}{\delta a_0}, \tag{A1}$$

$$A_s > \frac{u}{\delta a_0}\frac{1+2\delta}{\delta}, \tag{A2}$$

$$\tau^c < \bar{\tau}_u < \tau^* < \hat{\tau}, \tag{A3}$$

$$A_s > (1+q)A_u, \tag{A4}$$

$$\frac{\delta a_0 A_s - qu}{(1+\delta)(1+r)} > e > u(1-q)\frac{1+\delta}{\delta(1+r)}. \tag{A5}$$

Assumptions (A1) and (A2) rule out V_H as an optimal strategy, while (A5) implies that $V_{\text{SR}}[L_S, x_u] > V_{\text{HCR}}[N]$, and hence the latter is never chosen. To show this, note that $V_{\text{SR}}[L_S, x_u] > V_{\text{HCR}}[N]$ if and only if $(1+r)(e-x_u) < (a(1+\varphi) - qu/\delta)\left(1-(1+\delta)^{-N}\right)$, and the first inequality in (A5) ensures that this condition holds for all values of x_u (and hence of N).

Consider the three remaining strategies, $V_C[L_S]$, $V_{\text{CR}}[L_S]$, and $V_{\text{SR}}[L_S, x_u]$. Recalling that $a = a_0 A_u$ and $\varphi = A_s/A_u - 1$, we can show the following:

- $V'_{\text{CR}} > 0$ and $V'_{\text{SR}} > 0$,
- $V'_C > 0$, $V''_C < 0$ if and only if $A_u < \tilde{A}$, where $\tilde{A} \equiv (\delta A_s - u/a_0)/(1+\delta)$,
- $V_C[0] > V_{\text{CR}}[0]$ and $V_C[1] < V_{\text{CR}}[1]$,
- $V_{\text{SR}}[1, x_u] = V_{\text{CR}}[1]$, while $V_{\text{SR}}[L_S, x_u] \leq V_{\text{CR}}[L_S]$ if and only if $x_u \leq x_u^*$ where

$$x_u^* \equiv e - \frac{a_0(A_s - A_u) - qu/\delta}{1+r},$$

- $V_{\text{SR}}[1, x_u] > V_C[1]$, while $V_{\text{SR}}[0, x_u] \leq V_C[0]$ if and only if $x_u \leq x_u^{**}$ where

$$x_u^{**} \equiv x_u^* + \frac{a_0 A_u}{(1+r)\delta}.$$

- $V_{\text{SR}}[0, e] \leq V_C[0]$ if and only if $A_u \geq \bar{A}$, where $\bar{A} \equiv (\delta A_s - qu/a_0)/(1+\delta)$ and $\bar{A} > \tilde{A}$ since $q < 1$.

We can now prove the four propositions.

Proof of Proposition 1 When $A_u < \tilde{A}$ the schedule V_C is increasing and concave. We then need to consider four cases.

(*i*) Suppose $x_u < x_u^*$. Then $V_{\text{SR}} < V_{\text{CR}}$ for all values of L_S and V_{SR} is never chosen. We hence need to compare V_C and V_{CR}. Since $V_C[0] > V_{\text{CR}}[0]$ and $V_C[1] < V_{\text{CR}}[1]$, the two schedules intersect once. V_C dominates for low values of L_S, and V_{CR} dominates for high values of L_S.

(*ii*) Suppose $x_u^* \leq x_u \leq x_u^{**}$. Since $x_u \geq x_u^*$, then $V_{\text{SR}} \geq V_{\text{CR}}$ for all values of L_S and V_{CR} is never chosen. We hence need to compare V_C and V_{SR}. Note that $x_u \leq x_u^{**}$ implies $V_{\text{SR}}[0, x_u] \leq V_C[0]$. Hence the two schedules intersect once, with V_C dominating for low values of L_s, and V_{SR} for high values of L_S.

(*iii*) Suppose $x_u > x_u^{**}$, which as above rules out V_{CR}. Note that $x_u > x_u^{**}$ implies that V_C is below V_{SR} both at $L_S = 0$ and $L_S = 1$. Moreover, the second inequality in (A5) implies that for $x_u = x_u^{**}$ the slope of V_C is greater than that of V_{SR} when both are evaluated at $L_s = 0$. Hence there will be either two or no intersections between V_{SR} and V_C. Hence the two schedules either intersect twice or do not intersect. Increasing x_u reduces the slope of the V_{SR} schedule without affecting its value at $L_S = 1$, while changes in x_u do not affect V_C. Hence there exists a value x_u^{***} such that $V_{\text{SR}}\left[L_S, x_u^{***}\right]$ is tangential to V_C. That is, for $x_u^{**} < x_u < x_u^{***}$ the two schedules intersect twice, with V_C dominating for intermediate values of L_s, and V_{SR} for low and high values of L_S.

(*iv*) Suppose that $x_u \geq x_u^{***}$. Then V_C is below V_{SR} for all values of L_S and the latter strategy dominates.

□

Proof of Proposition 2 Consider the case $\bar{A} > A_u \geq \tilde{A}$. When $A_u \geq \tilde{A}$ the schedule V_C is decreasing and convex, while $\bar{A} > A_u$ implies that there exists a value of x_u which satisfies $x_u < e$ and for which $V_{\text{SR}}[0, x_u] > V_C[0]$. We then need to consider three cases.

(*i*) Suppose $x_u < x_u^*$. Then $V_{\text{SR}} < V_{\text{CR}}$ for all values of L_S and V_{SR} is never chosen. We hence need to compare V_C and V_{CR}. Since $V_C[0] > V_{\text{CR}}[0]$ and $V_C[1] < V_{\text{CR}}[1]$, the two schedules intersect once. V_C dominates for low values of L_S, and V_{CR} dominates for high values of L_S.

(*ii*) Suppose $x_u^* \leq x_u \leq x_u^{**}$. Since $x_u \geq x_u^*$, then $V_{\text{SR}} \geq V_{\text{CR}}$ for all values of L_S and V_{CR} is never chosen. We hence need to compare V_C and V_{SR}. Since V_C is decreasing and V_{SR} increasing, the two schedules either intersect once or do not intersect. Note that $x_u \leq x_u^{**}$ implies $V_{\text{SR}}[0, x_u] \leq V_C[0]$. Hence the two schedules intersect once, with V_C dominating for low values of L_s, and V_{SR} for high values of L_S.

(*iii*) Suppose $x_u > x_u^{**}$, which as above rules out V_{CR}. Since $x_u > x_u^{**}$ implies that V_C is below V_{SR} both at $L_S = 0$ and $L_S = 1$, then V_{SR} is above V_C for all values of L_S.

□

Proof of Proposition 3 Consider the case $A_u \geq \bar{A}$. Since this inequality implies $A_u \geq \tilde{A}$, the schedule V_C is decreasing and convex. Meanwhile, $A_u \geq \bar{A}$ implies that $V_{\text{SR}}[0, e] < V_C[0]$. That is, even for the lowest possible level of inequality $x_u = e$, the V_C schedule is above V_{SR} for $L_S = 0$. We then need to consider two cases.

(*i*) Suppose $x_u < x_u^*$. Then $V_{\text{SR}} < V_{\text{CR}}$ for all values of L_S and V_{SR} is never chosen. We hence need to compare V_C and V_{CR}. Since $V_C[0] > V_{\text{CR}}[0]$ and $V_C[1] < V_{\text{CR}}[1]$,

the two schedules intersect once. V_C dominates for low values of L_s, and V_{CR} dominates for high values of L_S.

(*ii*) Suppose $x_u \geq x_u^*$. Since $x_u \geq x_u^*$, then $V_{\text{SR}} \geq V_{\text{CR}}$ for all values of L_S and V_{CR} is never chosen. We hence need to compare V_C and V_{SR}. Since $V_C[1] < V_{\text{CR}}[1]$ and $V_C[0] > V_{\text{CR}}[0]$ irrespective of the degree of inequality, the two schedules intersect once. V_C dominates for low values of L_S, and V_{SR} dominates for high values of L_S.

□

Proof of Proposition 4 Proposition 4 follows from assumption (A3). If the party is permanently corrupt, τ^* will be chosen. Since $\bar{\tau}_u < \tau^*$, then the unskilled will never be able to study and the fraction of educated dynasties will be unchanged. If the party implements institutional reform, the only possible tax rate is τ. Since $\tau^c < \bar{\tau}_u$, unskilled dynasties will accumulate wealth and eventually be able to study. When the party introduces education expansion, this policy will result in $L_S = 1$. In order to increase its reelection probability, the party in power will undertake institutional reform. □

We need to check whether the thresholds for A_u that we have defined are in the range of possible parameter values. That is, whether $\tilde{A} > u/(a_0\delta)$ and $\bar{A} < A_s/(1+q)$. First note that $\tilde{A} > u/(a_0\delta)$ if and only if $A_s > u(1+2\delta)/a_0\delta^2$, which is precisely assumption (A2). Second, $\bar{A} < A_s/(1+q)$ if and only if $(1+q)qu > A_s(\delta q - 1)$. This inequality will be satisfied when q=0 but not when u=0. Hence, for certain parameter values, the threshold $\bar{A}$ will be outside the range of possible values of A_u, and Proposition 3 will not apply.

Lastly, we need to verify that the various parameter restrictions are compatible. In particular consider (A3). Note that $\tau^c < \bar{\tau}_u < \tau^*$ can be expressed in terms of the basic parameters as $\lambda_u(1-c\phi)^{1/(1-\alpha)} > e(1/(\beta(1+r))-1) > \lambda_u(\alpha(1-c\phi))^{1/(1-\alpha)}$. It is hence a condition on the degree of intergenerational altruism β, requiring that altruism is neither too high -as this would allow poor dynasties to study even with high taxes- nor too low—which would make them unable to afford education even under low taxes. The inequality $\tau^* < \hat{\tau}$ is equivalent to $(1-\alpha)(\alpha/r)^{\alpha/(1-\alpha)}(\alpha(1-c\phi))^{1/(1-\alpha)}(A_s - A_u) > e$, which like (A4) requires the skill premium to be sufficiently high.

Appendix II

Consider now the case in which education subsidies are universal. We then have

$$V_{\text{USR}}[x_u] = \frac{1+\delta}{\delta}u + a(1+\varphi) - \frac{qu}{\delta} - (1+r)(e - x_u)$$

As before, there are two possible strategies that result in education-led development, $V_{\text{USR}}[x_u]$ and $V_{\text{HCR}}[N]$. As before, we find that (A5) ensures that $V_{\text{USR}}[x_u] > V_{\text{HCR}}[N]$. Our analysis would be unchanged if we had a high cost of education so that $V_{\text{USR}}[x_u]$ is below $V_{\text{HCR}}[N]$. The only difference would be that education expansion would occur not because the government subsidizes education, but because low tax rates allow poor dynasties to accumulate sufficient wealth to eventually study.

Consider strategies, $V_C[L_S]$, $V_{\text{CR}}[L_S]$, and $V_{\text{USR}}[x_u]$. We can show that $V_{\text{USR}}[x_u] < V_{\text{CR}}[1]$, while $V_{\text{USR}}[x_u] \leq V_C[0]$ if and only if $x_u \leq x_u^{**}$. It is then straight forward to show that there are two possible configurations, as depicted in Fig. 5.

Appendix III

Lastly, consider the political equilibria if assumption (A3) does not hold so that either $\tau^* < \bar{\tau}_u$ or $\tau^c > \hat{\tau}$. If the cost of education is sufficiently low, i.e. $\tau^* < \bar{\tau}_u$, unskilled dynasties can study even under the corrupt tax rate. Then $L_S = 1$ irrespective of the tax rate and initial conditions, and V_{CR} will be the dominant strategy since it has the highest payoff under full education. If education costs are sufficiently high, then $\tau^c > \hat{\tau}$, implying that even the competitive tax rate would be too large for the wealthiest individuals to study. The economy would then converge to $L_S = 0$ irrespective of the tax rate and the initial level of education. Note, however, that whether it escapes or not corruption depends on the initial level of education. If the initial level of education was sufficiently high, V_{CR} will dominate and there will be no corruption in the long-run. If the initial level of education is low, V_C dominates implying that output is low both because $L_S = 0$ and because of the high (corrupt) tax rate.

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