United Nations University

WIDER

World Institute for Development Economics Research

Research Paper No. 2005/21

Wealth Distribution, Lobbying and Economic Growth

Theory and Evidence

Daniel T. Haile *

May 2005

Abstract

This paper presents a model allowing one to analyze the joint determination of inequality, taxes, human capital and growth. We consider the political economy of redistribution between three income groups in a dynamic economy. The paper seeks to explain the effect of corruptibility (exemptions) and lobby group size on policy outcomes. Theoretically, this paper provides a linkage between lobbying activities, wealth distribution and growth. By endogenizing the weights the social planner gives to their constituents, our analysis explains why the relationship between redistribution and inequality is non-monotonic. In particular, the theory predicts a non-monotonic relation between the level of education, taxation and growth. Our empirical results, moreover, confirm the conjectured effect that in economies with a higher degree of corruption and inequality, we observe a lower tax/GDP ratio, leading to a lower development of human capital and thus lower growth.

Keywords: income, redistribution, corruption, system of equations, panel data

JEL classification: C23, D31, D92, H26, I22, O15, O41

* PhD Fellow, Department of Economics and CentER, Tilburg University, The Netherlands; d.haile@uvt.nl.

This study has been prepared within the UNU-WIDER Internship Programme and is published in the project on ‘New Directions in Development Economics’.

UNU-WIDER acknowledges the financial contributions to the research programme by the governments of Denmark (Royal Ministry of Foreign Affairs), Finland (Ministry for Foreign Affairs), Norway (Royal Ministry of Foreign Affairs), Sweden (Swedish International Development Cooperation Agency—Sida) and the United Kingdom (Department for International Development).

ISSN 1810-2611 ISBN 92-9190-700-6 (internet version)

Acknowledgements

The preliminary version of this paper was finished during my visit to UNU-WIDER as part of the Internship Programme.

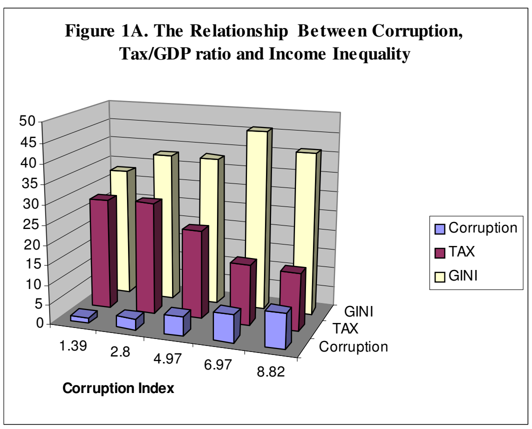
I am grateful for helpful comments from conference audiences at the Association of Public Economic Theory (APET) international meeting in Beijing. I also thank Lex Meijdam and Tony Addison for their helpful comments.

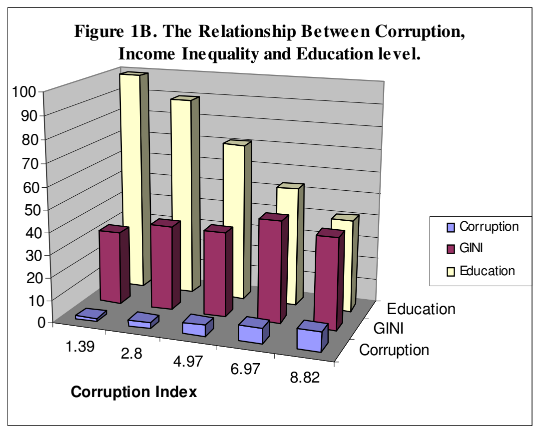
UNU World Institute for Development Economics Research (UNU-WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction

Investment in human capital affects income distribution mainly through the labor market. People with more education earn more in wage employment than people with less education. Greater human capital facilitates the adoption of technology and wages are likely to be higher. If this would be general, the question arises why do some countries under-invest in human capital while others don't?

The answer to this question lies in the mix of institutional setup and the degree of inequality. Figures 1A and 1B show the relationship between redistributive measures (Tax/GDP ratio) and level of education with respect to the level of corruption and the degree of inequality.[1] The diagrams show that in countries where a higher level of inequality and corruption dominate the economy, there is low level of Tax/GDP ratio and low accumulation of human capital, consequently lower growth rates.





One of the explanations given for this phenomenon is the existence of wealth bias in a political system. Taking the case of East Asian and Latin American countries as an example, South Korea and Taiwan engaged in early redistribution through land reform and higher pro-poor public spending so as to win political power against communist insurgency. By contrast, Latin American countries have long histories of high income inequality and find it difficult to raise taxes as policies are twisted towards the benefit of urban elites. For more on such circles, see Addison and Rahman (2001). In

[1] The corruption index is goes from 0 to 10, where 10 stands for highly corrupted countries.

a cross country regressions, Perotti (1996) finds that redistribution, proxied by different government redistribution measures, is negatively related to unequal societies.[2]

Benabou (2000) provides a theoretical underpinning for the existence of wealth bias in a political system arguing that the decisive voter has a higher income than the median voter.[3] If his income is sufficiently high, then redistribution will raise his cost and hence he/she will oppose a higher taxation. Benabou's idea is indeed relevant, but his model does not explain what determines the position of the decisive voter and how it changes over time. This is exactly what we want to explore in the present paper by investigating a model in which the pressure for redistribution changes endogenously during the interaction of economic agents and the growth process over time.

To the best of our knowledge, studies conducted to endogeneize the weight the politician attaches to its constituents are very rare. This paper, however, does so by linking the political decisions to economic variables rather than only to political settings. Not only does it explain why the relationship between redistribution and inequality is non-monotonic, but it also tries to contribute to the understanding of why some societies invest more in human capital than others. We use a pressure group model, that assumes active participation of potential voters in the form of lobbying to influence policies.[4] Our model of the political process is similar to Grossman and Helpman (1994) and Rodriguez (2000).[5] However, these papers typically neglect dynamic issues and focus on an endogenous policy model with interest groups of a fixed size. According to Baron (2002) little is known about the dynamics of political choice and how interest group strategies might change in such a setting. This paper however, will attempt to examine the dynamics of a policy choice since a policy choice by the politician requires to take into account the current period utility.

In this model, politicians maximize political support by mixing popular policies with campaign

[2] Note that this is contrary to the papers of Bertola (1993), Alesina and Rodrik (1994) and Persson, and Tabellini (1994). They show that greater skewness in the distribution of income leads to more redistribution in democratic societies. However, the evidence for a negative relationship between growth and redistribution is weak.

[3] The link between inequality, corruption and growth finds support in the numerous surveys in which business people sound their concern for corruption and preferential treatment (Lambsdorff 2002).

[4] Such activities are a common practice in democracies and often require real resources which would otherwise be utilized in direct production (see Rodriguez, 2000)

[5] Most recent contributions that apply this influence function approach to the politics of inter generational redistribution are Becker and Mulligan (1998) and Mulligan and Sala-i-Martin (1999).

spending. Campaign contributions are offered by individuals who are wealthy people with greater incentives and opportunities to use bribery (both grand political corruption and bureaucratic corruption) and fraud to escape taxation.[6] The effective pressure of lobbying depends not only on the economic position of its members but also on the size of the group and political activity. The unskilled are less likely to be exempt, as getting exemption demands financial contributions. They can be politically active groups, however, by investing time in political activities such as strikes, working on campaigns, writing to members of parliament, lockouts etcetera. In line with this, we assume that individuals who favour higher taxes invest time to influence the political outcome, i.e. the level of redistribution.[7]

On the economic side, we develop a two-sector endogenous growth model in which growth is driven by human capital, and capital markets are missing. It is important to note that investment in human capital is indivisible, as in Galor and Zeira (1993), which in turn implies that in the long run there will be polarization of wealth between educated (rich) individuals and uneducated (unskilled) ones. In such an economy, investment in human capital tends to be inefficiently low and redistribution may have significant effects on growth. Given this political and economic venue, we ask whether the dynamic political process leads to growth enhancing redistribution. Hence, in our model, the distribution of income, human capital accumulation, the growth rate, the tax rate and the weight the social planner attaches to society are simultaneously endogenous and are analyzed in a dynamic setting.

We conjecture that the actual tax revenue (effective tax rate) could be lower than the growth maximizing tax revenue as the rich people evade from paying taxes by bribing politicians. The potential tax revenue, which is positively related to human capital accumulation, will be blocked due to opposing forces leading to multiple steady state equilibria.[8] Thus, our paper can be viewed in terms of its contribution as providing an explicit mechanism through which politics leads to inefficiency.

Moreover, the paper provides empirical evidence for the prediction of the theoretical model.

[6] In this paper we neglect the benefits of campaign spending, rather we focus on the drawback of fund raising i.e. funds raised for corruption and the like.

[7] Studies of voting behavior indicate that political activity depends on the state of the macro-economy. For example Radcliff (1992) and Filer and *et al.* (1993) find that as real wages decline mobilization tend to rise and as a consequence voter turn out tend to increase.

[8] For a detailed description of the political process we refer to Section 2.3.

Given the endogeneity of the aforementioned variables, we build systems of equations and estimate the model using three stage least squares to analyze the relationship between these variables. Moreover, we also explore panel estimates. Our main findings are: both corruption and income inequality significantly reduce the tax/GDP ratio; the relationship of growth with respect to both effective tax rate and level of education is non-monotonic, the relation between effective tax rate and level of education is nonlinear.

We proceed in the following fashion. We first introduce the economy by specifying production, preferences, the extent of redistribution and how this redistribution is determined endogenously. The rationale behind the major incentive for exemptions and their economic consequences are also covered, and it is pointed out that the erosion of the tax base are worth more to the observed inefficiency. Section 3 examines the dynamics of bequests and redistribution. Section 4 explains the non-monotonicity of the relation between redistribution and growth and presents some numerical simulation results. Section 5 provides an empirical support for our hypothesis and reports the main findings. The last section concludes.

2 The Model

The model builds on Haile and Meijdam (2004). In this section we describe the economics, politics and the dynamic structure of the society at hand. We introduce a standard two-OLG model of a small open economy where parents are altruistic and leave bequests. We first present a brief description of the technology and behavior of households given the political institutions. Subsequently, we elaborate on the political process.

2.1 The Technology

There is a single good that can be produced with a simple linear technology using skilled labour S_t and unskilled labour U_t:

$$Y_t = A_t^u U_t + A_t^s S_t \tag{1}$$

Each type of labour is paid its marginal product, that is, $w_t^u = A_t^u$ and $w_t^s = A_t^s$. It is assumed that high skilled labour is more productive than unskilled labour: $w_t^s > w_t^u$. We assume that there is a continuum of knowledge innovations that increases production of skilled and unskilled via learning by doing. That is, knowledge creation is driven by production by skilled and unskilled workers and there are spill overs from one type of workers to the other:

$$\begin{cases} \Delta A_t^s = \theta^s \left(A_t^s S_t\right)^{\phi} \left(A_t^u U_t\right)^{1-\phi} \\ \Delta A_t^u = \theta^u \left(A_t^s S_t\right)^{\pi} \left(A_t^u U_t\right)^{1-\pi} \end{cases} \tag{2}$$

The parameters ϕ and π reflect the effect of production (and thus of the existing stock of knowledge) on the success of new knowledge production. We assume that skilled production is more important for the creation of knowledge of the skilled workers than unskilled production (i.e. $0.5 < \phi < 1$) and that the spillover from skilled workers to the unskilled is larger than the spillover from unskilled workers to the skilled (i.e. $\pi > 1 - \phi$). Note that because of the spill overs, the growth rate of wages of skilled and unskilled workers ($\frac{\Delta A_t^s}{A_t^s}$ and $\frac{\Delta A_t^u}{A_t^u}$ respectively) will be the same in the long run, though the levels of A_t^s and A_t^u will be different. From this we can derive that in the steady state:

$$\frac{A_t^s}{A_t^u} = \left(\frac{\theta^s}{\theta^u}\right)^{\frac{1}{1+\pi-\phi}} \left(\frac{S}{U}\right)^{\frac{\phi-\pi}{1+\pi-\phi}} \tag{3}$$

Plugging this into equation (2) gives the following expression for long-run growth:

$$g = \theta^s S \left(\frac{\theta^s}{\theta^u}\right)^{\frac{\phi-1}{1+\pi-\phi}} \left(\frac{S}{U}\right)^{\frac{\phi-1}{1+\pi-\phi}} \tag{4}$$

Note that the assumptions imply that both production by skilled workers and by unskilled workers raises long-run growth, but that the elasticity of growth with respect to an increase in skilled production is larger than the elasticity with respect to an increase in unskilled production.

2.2 The Households

The economy is populated by overlapping generations of individuals, each living for two periods. Each agent has one child, hence the population, N, is constant. Agents consume only in the second period of their life. Furthermore, we will assume that parents are altruistic, i.e. members of a dynasty are linked through bequests left to their children. Agents of a generation differ in the amount that they have inherited from their parents, but are the same in their preferences and abilities. Utility V_t^i of an agent born in period t is assumed to be a function of consumption in the second period of his life (c_{t+1}) and the bequest left to his child (b_{t+1}):

$$V_t^i = \alpha c_{t+1} + (1-\alpha) b_{t+1} \tag{5}$$

where α is the share of consumption while $(1-\alpha)$ is left for bequest. In the second period of their life, both skilled and unskilled individuals are endowed with one unit of time. The former supply all their labor endowment in production while the latter spend either on working (l_t) or on lobbying activities (γ_t). That is,

$$\gamma_t^i + l_t^i = 1 \tag{6}$$

Agents can work as a skilled labourer in the second period of their life if they invest in human capital during the first period. The investment in human capital is indivisible: that is either one invests $h_t > 0$ or one does not invest at all.[9] All investment must be financed out of inheritances, i.e. there is no capital market and hence agents can not borrow against future earnings to finance expenditures on education when young.[10] So only agents with an inheritance $b_t^i \geq h_t$ are able to become skilled. We denote by N_t^s the number of skilled individuals in period t and by $N_t^u = N - N_t^s$

[9] This model is perhaps best viewed as concerning the investment in higher education as affordability is not generally an issue at the primary and secondary school of education. It is assumed that the costs of education is proportional to the wage of skilled workers, i.e.. $h_t \equiv \varkappa A_t^s$.

[10] Empirical evidence has shown the existence of market failures in financing education. We do not model this market imperfections as this would complicate the model without changing the result. Moreover, credit on investment in human capital is constrained since embodied human capital is viewed as poor collateral by lenders. See Flug et al. (1998) for evidence.

the number of individuals of the same generation (i.e. born in period $t-1$) who remain unskilled. For all other variables we also distinguish between skilled and unskilled agents by the superscript s and u respectively. So the supply of skilled labour is $S_t = N_t^s$ and the supply of unskilled labour is $U_t = N_t^u l_t^u$. Notice that the unskilled lobby some part of their labor endowment as a group while the skilled individual do not lobby.

The government runs a redistribution scheme from the skilled to the unskilled of the same generation as a balanced budget scheme, financed by a tax on wealth and income of the skilled which are nonexempt:

$$\Lambda_t = (\tau_t - \beta\tau_t^2)E_t \tag{7}$$

where Λ_t = total revenue, $E_t = \int\limits_{h_{t-1}}^{p_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right] f(b_i)db_i$ is the total income of skilled non-exempt (total tax base), r is the exogenous interest rate determined in world capital markets and τ_t is income tax while $\beta\tau_t^2$ is a collection cost. The lower (h_{t-1}) and upper (p_{t-1}) boundaries of the tax base denote cost of human capital investment and minimum bequest level required for asking exemptions respectively. Note that (h_{t-1}) is also a critical parameter distinguishing taxpayers from benefit recipients.[11] Thus the income of the unskilled is given by:

$$y_i^u = b_{t-1}(1+r) + w_t^u l_t^u + \lambda_t, \tag{8}$$

where $\lambda_t = \frac{\Lambda_t}{N_t^u}$ is the per capita transfer for the unskilled individual.

Unlike the unskilled, the skilled invest in human capital in the first period and receive a wage of w_t^s in the second period. The income of a skilled middle class worker who is nonexempt is thus given

[11] Note that in case where there is no exemption, the upper boundary goes to the maximum bequest level $\left(\bar{b}_{t-1}\right)$, since tax is applicable to all skilled individuals The tax base when there is no exemption will be $B_t = \int\limits_{h_{t-1}}^{\bar{b}_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s l_t^s\right] f(b_i)db_i$.

as:

$$y_i^{sn} = \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right](1-\tau_t) \tag{9}$$

We assume an individual prefers to work as skilled, i.e. we assume $V_t^s > V_t^u$, which implies:[12]

$$w_t^s > \frac{\tau_t(1+r)(b_{t-1} - h_{t-1}) + (1+r)h_{t-1} + w_t^u l_t^u + \lambda_t}{1-\tau_t} \tag{10}$$

In case where there is exemption, the income of the skilled who is exempted is:

$$y_i^{se} = \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right](1-\tau_t+\varepsilon_i) - C_t^i - f \tag{11}$$

where ε_i is an exemption rate that an individual gets, C_t^i is the contribution that individual i provides to the politician in an effort to get exemptions, and f is a fixed cost incurred for the mobilization or organizing the contribution scheme independent of what others do.[13] The extreme rich individuals ask for getting exemptions only if the following condition is satisfied

$$\left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right]\varepsilon_i - C_t^i - f > 0 \tag{12}$$

2.3 Political Equilibrium

The purpose of this subsection is to link household heterogeneity to redistributive lobbying. It is important to note that we abstract from commitment and persistence. That is, each period the tax rate is determined independently from the tax rates in previous or future periods. The only form of taxes in the model is wealth and income taxes, which are proportional and have distortionary effects. It is assumed that the government does play an active role in the political process but is also captured

[12] Note that this condition involves several endogenous variables. Consequently, it can not be assumed to hold ex ante.

[13] In the literature of interest groups, lobbying costs are studied in three different formats. First some costs are exogenous and hence fixed. This includes salaries of experts who are demanded to present some briefings to policy makers. The second costs entail groups discretion. That is once a lobby group bears the costs, interest groups expend beyond the minimum necessary to signal their desire. The third cost is imposed by policy makers. In this paper, for the sake of simplicity, we assumed the cost to be fixed.

by the special interests of the skilled and the unskilled. Moreover, we abstract from free riding effects and assume that the unskilled individual chooses the amount of available resources in influencing the redistributive policy so as to maximize his/her life time utility.

Therefore, we consider a government or policy maker that combines social welfare and the influence of political contributions. To keep the analyzes very simple, there is only one group favouring a higher tax. We assume that this lobby group solves its intra-group collective action problems. Moreover, the extreme rich ones are able to ask for exemptions. This lobby group will have to satisfy the participation constraint of the government. In other words, its contributions must at least match the government's utility without the policy advocated by the group and contributions should be such that they induce a change. The objective function of the politician reads as follows:

$$V_t = u_t \int_{\mathrm{b}_{t-1}}^{h_{t-1}} y_i^u(b_i)f(b_i)db_i + z_t \int_{h_{t-1}}^{p_{t-1}} y_i^{sn}(b_i)f(b_i)db_i + e_t \int_{p_t}^{\bar{b}_{t-1}} y_i^{se}(b_i)f(b_i)db_i + x \int_{p_{t-1}}^{\bar{b}_{t-1}} C_i(b_i)f(b_i)db_i \quad (13)$$

where V_t stands for utility of the politician while the first three terms reflect the utility of the general public i.e. (u_t) indicates the weights attached to the unskilled, z_t is the weights given to the skilled nonexempt.[14] The parameter (x) represents the trade-offs between aggregate welfare and contributions. The higher is x the greater the weight placed by the government on monetary contributions. Thus x is a malevolence measure which permits lot of exemptions.

The timing of events is as follows:

At $t = 0$, individuals are organized into various political activities. The unskilled mobilize their resources so as to get political support or impeding the mobilization of their opponent. i.e. strikes, lockout etc. by investing time. The high income individuals who are not subject to tax, instead participate in monetary contribution that requires an entry cost which could be relatively fixed and outside the control of these individuals. We assume that only those extremely rich ones are able to

[14] In considering the utility of the general public, for simplicity we assume that the politician attaches a weight of zero to the skilled exempted i.e. $e = 0$ as it would not alter any of our qualitative result.

participate in monetary contribution and are able to ask for exemptions.[15]

At $t = 1$, by taking into account the welfare of individuals in the economy and the monetary contribution, the government sets the tax rate to maximize its own utility.

At $t = 2$ of the game, the politician and the contributors determine the rate of exemptions. The policy maker and the contributor bargain over (ε_t^i) but not over (τ_t) albeit the tax rate affects the domain of the exemption rate. A typical explanation given for this is that officials can get utility from bribes. Let's first see the result in cases where the politician has no incentive to provide exemptions.

2.3.1 Case I: No Exemption

We first explore the scenario where the politician puts a lot of concern for the utility of the general public. The first step is to solve for the set of efficient bargains that can be reached between each contributor and the politician in $t = 2$. By doing so they are implicitly solving the contribution level. Since we are interested in equilibrium policies, we disregard the calculations of the optimal contribution level. We rather approximate in a simpler way i.e. we assume that efficient surplus is shared between the politician and the contributor. The politician has the possibility of choosing $\varepsilon_t^i = 0$ and place a higher relative weight on the overall distributional concern. This is particularly true if the weights attached to the unskilled (u_t) are greater than the weights given to the contributors (x_t).

Proposition 1 *When $x - u_t < 0$, there will be no exemptions and thus no contributions. Hence individuals with inheritance greater than h_{t-1} will pay full τ_t.*

Proof. See Appendix A. ■

Continuing the backward induction, the next step would be to characterize the politician's choice of the tax rate. Thus if agreement is not reached at stage 2, the politician will maximize his utility when there are no contributions. In this case $\varepsilon_t^i = 0$ and hence $C_t^i = 0$. The other possible outcome in stage 2 is that the contributors and the politicians reach an agreement. We postpone this, however, until the next subsection.

[15] Empirical evidence shows that in a society where asset ownership is concentrated in a small elite, asset owners can use their wealth to lobby the government for favorable preferential tax treatments of their assets. (See cf. Benabou 2000)

The objective function now reads as:

$$V_t = u_t \int_{\underline{b}_{t-1}}^{h_{t-1}} y_t^u(b_i) f(b_i) db_i + s_t \int_{h_{t-1}}^{\bar{b}_{t-1}} y_t^{sn}(b_i) f(b_i) db_i \tag{14}$$

where V_t is politician's utility and s_t is the weights given to skilled individuals. Assuming a uniform density distribution in the bequest function, $f(b_i) = \frac{1}{\bar{b}_{t-1} - \underline{b}_{t-1}}$, differentiating and integrating we get the following equilibrium tax rate:

$$\tau_t^* = \frac{u_t - s_t}{2\beta u_t} \tag{15}$$

where $u_t = \eta_o^u d_t \gamma_t^u$ and $s_t = \eta_o^s \varsigma_t$ are the weights attached to both unskilled and skilled individuals while η_o^u and η_o^s are the shift parameter of the lobbying technology. Parmeters d_t and ς_t are proportion of unskilled and skilled indivduals respectivily.[16] Notice that the outcome of the political decision process depends not only on the individual investment of time in lobbying, but also on the size of the groups. In particular, the tax rate is a declining function of the size of skilled group while it is an increasing function of the unskilled. The latter is in line with Cameron (1988), who noted that group size reflects a relevant resource in getting political power. Even though Olson (1965) has emphasized the free-rider problems affecting the organization of large groups, recently Acemoglu and Robinson (2001) have shown that larger groups have more influence in political decision making. Therefore, we assume that individual lobby time as well as group size have a positive effect on political influence. As one can notice from the equilibrium tax rate of equation (15), we have the following signs after taking the first-order and second-order derivatives:

$$\tau_t^u \equiv \frac{d\tau_t}{d\gamma_t^u} > 0, \tau_t^{uu} \equiv \frac{d^2\tau_t}{(d\gamma_t^u)^2} < 0, \tag{16}$$

If the unskilled invests more in lobbying, he is *ceteris paribus* more successful in achieving his objective, but the marginal effect of these rent-seeking investments is decreasing in absolute value.

[16] For the derivation of the equilibrium tax rate see Appendix B.

We assume that each individual maximizes his/her lifetime utility by choosing the optimal amount of lobbying effort. That is, in the initial stage/period agents take into account the utility function of the politician and compete for favor through mobilization. Moreover, we assume that it takes the decision of the political opponent as given when deciding on the lobby effort. The first-order condition for the unskilled is:

$$w_t^u = \frac{\eta_o^u \tau_t^u (1 - 2\beta\tau_t) B_t}{N^u} \tag{17}$$

where B_t is the tax base when there is no exemption. Hence, the unskilled invest in political influence until the marginal effect of lobbying equals the opportunity costs of time, i.e. the (after-tax) wage. The optimal contribution of an individual γ_t^u for the skilled is given by:

$$\gamma_t^u = \frac{1}{\eta_o^u d_t} \sqrt[3]{\left(\frac{s_t^2 B_t \eta_o^u}{2\beta N_t^u w_t^u}\right)} \tag{18}$$

The per capita transfer is the same for every unskilled individual and hence the amount of hours they lobby is the same. For the unskilled, the marginal benefit of lobbying depends on the income of the skilled as well as on the number of skilled relative to unskilled individuals. As a result, the unskilled will, for example, lobby more if the number of skilled rises.

2.3.2 Full Exemption

In this subsection we discuss the case where the politician offers exemptions in return to monetary contributions. Continuing the backward induction begun in the previous subsection, we look at a case where the politician puts a lot of weight on monetary contributions.

Proposition 2 *When $x - u_t > 0$, there will be full exemption for the extremely high income groups.*

Proof. See Appendix A. ■

An assumption is made i.e. $p_{t-1} > h_{t-1}$, where $p_{t-1} = \frac{fx}{(1+r)(x-u)\tau} + h_{t-1} - \frac{w_t^s}{(1+r)}$ and this requires that $\frac{fx}{(x-u)\tau} > w_t^s$. Skilled individuals with income $(b_{t-1} - h_{t-1})(1+r) + w_t^s < \frac{fx}{(1+r)(x-u)\tau}$

do not give contributions and hence do not get exemptions. This is because, when the income of the skilled is less than $\frac{fx}{(1+r)(x-u)\tau}$, it does not pay too much for him/her to offer a politician to make him indifferent between giving exemptions and gathering taxes. But rather it is better for him/her to engage in time intensive lobbying so as to block from paying a higher tax.

Under this scenario the politician is assumed to maximize his utility function which is a weighted average of the general public and the total of contributions as shown in equation (13). In this case, politicians will desire to set a higher tax rate so as to raise their bargaining position against the contributors. The efficiency gains of the equilibrium tax rate, however, are subject to the extent of the magnitude on how the surplus is distributed. For simplicity, here we assume the surplus of the bargaining is received by the policy maker i.e. $\bar{C} = [(b_{t-1} - h_{t-1})(1+r) + w_t^s]\,\tau_t - f$. The policy maker maximizes the target function subject to his budget constraint (7), so that the transfer must be financed from taxes on skilled workers who are non-exempt. The equilibrium tax rate arising out of the above political process is:

$$\tau_t^* = \frac{(u_t - z_t)E_t + \Gamma_t}{2\beta u_t E_t} \tag{19}$$

where $z_t = \eta_o^s \upsilon_t$ is the weight attached to skilled individuals who are subject to tax and $\Gamma_t = \frac{d}{d\tau}(x \int_{p_{t-1}}^{\bar{b}_{t-1}} [\overline{C}] f(b_i) db_i)$ and individuals contributions are an increasing function of wealth. [17] The number of unskilled individuals will tend to be high as the effective redistribution is lower and this will increase u_t. However, γ_t^u could also decrease since the tax base is reduced from B_t to E_t $[E_t < B_t]$ leading to a decrease in influencing the policy maker and this in turn leads to a lower tax rate. This is easily observed from the optimality condition of the unskilled individual:

$$\gamma_t^u = \frac{1}{\eta_o^u d_t} \sqrt[3]{\left(\frac{\eta_o^u (z_t E_t - \Gamma_t)(z_t E_t - \Gamma_t)}{2\beta N_t^u w_t^u E_t}\right)} \tag{20}$$

[17] We assume that when the politician decides the tax rate, he does not take into account the indirect effect of tax rate i.e. $\frac{\partial p_{t-1}}{\partial \tau_t} = 0$.

Skilled individuals above the threshold level of p_{t-1} (which insulates skilled who are subject to tax and those who are exempted) are not subject to tax and this decreases the amount of income that is taxable at the initial equilibrium. This is summarized in the following proposition:

Proposition 3 *A decrease in the tax base caused by the presence of exemptions:*

i) reduces tax revenue collected if the distribution is skewed to the right.

ii) has an ambiguous effect on the equilibrium tax rate compared to the no exemption case.

Proof. See Appendix for the Proof of Proposition 3. ■

The intuition behind proposition 3 is tax base shrinks i.e. the percentage of skilled people who are subject to tax will be lower. The situation could also be exacerbated if the distribution of income is highly skewed to the right. Recent empirical evidence show that the distribution of income in the upper range is very well fitted by the Pareto density, while log-normal distribution for the rest of the distribution. Thus exempting the top income tax payers erodes the potential tax revenue than otherwise.

3 Dynamics of Wealth and Redistribution

As already noted, individuals who inherit an amount larger than h_{t-1} are able (and willing) to invest in human capital and become skilled in the second period of their life. Consequently, the distribution of inheritances in period t determines the number of skilled in period $t+1$. Let D_t be this distribution: $\int_0^\infty dD_t\left(b_t\right) = N$, then the number of skilled in the next period is:

$$N_{t+1}^s = \int_h^\infty dD_t\left(b_t\right) \tag{21}$$

and the number of unskilled:

$$N_{t+1}^u = \int_0^h dD_t\left(b_t\right) \tag{22}$$

The distribution of wealth at time t not only determines the number of skilled and unskilled in period $t+1$, but also affects redistribution, technological spill overs and growth in both sectors, and thus indirectly the distribution of inheritances in future periods. These dynamic effects are quite complex. In this section we neglect the effects on technology and growth (i.e. we assume $\theta^s = \theta^u = 0$ so that w^u, w^s and h are constant) and discuss the dynamic relation between redistribution and wealth. The dynamics when there is no exemption can be described by:

$$b_t = \begin{cases} b_{t+1}^u = (1-\alpha)(1+r)b_t^u + q_t \\ b_{t+1}^s = (1-\alpha)(1+r)(1-\tau)b_t^s + q_t \end{cases} \tag{23}$$

where q_t is

$$q_t = \begin{cases} (1-\alpha)\left[l_t^u w^u + \lambda_t\right] \equiv q_t^u \text{ if } b_t < h \\ (1-\alpha)(1-\tau_t)\left[w^s - (1+r)h\right] \equiv q_t^s \text{ if } b_t \geq h \end{cases} \tag{24}$$

Moreover, we assume that initially $q_t^u < [1-(1-\alpha)(1+r)]h$ and $q_t^s < [1-(1-\alpha)(1+r)(1-\tau)]h$. That is, we assume that polarization prevails and children of unskilled parents will be unskilled and children of skilled parents will become skilled. This case is illustrated by the lines AB and CD in Figure 2A.

INSERT FIGURE 2A

In this case, the number of skilled and unskilled is constant, and hence (given that the wages are also assumed to be constant) the tax rate and q^u and q^s will be constant. As a result, equation (23) is a piecewise linear function that intersects the 45^o-line two times, at the equilibria, $b_u^* \equiv \frac{q^u}{1-(1-\alpha)(1+r)}$ and $b_s^* \equiv \frac{q^s}{1-(1-\alpha)(1+r)(1-\tau)}$. So, in the long run, wealth levels within the groups converge, but there is complete dichotomy between the two groups. The long-run level of average wealth can be expressed as $\bar{b} = b_u^* + \frac{N^s}{N}\left(b_s^* - b_u^*\right)$,which is increasing with $\frac{N^s}{N}$ if b_u^* and b_s^* are taken to be constant.

Note that under no-exemption, the system converges into two steady states equilibria while during exemptions the distribution of bequests converges into three steady states equilibria which can be described by:

$$b_t = \begin{cases} b_{t+1}^u = (1-\alpha)\,(1+r)b_t^u + q_t \\ b_{t+1}^{sn} = (1-\alpha)\,(1+r)\,(1-\tau)b_t^{sn} + q_t \\ b_{t+1}^{se} = (1-\alpha)\,(1+r)\,(1-\tau)b_t^{se} + q_t \end{cases} \tag{25}$$

where q_t is

$$q_t = \begin{cases} (1-\alpha)\,[l_t^u w_t^u + \lambda_t] \equiv q_t^u \text{ if } b_t \leq h_t \\ (1-\alpha)\,(1-\tau_t)\,[w^s - (1+r)\,h] \equiv q_t^{sn} \text{ if } h_t < b_t < p_t \\ (1-\alpha)\,(1-\tau_t)\,[w_t^s - f - (1+r)h] \equiv q_t^{se} \text{if } b_t \geq p_t \end{cases} \tag{26}$$

We assume that the dynamic equation is stable,

$$(1-\alpha)\,(1+r) < 1$$

Moreover, we assume that initially $q_t^u < [1-(1-\alpha)(1+r)]h$, $q_t^{sn} < [1-(1-\alpha)(1+r)(1-\tau)]h$ and $q_t^{se} < [1-(1-\alpha)(1+r)(1-\tau)]p$. That is, we assume that polarization prevails and children of unskilled parents will be unskilled. Moreover some children of skilled parents will become skilled but taxed while others will be exempted. This case is illustrated by the lines AB, CD and EF in Figure 2B.

INSERT FIGURE 2B.

From Figure 2B, equation (25) is a piecewise linear function that intersects the 45^o-line three times, at the equilibria, $b_u^* \equiv \frac{q^u}{1-(1-\alpha)(1+r)}$, $b_{sn}^* \equiv \frac{q^{sn}}{1-(1-\alpha)(1+r)(1-\tau)}$ and $b_{se}^* \equiv \frac{q^{se}}{1-(1-\alpha)(1+r)(1-\tau)}$. So, in the long run, wealth levels within the groups converge, but there is complete dichotomy between the three groups. The long run level of average wealth can be expressed as $\bar{b} = b_u^* + (b_{sn}^* - b_u^*)\,\frac{N^s}{N} + (b_{se}^* - b_{sn}^*)\frac{N^{se}}{N}$, which is increasing with $\frac{N^s}{N}$ if b_u^*, b_{sn}^* and b_{se}^* are taken to be constant. However, a change in the number of skilled will shift the political equilibrium and thus affect b_u^*, b_{sn}^* and b_{se}^*. In particular, an increase in the number of skilled will decrease the tax rate, and lower b_u^* and raise b_{sn}^* and b_{se}^*. So the relation between redistribution and average wealth is not straightforward.

In order to further investigate the relation between redistribution and wealth, the next subsection presents the dynamic effects of an increase in the wage of the skilled.

An increase in the wage of the skilled

We first look a case where the politician offers no exemption. The analysis starts from the initial situation as illustrated by the lines AB and CD in Figure 2A.[18] We analyze the effect of a once-and-for-all increase in w^s. The analysis in this subsection is based on the assumption that the tax rate and the net income of both the skilled and the unskilled rise.

The increase in w^s raises q^s. This results in an upward shift of the line CD in Figure 3A to C'D'. The subsequent increase in redistribution raises q^u and lowers q^s, but we assume that q^s will still be larger than in the initial situation. So $C'D'$ shifts down to C"D" and AB shifts up. Now there are two possibilities: the increase in q^u may or may not be large enough to allow the children of the unskilled with the highest inheritance to become skilled. In the latter case, AB shifts up to $A'B'$, but the number of skilled does not change and the lines in the figure do not shift anymore. In the former case, however, the dynamic process is much more complicated. In this case AB shifts up further, for example to A"B". As a consequence, children with an inheritance just below h will be able to afford investing in human capital and consequently, in the next period the number of skilled will be higher. In other words, liquidity constraints are less binding for these individuals receiving larger transfers. This shifts the political equilibrium. In particular, the unskilled will lobby more as the higher number of skilled implies a larger tax base and thus an increase in the marginal benefit from lobbying for a higher tax rate while the marginal costs of lobbying will not change. This *dependency ratio effect*[19] will have an upward effect on the tax rate. At the same time however, the lobby of the skilled will gain influence relative to that of the unskilled because of the increase in their relative number. This *group size effect* will - *ceteris paribus* - lower the tax rate. We assume the dynamic process to be stable, i.e. it assumes that the group size effect dominates the dependency ratio effect so that the tax rate will fall again. This will in the next period shift A"B" downward again while C"D" shifts up again. Once more, there are two possibilities: either the number of skilled remains constant from then on and curves do

[18] To be more precise, we analyze the effects of an increase in the productivity of skilled labour A^s that is assumed to be constant here. We do not raise h and a, however, so the increase in A^s goes along with a decrease in $\varkappa$.

[19] In fact, the *dependency ratio effect* is a special case of what we labelled the *cost-benefit effect.*

not shift anymore, or the number of skilled rises further and the process goes on shifting AB further down and CD further up. This continues until AB is so far down that a new equilibrium is reached where the number of skilled does not rise anymore. In this new equilibrium, the number of skilled will be larger than in the initial situation, and the number of unskilled will therefore be lower. Moreover, redistribution and the amount of time both groups spend on political activities will have changed.

With the case of exemptions, however, things are different. This is illustrated by the lines AB, CD and EF in Figure 2B. The analysis in this subsection is based on the assumption that the tax rate and the net income of the skilled rise while that of unskilled declines. The increase in w^s automatically raises q^{sn} and q^{se}. This results in an upward shift of the line CD and EF in Figure 2B to $C'D'$ and $E'F'$ respectively.

The wage differential between unskilled and skilled leads to an increase in the political activity of the unskilled i.e. it is worthwhile for the unskilled to undertake more lobbying activities. The subsequent increase in taxes lowers q^{se}. This is because, even if the exempted group is free of tax, an increase in tax rate declines their income from $E'F'$ to $E''F''$ as contribution levels are linear to tax rate i.e. there is an increase in rent seeking. However, we assume that q^{se} will still be larger than the initial situation.

Moreover, the increase in q^{sn} may or may not be large enough to allow the children of the skilled with the highest inheritance to ask for exemptions. When the children of the nonexempt skilled are able to ask exemptions, this shifts the political equilibrium. First, it might cause some of the children of the nonexempt group to ask for exemption because the incentive to ask for exemption is greater than paying a higher tax. In this case CD shifts up further, for example to $C'D'$. As a result, children with an inheritance just below (p), will consequently be able to ask for exemptions and in the next period the number of skilled exempted will be higher. This is reflected by $\frac{\partial p}{\partial \tau} < 0$. As some individuals ask for exemptions and hence the tax base declines.

In this case, q^u declines and does increase the initial number of unskilled i.e. AB shifts to $A'B'$. This will mean that the tax that is used for inter-generational redistribution does not transform the children of the unskilled to be skilled. The per capita transfer will decline i.e. $\frac{\partial \lambda_t}{\partial \tau_t}$as large number of unskilled individuals remain. Second, this will also result in an increase in political support for the unskilled because of the reduction in skilled nonexempt - groups. Note that an increase in u_t does not result from an increase in the political activity. The marginal costs of lobbying for the unskilled is higher while the marginal benefit of lobbying will not change i.e. exemption implies a lower tax base.

The politician will not give tax favours for a long period, as an increase in the political support means a reduction in the relative weight of a given exemption. The politician loses revenue supposed to improve the welfare of the unskilled. This is reflected by the fact that the politician cares not only about contributions but also about the welfare of the unskilled. This is also observed from $\frac{\partial p}{\partial u} > 0$. This will shift line C'D' to C"D". In the latter case $C'D'$ shifts downward to $C"D"$ i.e. we assume that q^{sn} will still be larger than in the initial situation.

Note that in this subsection we abstracted from technological spill-overs and growth. However, it is evident that if we take growth into account, the growth rate in the new steady state will be different from the initial growth rate. It is not evident what the exact effect on growth is, however. Therefore, in the next section, we analyze the relation between redistribution, the size of both sectors and long-run growth.

4 Redistribution, Spill-overs, and Growth in the Long Run

The aim of this section is to illustrate the relation between redistribution, technological spill-overs, and economic growth. We first analyze the relation between the long-run growth rate and the number of skilled and unskilled, for given amounts of time spend on lobbying by both groups. Subsequently, we analyze the relation between growth and the tax rate.

Increasing the number of skilled *ceteris paribus* increases skilled production which, due to spill-over effects, leads to higher growth rates in both sectors. However, given total population size, an increase in the number of skilled implies a decrease in the number of unskilled which exerts downward pressure on the growth rates in both sectors. As a result, an increase in the number of skilled only increases growth if the number of unskilled is relatively large, i.e. if the number of skilled is below its optimal level. This is summarized in the following proposition.

Proposition 4 *An increase in the number of skilled leads to higher long-run growth if and only if* $N^s < \delta N$.

Proof. See Appendix D. ■

This proposition assumes the amount of time individuals spend on lobbying to be constant. However, we know from the political model that, in general, changes in the size of both lobby groups affect lobby efforts. Consequently, given wages of skilled and unskilled, there is a relation between group size and the tax rate. Using the corresponding first-order conditions to substitute out γ_t^u, we can specify the relation between group size and the tax rate. Combining this with the relation between group size and long-run growth as summarized in Proposition 4, we are able to derive a relation between the tax rate and long-run growth rate. Expressing the growth rate in terms of tax rate produces, some complicated expressions. This relation is depicted in Figure 3D.[20]

High initial inequality leads to higher tax rates. That is, the political activity of unskilled is higher in comparison to that of the skilled ones. An increase in tax rates could have two effects depending on the institutional setup of the countries i.e. the degree of corruption (denoted by x in the model). First it could lead to a higher tax/GDP ratio i.e. as taxes are higher, the per capita transfer (λ_t) will increase. This is because taxation is redistributive in the model. That is, income taxes are levied in a non-lump sum fashion whereas the tax revenue is redistributed via lump-sum to the unskilled individuals enabling them to leave higher bequests to their children. The higher inheritance received by their children will enable them to invest in human capital. Increasing the number of skilled *ceteris paribus* increases skilled production which, due to spill-over effects, leads to higher growth rates in both sectors. However, given total population size, an increase in the number of skilled implies a decrease in the number of unskilled which exerts downward pressure on the growth rates in both sectors. As a result, an increase in the number of skilled only increases growth if the number of unskilled is relatively large, i.e. if the number of skilled is below its optimal level.

[20] It should be noted that both the tax rate and the rate of growth are endogenous variables. The relation between these two variables results from comparing steady states with different number of skilled.

As already suggested by Proposition 4, there is an optimum for the relative production by skilled workers and thus an optimum tax rate. As long as the tax rate is below this growth-maximizing level, raising the tax rate increases growth, above this level a higher tax rate leads to lower growth. Thus a non-monotonic relationship prevails between long-run growth and tax rate: for low values of the tax rate more redistribution goes along with higher growth, for high tax rates a further increase of redistribution goes along with lower growth.

Numerical Example: In this sub-section, we illustrate the full dynamic adjustment process by numerical simulation experiments. When the economy is not in the steady state, it converges via an adjustment process towards an equilibrium. During this adjustment process, wages of skilled and unskilled will grow at different rates. This adds additional effects to the relations discussed so far. As already noted, the adjustment process as well as the steady state depends on the initial wealth distribution. The basic simulation experiment starts from a uniform distribution of wealth. We discuss the full dynamic effects of a technological shock that increases the wage of the skilled. This complements the discussion of the partial effects of this shock in Sections 2 and 3.

The parameters for the basic simulation can be found in the Appendix. This basic simulation starts with 100 individuals with wealth levels uniformly distributed on the interval $[1, 100]$. The starting level of the investment in human capital h is 60, and in the subsequent periods h is assumed to grow at the same growth rate as the wage of the skilled. Given the initial value of h and the distribution of wealth, the initial number of unskilled is 60. However, given the initial wage levels and the tax rate that initially results from the political process, some children of the initial generation of unskilled will be able to afford education and hence the number of unskilled drops to 57. The fact that the gap between the wages of the skilled and the unskilled has increased a bit due to the growth rate of skilled wages being higher than that of unskilled wages, implying a growing wage gap and increasing investment in political activity by the unskilled. This development continues at with decreasing intensity in periods 3 and 4. By then the number of unskilled has decreased to 56 and the tax rate is more than its initial value. This reduces the political influence of the unskilled and hence the tax rate is blocked over a course of time. From then onwards, no children of unskilled are able to pass the threshold h and there is a complete dichotomy between skilled and unskilled. As a result, the decrease in the tax rate that results from the growth in size of the lobby group of the skilled stops. Therefrom, the tax rate slightly decreases again. The reason for this is that due to spillover effects, the difference in the growth rate of wages of skilled and unskilled decreases over time and eventually the wage gap stabilizes and the economy reaches a steady state.

Figures 3A-C present the results of the adjustment process if we start from an initial situation with a higher wage for the skilled as compared to the results of the basic simulation.[21]

INSERT FIGURES 3A-C

The higher wage of the skilled will not affect the initial number of unskilled. However, the increased wage gap makes them lobby more. The adjustment process is again similar to the one described above. However, the increased redistribution enables more unskilled to become skilled in the course of time. So, in the steady state, the number of skilled is higher. So, if the investment in human capital is inefficiently low due to capital market constraints, a technological shock that initially only benefits the skilled will eventually benefit all individuals. Via the political redistribution process, the unskilled will appropriate part of the gains which allows more unskilled to become skilled and thus fosters growth.

In the case of exemptions, however, things could be different. It could in turn lead to unintended consequences i.e. the extreme rich ones could ask exemptions to escape from paying taxes which lowers λ_t, reducing the accumulation of human capital. This leads to the following proposition.

Proposition 5 *An increase in tax rates that result from wage differentials do not lead to an increase in per capita transfer as higher taxes erode tax bases when there is exemptions i.e.* $\frac{\partial \lambda_t}{\partial \tau_t} < 0$.

Proof. See Appendix E. ■

[21] That is, we start from a higher value of A_0^s,but h_0 is not increased.

5 Empirical Evidence

In this section, we present basic evidence for our hypotheses. The theoretical analysis revealed that a higher inequality does not necessarily yield a higher redistribution. The effect could even be reversed if inequality emerges in a situation where there is a wealth bias in the political system. Checking our main hypothesis requires a measure of wealth bias to be included in the regression analysis. In principle, the required parameter should represent an evaluation of institutional set up reflecting weak governance, bad tax administration and excessive tax evasion. Clearly, there is no simple way to assess the measure of wealth bias across countries. The closest we can think of is "corruption". The main indicators for corruption used in this analysis are Transparency International (TI)'s. It becomes natural to think that in societies where corruption is prevalent, excessive exemptions are observed and thus a lower score of tax/GDP ratio.

We will use two measures of inequality i.e. land Gini and income Gini. Note that the key feature of the theoretical model is that individuals differ in their inheritances which affect the number of skilled and unskilled individuals. In the regressions, we use land inequality as a proxy for differences in the initial inheritance distribution. An economy which start with high wealth distribution could end up in poverty trap, while the tax rate could increase, the per capita transfer could be small enabling the children of unskilled parent not to invest in education. Therefore, land inequality could in fact lead to a lower development of human capital.

Data for before tax and after tax household incomes for the same countries hardly exist. Even the high quality data set compiled by Deininger and Squire (1996) that are based on household incomes include government transfers. We do not use the data on Inequality from Deininger and Squire (1996) as observations for the mid-1990s are hardly available. We will instead use income inequality compiled by the Texas Inequality Project which is available for quite a long period of time which is convenient for panel data analysis. Technological change that widens the wage gap between skilled and unskilled will result, to an increase in tax rates as political activity of the unskilled will be higher. This will have two effects. First, it will increase the number of skilled individuals which in turn could block redistributions. Second, it could encourage tax payers to ask for more exemption which erodes the tax base. This leads to a lower tax revenue assumed to have a direct link with human capital accumulation and growth. Thus even though an increase in inequality raises the proportion of skilled individuals which are not subject to tax, it also raises the amount of resources devoted to rent seeking. We turn to this task in the next section.

Following recent studies on the relation between inequality and growth, we also consider many other control variables in our regression analysis; e.g. the log of initial GDP per capita, domestic investment share of GDP (GDI), education level, tax GDP ratio, openness (defined as sum of exports and imports over GDP), ethnicity, political right index and fertility rate. For more data description and sources see Appendix F.

Tables 1 and 2 report summary statistics of the variables used in the paper. Our study attempts to identify the relationship between the aforementioned variables. Having securing data for 20 years of 53 countries, we would be able to form panel with 4 periods, namely, 1980-1984, 1985-1989, 1990-1994 and 1995-1999, from 53 countries. Furthermore, in order to abstract from business cycle effects, similar to Lundberg and Squire (2003), we use five-year averages of the growth variable while most of the variables are at their initial values. In other words, the explanatory variables are at their initial values in a 5-year period. Earlier data and wide coverage are not considered due to the incompleteness of data on corruption.

5.1 Estimation Method

To address the risk of using an inappropriate estimation method, we used two variants of estimation methods, viz. panel estimates and 3SLS. This data set allows us to consider various specifications for panel data models. We also estimated the growth regression using both the fixed-effects and the random effects models. This permits us to partially mitigate the confounding impact of omitted variables on the inequality-growth relationship by controlling for country-specific effects via the following specification.

$$\begin{aligned} g_{it} \quad = \quad & G_1(LogGDP_{i,\,t-1}, TAX_{i,\,t-1}, TAX^2_{i,\,t-1}, EDU_{i,\,t-1}, EDU^2_{i,\,t-1}, \\ & GOVT_{i,\,t-1},\, OPEN_{i,\,t-1}, INEQ_{i,\,t-1}, CORR_{i,\,t-1}, \eta_i) + u_{it} \end{aligned} \tag{27}$$

where $i = 1, 2, ...N$ (number of countries) and the subscript $t = 1, 2, ..., T$ (five-year time period). g_{it} is real GDP growth rate, $LogGDP_{i,\, t-1}$ is the log of lagged per capita real GDP level; $EDU_{i,\, t-1}$ the education level proxied by the enrollment ratio in secondary schooling[22] and $TAX_{i,\, t-1}$ is the tax revenue/GDP ratio; $GOVT_{i,\, t-1}$ is government consumption ratio; $OPEN_{i,\, t-1}$ is openness to control for the role of international factor mobility to economic growth; $INEQ_{i,\, t-1}$ is lagged for a five year period Income Gini Coefficient. The right hand side variables are all initial values in the 1980,1985,1990,1995. Whereas η_i is unobserved heterogeneity with variance σ^2_η. It can be viewed as unobserved country characteristics e.g. due to technical inefficiency, that are constant over time and influence g_{it}; and u_{it} is an idiosyncratic error term with variance σ^2_u. Moreover, in order to capture nonlinearity between tax rates, education and growth - as predicted by the theory - we include the squared terms EDU^2_{t-1} and TAX^2_{t-1} to the growth equation.

Our focus is not only to investigate the relationship between growth and income inequality but also to examine how inequality and corruption affect the development of taxes and education levels which in a way are important variables to growth. In order to understand the channels as to how inequality and corruption affect the development of these variables, we run 3SLS. Studies conducted to examine the relationship between growth versus inequality using a system of equations hardly exist; with the exception of Barro (2000) and Lundberg and Squire (2003). Based on cross-country panel data, Barro (2000) applies 3SLS and finds that the overall relationship between inequality and growth is almost zero. Lundberg and Squire (2003) examine the determinants of the simultaneous evolution of growth and inequality. They find that low inflation, education and land redistribution improves growth and lowers income inequality. Neither paper, however, includes redistributive policy measure as an endogenous variable nor examines the channel through which growth is affected, which is relevant for testing our hypothesis. It is important to note that human capital accumulation, the growth rate, and the tax rate are simultaneously endogenous. To take into account these endogenous interactions,

[22] Primary education is compulsory and free in many countries. Even though a higher education may also be free in some countries, it is never compulsory (i.e. a decision variable of households) and comes at the cost of forgone consumption.

we first build the following system of equations:

$$\begin{aligned} g_t &= G_2(LogGDP_{t-1}, GDI_{t-1}, TAX_{t-1}, TAX^2_{t-1}, \\ &\quad GOVT_{t-1}, POL, OPEN_{t-1}) \end{aligned} \tag{28}$$

$$\begin{aligned} g_t &= G_3(LogGDP_{t-1}, GDI_{t-1}, EDU_{t-1}, EDU^2_{t-1}, \\ &\quad GOVT_{t-1}, POL, OPEN_{t-1}) \end{aligned} \tag{29}$$

$$\begin{aligned} g_t &= G_4(LogGDP_{t-1}, GDI_{t-1}, TAX_{t-1}, TAX^2_{t-1}, EDU_{t-1}, \\ &\quad EDU^2_{t-1}, GOVT_{t-1}, POL, OPEN_{t-1}) \end{aligned} \tag{30}$$

$$TAX_{t-1} = T(INEQ_{t-1}, CORR_{t-1}, GOVT_{t-1}, ETHNIC) \tag{31}$$

$$EDU_{t-1} = E(TAX_{t-1}, TAX^2_{t-1}, INEQ_{t-1}, FERTILITY_{t-1}) \tag{32}$$

We have three variants of the growth equation. Looking at proposition (4), both taxes and level of education are the mirror of each other to the growth system. In order to minimize multicollinearity, we place taxes and education level one after another in the growth equation of (28) and (29). We also checked whether the inclusion of these variables together in a growth equation (30) alters the results.

Most growth regressions include controls for physical capital investment (GDI_{t-1}) and the log of lagged level of GDP as indicated in equation (28, 29 and 30). Easterly *et al.* (1993) include both primary and secondary school enrollment, but here we take only secondary enrollment as primary school entrance is almost free of cost. We also include openness to control for the role of international factor mobility to economic growth. Finally, we include the government consumption ratio and the political right index in the growth equation.

Equation (31) aims at examining the determinant of tax GDP ratio. Besides inequality and corruption variables, we also include ethnicity and government consumption as additional variables. The first variable is to control for the well documented fact that highly fragmented societies do have inefficient government redistributive measures (cf. Easterly *et al.* (2000)) while the latter variable is included to control for the response of the tax revenue due to an increase in demand for government programmes. Similarly, equation (32) shows the educational variable as a function of effective tax rate and land inequality. We also include the fertility rate in the education equation as an instrument, since a higher fertility rate affects the development of education negatively. See Barro (2000) and Perotti (1996).

5.2 Empirical results

The question we raised is how inequality and corruption affect the collection of tax revenue and the accumulation of human capital and thereby economic growth. Table 3 shows the results of the estimates of panel regression i.e. equation (27). Since the Hausman specification test points out that in almost all specifications the random effects is violated, we report the results from the fixed-effect approach.[23] From Table 3 of column 1, it becomes clear that the results estimated from the fixed effects estimates are consistent with our hypothesis i.e. the education and the tax variable enter into the growth equation with expected sign and are also statistically significant. In Figure 4 below, we plot the relationship between growth and Tax/GDP ratio controlling for all variables at their sample means. Consistent with our theory, the Tax variable has a positive and significant sign, but the marginal effect of taxes is declining as Tax^2 has a negative sign and is statistically significant suggesting the nonlinear effect of taxes to growth. Evaluated at the sample mean, a unit increase in Tax/GDP ratio causes an increase in growth by 0.087 units ($= 0.357 - 0.006$x2x22.541). As illustrated by Figure 4, a unit increase of

[23]In both panel estimates the subset of coefficients that are estimated by the fixed effects estimator and the random effects estimators are significantly different suggesting that η_i and $\mathbf{X}_{it}^{'}$ are correlated. The null Hypothesis that there is no systematic difference in coefficients is rejected as p value is less than 5%, Hausman is in favour of the fixed effects estimator.(See Table 3)

Tax/GDP ratio at sufficiently high values reduces growth rates. At a Tax/GDP ratio 2 SD above the mean , the effect of an increase in Tax/GDP ratio on growth falls somewhat to -0.18. Similarly, the relationship between education and growth is also non monotonic. The education variable has a positive and significant sign, but the marginal effect of education is declining as Education^2 has a (small) negative and significant coefficient. This implies that an increase in the number of skilled only increases growth if the number of unskilled is relatively large, i.e. if the number of skilled is below its optimal level. a unit increase in education level has 0.029 effect on growth rates ($0.174 - 0.001$x2x72.277).

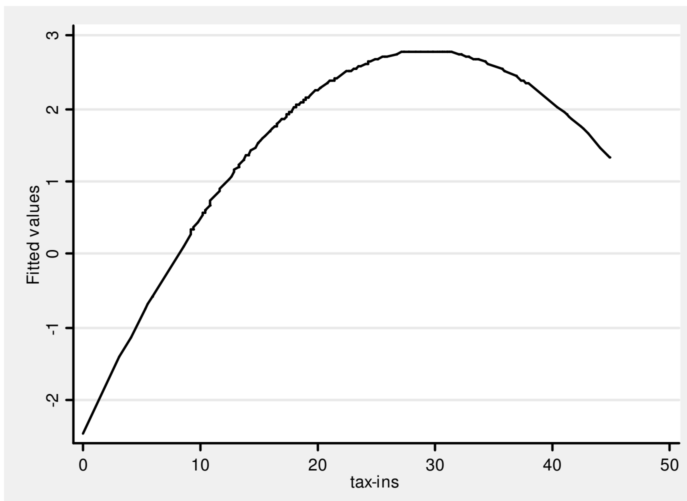


Figure 4. Tax /GDP ratio versus Growth

Moreover, government consumption ratio has the expected sign and is statistically different from zero. We find that openness positively relates to the growth rates and is statistically significant. The coefficient of income inequality is negative and significant. However, the corruption variable is insignificant. In column 2, of Table 3 we include the interactive term between inequality and corruption. The fit of the model improves slightly i.e. by 3%. The coefficient on inequality is not anymore significant. The net effect of corruption is negative as the coefficient of the interactive term between inequality and corruption is negative and statistically significant at 5%.[24] As one can see from Table 3, the results of the rest of the variables remain unchanged.

[24] Higher corruptibility clearly correlates with lower growth rates. A unit increase in corruption decreases growth (at the mean) by 0.028 units ($= 1.717 - 0.044$ x 39.669).

We now turn to the results of the 3SLS. In 3SLS estimator, η_i is assumed to be zero, and $\mu_{i,t}$ are i.i.d. and independent of all explanatory variables. In other words, 3SLS assumes that the intercepts do not vary across all countries (homogenous), that each observation is cross sectional and time-series independent and that all explanatory variables are strictly exogenous. [25]

We start our analysis from Table 4 which estimates the growth equation (28), tax equation (31) and education equation (32) using 3SLS. To check the robustness of inequality measurement, we also run the same regressions with income inequality, land inequality and the nested model (it places both measures of inequality in one regression) as shown in column (1), (2) and (3) of Table 4 respectively. Running regressions with income and land inequality do not change the results substantially for the growth equation. From Table 4, consistent with our theory, the Tax variable has a positive and significant sign, but the marginal effect of taxes is declining as Tax^2 has a negative sign and is statistically significant suggesting the nonlinear effect of taxes to growth.

Table 5, estimates equation (29) which takes into account the education variable in the growth equation. Consistent with our theory, the relationship between education and growth is also non monotonic. The education variable has a positive and significant sign, but the marginal effect education is declining as Education^2 has a (small) negative and significant coefficient. This implies that an increase in the number of skilled only increases growth if the number of unskilled is relatively large, i.e. if the number of skilled is below its optimal level.

Table 6 of the growth regression estimates equation (30). It places both the education and tax variable in the growth regression and checks whether the estimation results are sensitive to multicollinearity. Indeed, the growth regression performs poorly from the estimated equations of (2) and (3) in terms of significance level of the education and tax/GDP ratio variables, suggesting the endogeneity of the two variables. Looking at Table (4), (5) and (6), while the education and tax variables have the expected sign, their significance level varies dramatically when one uses income or land as measure of

[25] Clearly, these assumptions are restrictive: e.g. if there are country-specific effects on growth, the homogeneity assumption will be violated.

the degree of inequality.[26]

From the growth regression of Tables (4), (5) and (6), we can see that the control variables are highly significant. For example, investment is a significant contributor to economic growth. The coefficient of per-capita income is negative and statistically significant suggesting conditional convergence. Similar to the findings of Barro (2000), the measure of government ratio and the political right index have negative signs and are statistically different from zero at 1%. Similar to Easterly *et al.*, (1993) measure of trade openness i.e. the ratio of imports and exports to GDP, we find that openness negatively enters the growth equation, although the coefficient of openness is not significant with the exception of results in Table 4, 5.[27]

The education equation suggests that the coefficient of Tax/GDP ratio and its square term have a positive and negative sign respectively, indicating the nonlinear relationship of tax rate and accumulation of human capital. This is observed from the reduced form education regression of Table 4, 5 and 6. We also find the fertility variable to negatively affect the development of human capital accumulation. Similar to Perotti (1996) and Figini (1999), we also find land inequality to negatively affect the development of school enrollment ratios.

From the tax equation, we find corruption and ethnicity to negatively affect raising tax revenue that could be useful for the accumulation of human capital. We find, similar to Alesina and Rodrik (1994), land inequality to positively affect the tax/GDP ratio. However, we find that income inequality negatively affects tax/GDP ratio. Moreover, our findings corroborate recent empirical research which shows smaller government size is found to be associated with higher levels of corruption. (La Porta *et al.* (1999)). The government consumption ratio as a regressor, however, is positively related to the tax/GDP ratio as one would expect.

[26] However, F test shows that estimates of both the education and tax variables are jointly significant. For example, from Column 1 of Table 6, though the education variables (Education, Education^2) are individually insignificant, F-test reveals that both the education and its square term are jointly significant. The Null Hypothesis that the coefficient of both variables is zero, is rejected at 1%. Similarly, the tax variables in Column 2 and Column 3 are jointly significant both at 1% and 6% significance level.

[27] Moreover, we also build systems of equations with varying time periods. For example, there exists no difference between the results of data averaged over five year periods and data averaged over 10 year periods for the growth equation. This suggests that not only our results are robust across different specifications but also different time dimensions.

6 Concluding Remarks

This paper presents a model allowing one to analyze the joint determination of inequality, taxes, human capital and growth. We consider the political economy of redistribution between three income groups in a dynamic economy. The paper seeks to explain the effect of corruptibility (exemptions) and lobby group size on policy outcomes in a two-sector endogenous growth model where growth is driven by human capital, investment in human capital is indivisible and capital markets are missing. In such an economy, investment in human capital tends to be inefficiently low and redistribution may have significant effects on growth.

Our result strongly supports the spreading view that growth rate effects of inequality are linked to the institutions governing the economy. The political outcome is dependent on the differences in the balance between the costs and benefits of lobbying. If technological progress increases the wage gap between the skilled and the unskilled, for example, this will result in more active political support. An increase in tax rates could have two effects depending on the institutions governing the economy.

First, it could lead to a higher tax/GDP ratio i.e. as taxes are higher, the per capita transfer will increase leading to higher human capital and raises growth. There is an optimum for the relative production by skilled workers and thus an optimum tax rate. As long as the tax rate is below this growth-maximizing level, raising the tax rate increases growth, above this level a higher tax rate leads to lower growth. The total effect of increase in tax rates is therefore not straightforward but rather depends on the position of the tax rates i.e. whether it is above or less than optimal tax rate.

Second, a higher tax rate do not necessarily lead to a higher per capita transfer. We showed how income inequality and corruption simultaneously do result in a smaller redistributive outcome. The channel we examine is to endogeneize the incentive to ask for exemptions. An increase in taxes could trigger the extreme rich ones to ask for exemptions resulting in a lower average tax rates. In a situation where wealth bias in political decision making is prevalent, the tax base is likely to be eroded and lower effective tax rates (per capita tax or per capita transfer) are observed, making it difficult to finance education. Thus persistence in inequality prevails leading to multiple steady state equilibria. Moreover, an increase in inequality not only raises the proportion of skilled individuals which are not subject to tax but it also raises the amount of resources devoted to rent seeking. Clearly, the development of effective tax rates, human capital and growth may be severely damaged by inequality that prevails in wealth biased system of politics.

In an attempt to give these theoretical predictions an empirical support, we run a system of equations using panel-data on per-capita growth, education level, and tax/GDP ratio. The effect seems to be strong enough to support our hypothesis. The adverse effect of redistributive measure and human capital accumulation is entirely captured by the degree of inequality and corruption. Both taxes and education positively and significantly contribute to growth rates though their relation is nonlinear with growth rates.

Given the fact that the empirical findings confirm the non-linear relationship between the taxes and growth, the implication is that effective redistribution of wealth can promote growth if taxes fall below the optimal level. That of course leaves open the question of whether such redistributions are feasible, because political decisions are easily twisted by people who are well advantaged. Broadly interpreted, our results show that an equalizing redistribution of wealth coupled with good institutions lead to a higher accumulation of human capital and this raises economic growth.

The analysis presented in this paper allows for many useful extensions. For example, we did not take into account the accumulation of physical capital. This may overestimate the benefit that the unskilled derive from redistributive taxation as the income tax may reduce the pace of physical capital accumulation. Another useful extension of the model could be to allow for nonlinear redistributive schemes and progressivity in income tax rates.

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Appendix A1: Proof of Proposition 1 and 2 To characterize the efficient bargain, it is simply necessary to note that the individual rationality constraints of the agents are:

$$\left[\left(b_{t-1}-h_{t-1}\right)(1+r)+w_t^s\right]\varepsilon_t^i-C_t^i-f\geqslant 0 \tag{A1}$$

$$-\left[\left(b_{t-1}-h_{t-1}\right)(1+r)+w_t^s\right]u_t\varepsilon_t^i+xC_t^i\geqslant 0 \tag{A2}$$

$A2$ requires that the politician receives at least his reservation utility (normalized, recall, at zero) irrespective of contributions and the lost tax revenue. The distribution of contributions is subject to the choice among efficient bargains. If the extreme rich one is able to extract all surplus from the politician, he will pay $C_t^i = \frac{[(b_{t-1}-h_{t-1})(1+r)+w_t^s](u_t)\varepsilon_t^i}{x}$, the minimum he needs to make the politician willing to carry out the policy. If the politician captures the surplus, then the contribution level will be $-f+[(b_{t-1}-h_{t-1})(1+r)+w_t^s]\,\varepsilon_t^i$.

Exemption is henceforth called admissible iff it satisfies A1 and A2 and the set of C_t^i is:

$$C_t^i \in \left\{ \frac{[(b_{t-1}-h_{t-1})(1+r)+w_t^s]\,u_t\varepsilon_t^i}{x}, [(b_{t-1}-h_{t-1})(1+r)+w_t^s]\,\varepsilon_t^i - f \right\} \tag{A3}$$

A necessary condition for $(A3)$ to be non empty is
$\frac{[(b_{t-1}-h_{t-1})(1+r)+w_t^s]u_t\varepsilon_t^i}{x} \leq [(b_{t-1}-h_{t-1})(1+r)+w_t^s]\,\varepsilon_t^i - f$, which can be expressed as:

$$b_{t-1} \geq \frac{fx}{(1+r)(x-u_t)\,\varepsilon_t^i} + h - \frac{w_t^s}{1+r} \tag{A4}$$

It follows that, there will be no individual for which $\frac{fx}{(1+r)(x-u_t)\varepsilon_t^i} + h - \frac{w}{1+r} > b_{t-1}$ there exists a bargain that fulfills the individual rationality conditions. Therefore individuals with income lower than $\frac{fx}{(1+r)(x-u_t)\varepsilon_t^i} + h_{t-1} - \frac{w_t^s}{1+r}$ will give no contributions and get no exemptions. Now when $(A4)$ is satisfied, there will be a set of efficient bargains which (weakly) Pareto dominate the reservation utility of the politician , and thus we shall expect $\varepsilon_t^i > 0$ in these cases.

It is left to establish that when $(A4)$ is satisfied then full exemption $\varepsilon_t^i = \tau_t$ is granted. To see this, we write down the utility possibility frontier as the solution to:

$$Max\left\{[(b_{t-1}-h_{t-1})(1+r)+w_t^s]\,\varepsilon_t^i - C_t^i - f\right\} \tag{A5}$$

$$\begin{aligned} \text{Subject to } -[((b_{t-1}-h_{t-1})(1+r)+w_t^s)u_t]\varepsilon_t^i + xC_t^i &\geqslant 0, \\ \varepsilon_t^i &\leq \tau_t \end{aligned} \tag{A6}$$

Substituting the first constraint in the objective function

$$Max\left\{[(b_{t-1}-h_{t-1})(1+r)+w_t^s]\,\varepsilon_t^i - \frac{[(b_{t-1}-h_{t-1})(1+r)+w_t^s](u_t)\varepsilon_t^i}{x} - f\right\} \tag{A7}$$

the maximand is linear in ε_t^i if $x - u_t$ is greater than zero and thus $\varepsilon_t^i = \tau_t$. If $u_t > x$, the politician will not give exemptions.

Appendix B: Derivation of the equilibrium tax rate. Derivation of the equilibrium tax rate under no exemption. Note that the politician will set the tax rate to maximize:

$$V_t = u_t \int_{\underline{b}_{t-1}}^{h_{t-1}} y_t^u(b_i)f(b_i)db_i + s_t \int_{h_{t-1}}^{\bar{b}_{t-1}} y_t^{sn}(b_i)f(b_i)db_i \tag{B1}$$

substituting equation (7), (8) and (9), we have

$$\begin{aligned} V_t \quad = \quad & u_t(\int_{\underline{b}_{t-1}}^{h_{t-1}} [\,(b_{t-1}-h_{t-1})(1+r)+w_t^u \\ & +\frac{(\tau-\beta\tau^2)}{N^u}\int_{h_{t-1}}^{\bar{b}_{t-1}} [(b_{t-1}-h_{t-1})(1+r)+w_t^s l_t^s]\,f(b_i)db_i]f(b_i)db_i) \\ & +s_t(1-\tau)\int_{h_{t-1}}^{\bar{b}_{t-1}} [(b_{t-1}-h_{t-1})(1+r)+w_t^s l_t^s]\,f(b_i)db_i \end{aligned} \tag{B2}$$

The derivative of (B2) with respect to the tax rate

$$\frac{\partial V_t}{\partial \tau} = u_t \frac{d}{d\tau} \int_{\underline{b}_{t-1}}^{h_{t-1}} \frac{(\tau - \beta\tau^2)}{N^u} [\int_{h_{t-1}}^{\bar{b}_{t-1}} [(b_{t-1} - h_{t-1})(1+r) + w_t^s l_t^s] f(b_i) db_i] f(b_i) db_i \tag{B3}$$
$$+ s_t \frac{d}{d\tau} \int_{h_{t-1}}^{\bar{b}_{t-1}} [(b_{t-1} - h_{t-1})(1+r) + w_t^s l_t^s](1-\tau) f(b_i) db_i$$

simplifying $B3$ gives us:

$$u_t (1 - 2\beta\tau_t) B_t = s_t B_t \tag{B4}$$

where B_t is $\int_{h_{t-1}}^{\bar{b}_{t-1}} [(b_{t-1} - h_{t-1})(1+r) + w_t^s l_t^s] f(b_i) db_i$.

Rearranging and rewriting $B4$, the equilibrium tax rate will be:

$$\tau_t^* = \frac{u_t - s_t}{2\beta u_t} \tag{B5}$$

Following the same procedure the equilbrum tax rate when there is exemption will be

$$\tau_t^* = \frac{(u_t - z_t)E_t + \Gamma_t}{2\beta u_t E_t} \tag{B6}$$

Appendix C. Proof of Proposition 3 (i). The tax base under the no exemption is always higher than the tax base when there is exemption since it is assumed that $p_{t-1} > h_{t-1}$. Suppose that $\tau_t^{'}$ and $\tau_t^{''}$ are the equilibrium tax rates under no-exemption and exemptions respectively. While, it is true that in advance we can't tell too much the magnitude of the equilibrium tax rate under each case if $\tau_t^{'} > \tau_t^{''}$, then it is evident that revenue collected under no exemption will always be higher. Suppose that $\tau_t^{''} = \tau_t^{'} + \varepsilon$ i.e. the tax rate is slightly higher under exemption case. If C1 is satisfied, it can be shown that a mean preserving redistribution of income to upper income groups will sufficiently degrade the collection of tax revenue.

$$\tau_t^{'} \int_{h_{t-1}}^{\bar{b}_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s l_t^s\right] f(b_i) db_i\right] \geq \tau_t^{''} \int_{h_{t-1}}^{p_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s l_t^s\right] f(b_i) db_i\right] \quad \text{(C1)}$$

From C1 it follows that:

$$\tau_t^{'} \left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f(b_i) db_i + \int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f(b_i) db_i \right) \geq \tau_t^{''} \left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f(b_i) db_i \right) \quad \text{(C2)}$$

Rearranging C2, we have that

$$\tau_t^{'} \left(\int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f(b_i) db_i \right) \geq (\tau_t^{''} - \tau_t^{'}) \left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f(b_i) db_i \right) \quad \text{(C3)}$$

C3 will result in the following:

$$\frac{\left(\int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f(b_i) db_i \right)}{\left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f(b_i) db_i \right)} \geq \frac{\tau_t^{''}}{\tau_t^{'}} - 1 \quad \text{(C4)}$$

To analyze the impact of the skewness of the distribution of income on the erosion of the tax base, consider two density function of bequest $f_1(b_i)$ and $f_2(b_i)$. Suppose that a mean preserving redistribution takes place from skilled tax payers to skilled exempt which leaves the individual with threshold bequest level unchanged p_{t-1}. That is,

$$\begin{aligned} f_1(b_i) &> f_2(b_i) \forall b_i \epsilon [h_{t-1},\ p_{t-1}) \\ f_1(p_{t-1}) &= f_2(p_{t-1}) \\ f_1(b_i) &< f_2(b_i) \forall b_i \epsilon (p_{t-1},\ \bar{b}_{t-1}] \end{aligned} \quad \text{(C5)}$$

From this one can see that the amount of income that is taxable at the initial equilibrium will be lower

$$\left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f_1(b_i) db_i\right) > \left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f_2(b_i) db_i\right) \tag{C6}$$

Similarly, the amount of income which is not subject to tax also increase, that is

$$\left(\int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f_1(b_i) db_i\right) < \left(\int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f_2(b_i) db_i\right) \tag{C7}$$

For given tax rates, the erosion of the tax base is clearly observed and therefore the following will hold and , $y_t^{sn}(b_i) \neq 0$

$$\frac{\left(\int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f_2(b_i) db_i\right)}{\left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f_2(b_i) db_i\right)} > \frac{\left(\int_{p_{t-1}}^{\bar{b}} y_t^{sn}(b_i) f_1(b_i) db_i\right)}{\left(\int_{h_{t-1}}^{p_{t-1}} y_t^{sn}(b_i) f_1(b_i) db_i\right)} \geq \frac{\tau_t^{''}}{\tau_t^{'}} - 1 \tag{C8}$$

Appendix D: Proof of Proposition 4. From equation (4) we have that:

$$g_A = \theta^s S \left(\frac{\theta^s}{\theta^u}\right)^{\frac{\phi-1}{1+\pi-\phi}} \left(\frac{S}{U}\right)^{\frac{\phi-1}{1+\pi-\phi}} \tag{D1}$$

Rewriting $(D1)$ and letting $\delta = \frac{\pi}{1+\pi-\phi}$ and $1-\delta = \frac{1-\phi}{1+\pi-\phi}$ we find:

$$g_A = \theta^s \left(\frac{\theta^s}{\theta^u}\right)^{\delta-1} (N^s)^{\delta} \left((N-N^s)\, l^u\right)^{1-\delta} \tag{D2}$$

The effect of an increase in the supply of skilled people N^son growth is determined by partially differentiating the above function w.r.t. N^s and applying the product rule, which gives the following relation:

$$\frac{\partial g_A}{\partial N^s} = \left[\theta^s \left(\frac{\theta^s}{\theta^u}\right)^{\delta-1}\right] \left[\frac{N^s}{(N-N^s)\, l^u}\right]^{\delta} l^u \left[\delta\frac{(N-N^s)}{N^s} - (1-\delta)\right] \tag{D3}$$

The sign $\frac{\partial g_A}{\partial N^s}$ is positive if and only if the last term in RHS of equation D3 is positive. This requires $\delta N > N^s$.

Appendix E. Proof of Proposition 5

From equation (8) we know that the per capita transfer is

$$\lambda_t = \frac{(\tau_t - \beta\tau_t^2)}{N^u} \int_{h_{t-1}}^{p(\tau)_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right] f(b_i) db_i \tag{E1}$$

Taking the partial derivative of λ_t with respect to τ_t using the rule of Leibniz gives:

$$\begin{aligned}\frac{\partial\lambda_t}{\partial\tau_t} &= \frac{1-2\beta\tau_t}{N^u} \int_{h_{t-1}}^{p(\tau)_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right] f(b_i) db_i \\ &\quad + \frac{(\tau_t - \beta\tau_t^2)}{N^u}\frac{\partial p_{t-1}}{\partial\tau_t}(\left[\left(p(\tau)_{t-1} - h_{t-1}\right)(1+r) + w_t^s\right] f(b_i))\end{aligned} \tag{E2}$$

Recalling that $p(\tau)_{t-1} = \frac{fx}{(1+r)(x-u)\tau} + h_{t-1} - \frac{w_t^s}{(1+r)}$ and suppressing the first term $(\frac{fx}{(1+r)(x-u)\tau})$ to A, $\frac{\partial p_{t-1}}{\partial\tau_t}$ gives $-\frac{A}{\tau}$. Substituting $-\frac{A}{\tau}$ to E2 and rearranging E2 gives as:

$$\begin{aligned}\frac{\partial\lambda_t}{\partial\tau_t} &= \frac{1-2\beta\tau_t}{N^u}(\int_{h_{t-1}}^{p(\tau)_{t-1}} \left[(b_{t-1} - h_{t-1})(1+r) + w_t^s\right] f(b_i) db_i \\ &\quad -A(\left[\left(p(\tau)_{t-1} - h_{t-1}\right)(1+r) + w_t^s\right] f(b_i)))\end{aligned} \tag{E3}$$

Assuming uniform bequest density i.e. $f(b_i) = \frac{1}{(\bar{b}-\underline{b})}$ and integrating our result in E3 results to:

$$\begin{aligned}\frac{\partial \lambda_t}{\partial \tau_t} &= \frac{1-2\beta\tau_t}{N^u(\bar{b}-\underline{b})}(\frac{1}{2}(1+r)p(\tau)_{t-1}^2 - (1+r)h_{t-1}p(\tau)_{t-1} + w_t^s p(\tau)_{t-1} - \frac{1}{2}(1+r)h_{t-1}^2 - w_t^s h_{t-1} \\ &+(1+r)h_{t-1}^2 - A(\left[\left(p(\tau)_{t-1} - h_{t-1}\right)(1+r) + w_t^s\right]) \end{aligned} \tag{E4}$$

Substituting p and after some manipulation, E4 can be written as:

$$\frac{\partial \lambda_t}{\partial \tau_t} = \frac{1-2\beta\tau_t}{N_t^u(\bar{b}-\underline{b})}\left(-\frac{1}{2}(1+r)A^2 - \frac{w_t^s}{2(1+r)}\right) \tag{E5}$$

The expression in the bracket in E5 is negative, suggesting that an increase in tax rates lead to a decrease in per capita transfer i.e. $\frac{\partial \lambda_t}{\partial \tau_t} < 0$.

Figure 2A. Dynamics of Wealth Distribution when there is no exemptions.

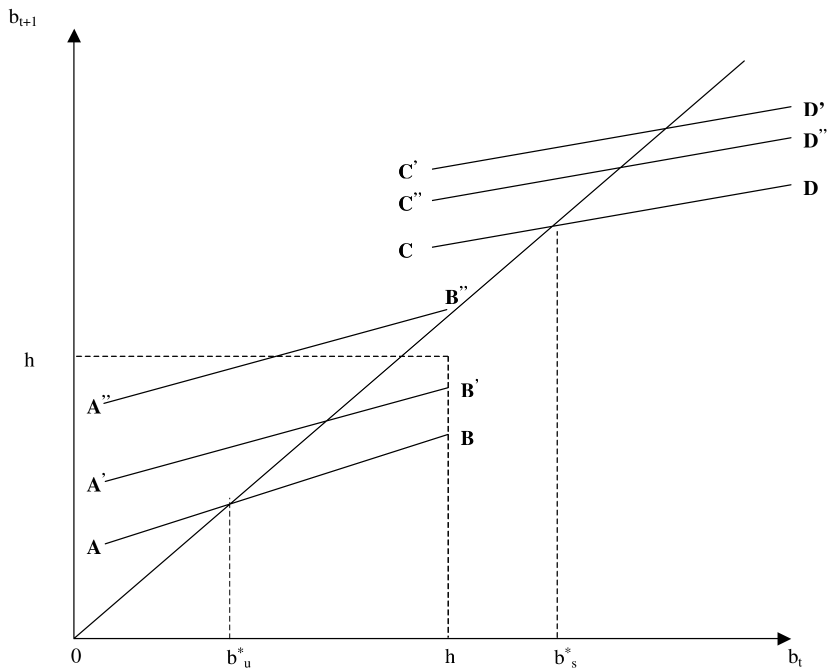
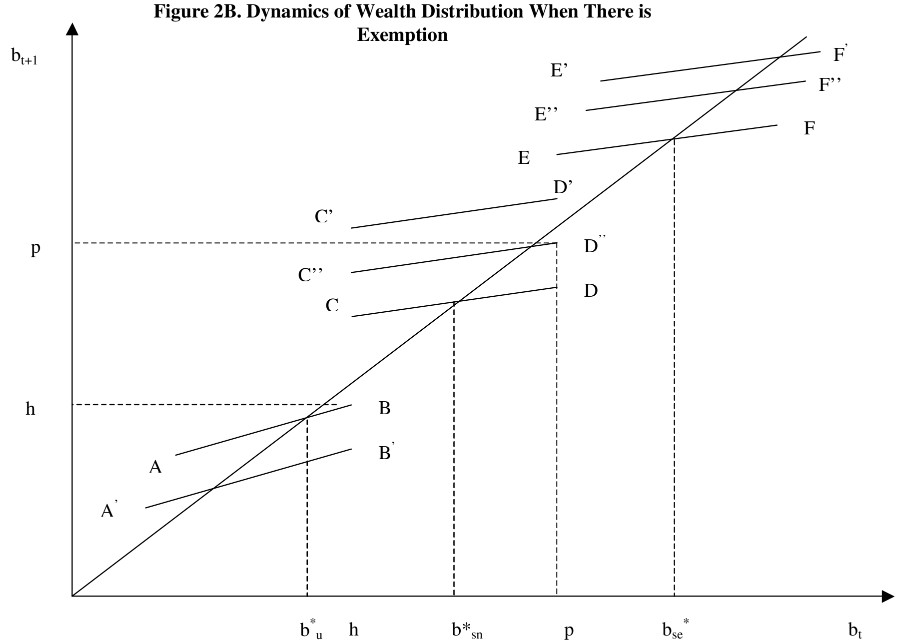


Figure 2B. Dynamics of Wealth Distribution When There is Exemption



The table below presents the parameter settings used in the experiments. We provide some information on the numerical simulation examples we performed. The simulations are performed by Compaq Visual Fortran. The relevant program is available from the authors.

Parameter	Definition	Value
h_0	Initial cost of becoming skilled	60
A_0^u	Initial wage of unskilled workers	30.5
A_0^s	Initial wage of skilled workers	140
η^u	shift parameter of lobbying technology	2
η^s	shift parameter of lobbying technology	0.025
α	Share of consumption	0.32
r	Interest rate	0.005
N	Total number of individuals	100
β	Parameter of the collection cost	3
θ_u	Shift parameter of knowledge spillover	0.0009
θ_s	Shift parameter of knowledge spillover	0.004
π	Effect of production on creation of knowledge of unskilled	0.65
ϕ	Effect of production on creation of knowledge of skilled	0.85

Figure 3A. Effect of Wage increase on wage gap

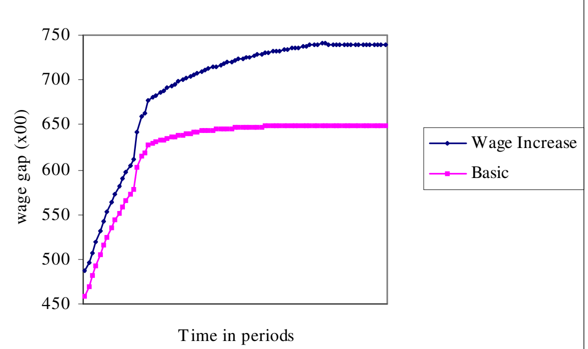


Figure 3B: Effect of Wage Increase on the evolution of the lobbying efforts of unskilled individuals

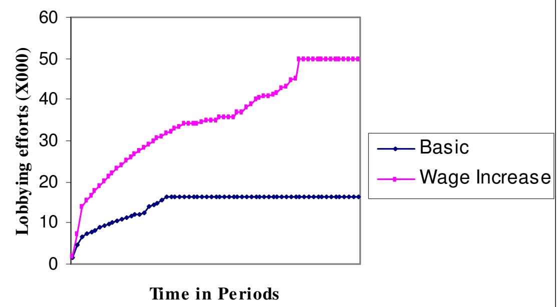


Figure 3C. Effect of wage increase on the evolution of the longrun # of unskilled individuals

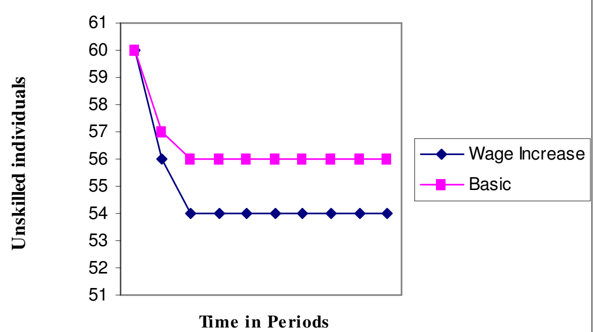
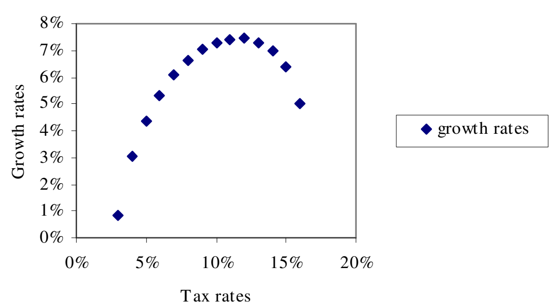


Figure 3D. Non- monotinic relationship between growth and tax rates



Appendix F. Description and Source of the Data.

Corruption: It is from Transparency International (a coalition against corruption in international business transactions). This index is based not only on the locals but also on international surveys of business people and reflects their impressions and perceptions of the countries surveyed. The index is available from 1980-85, 1988-92, and 1995-2002. It ranks countries on a scale of 0 (completely corrupt) to 10 (clean). For conformity, we inverted the scale i.e. 0 means the lowest level of corruption and 10 is the highest. (www.transparency.de)

Growth rate of Real GDP per Capita (Growth): World Bank's World Development Indicators (WDI). We choose WDI rather than the Penn World Trade because the WDI is more updated and it contains more observation for extended time periods than the latter. (average of 80-84,85-89,90-94,95-99)

Income Inequality [**Gini**]: Estimated household income inequality is used as a measure of income Gini. It is available for a long period of time. This approach uses econometric methods to estimate the relationship between income inequality and pay inequality. The estimates are conditioned by other variables, including the relative size of the manufacturing sector, for a matched set of observations covering just over 500 data points in Deininger and Squire. The estimated regression coefficients are available from http://utip.gov.utexas.edu/ web site. The index takes values between 0 and 100, with a higher number indicating greater inequality.

Land Gini [**LandGini**]: is from FAO which compiles summaries of official "Agricultural Census". Source (Klause Deininger and Pedro Olinto). The index takes values between 0 and 100, with a higher number indicating greater inequality.

Gross Domestic Investment % of GDP (Investment): is the ratio of real investment to real GDP. The measure is the average of the annual observations on the ratio for each of the periods. (1980-1984,1985-1989,1990-1994,1995-1999)

Log of Initial GDP per capita (Loggdp) is from **CD Room of WDI 2003.** (1980,1985,1990,1995)

Tax revenue (% of GDP) (Tax). Tax revenue comprises compulsory transfers to the central government for public purposes. Compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue. Data are shown for central government only. Source World Development Indicators 2003.

Education (Educins): The proxy for human capital endowment is secondary schooling enrollment ratio. (1980-1984,1985-1989,1990-1994,1995-1999)

Openness: openness, defined as the sum of exports and imports of goods and services as a share of gross domestic product. (averaged over five year periods) Source: The World Bank's World Development Indicators CD-Rom 2003.(1980-1984,1985-1989,1990-1994,1995-1999)

Ethnicity: the proxy for ethnicity is an index of ethno linguistic fractionalization for 1960. It measures the probability that two randomly selected persons from a given country will not belong to the same ethno linguistic group.

Fertility rate: Fertility rate, total (births per woman) Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with prevailing age-specific fertility rate is the number of infants dying before reaching one year of age, per 1000 live births in a given year. WDI CD Room 2004.

General government consumption (Govt) it includes all government current expenditures excluding military expenditures that are part of government capital formation. WDI CD Room 2003.

Political Rights Index [Polright] is an index that measures the level of political freedom. The index ranks countries on a scale of 0 to 7. I reversed the scale and converted the original ranking of 0 to 7 into a scale of 0 to 10 where the higher the score means the lower the level of political freedom.

Table 1: Descriptive Statistics of the Variables Used for 3SLS

Variable	N=161		N=146	
	Mean	Std.Dev.	Mean	Std.Dev
Growth	1.990	2.097	1.994	2.120
Log initial gdp	3.899	0.420	3.888	0.420
Gdi	22.447	5.127	22.329	5.165
Education	74.081	30.755	73.905	29.990
Education^2	5928.861	4412.832	6355.145	4392.056
Tax	22.952	9.840	23.032	9.951
Tax^2	623.052	505.109	628.85	508.477
Income Inequality	38.51771	7.031192	39.364	6.100
Land Inequality	62.954	16.497	63.331	16.674
Corruption	4.677	2.643	4.604	2.648
Openness	61.4239	39.81214	59.839	32.0311
Govt	16.502	6.066	16.663	6.207
Fertility	2.835	1.484	2.893	1.503
Ethnic	31.674	28.689	31.078	28.914

Table 2: Descriptive Statistics for Variables Used In Panel Estimates

Variable	Obs	Mean	Std.Dev.
Growth	152	1.883	2.321
Log initial gdp	152	3.864	0.447
Education	152	72.366	30.715
Education^2	152	5928.861	4412.832
Tax	152	22.523	10.150
Tax^2	152	603.4888	507.123
Income Inequality	152	39.669	6.278
Land Inequality	188	64.11425	16.8744
Corruption	152	4.719	2.683
Openness	152	61.424	39.812
Govt	152	16.510	6.165

Table 3: Short run panel estimates of the non monotonic relationship between taxation, education and growth

	Fixed Effects (1)		Fixed Effects (2)	
Growth	Coef.	Std. Err.	Coef.	Std. Err.
Loggdp	-11.787	(2.908)***	-12.552	(2.889)***
Gini	-0.121	(0.059)**	0.176	(0.159)
Tax	0.357	(0.178)**	0.313	(0.176)*
Tax^2	-0.006	(0.003)*	-0.006	(0.003)*
Education	0.174	(0.064)***	0.208	(0.065)***
$Education^2$	-0.001	(0.0003)*	-0.001	(0.0003)**
Corruption	-0.007	(0.253)	1.717	(0.895)*
Govt	-0.250	(0.094)***	-0.247	(0.093)***
Openness	0.048	(0.016)***	0.046	(0.015)***
Corr*gini			-0.044	(0.022)***
Cons	39.676	(11.352)***	31.184	(11.953)***
R^2	0.33		0.36	
Observations	152		152	
Hausman(p-value)	0.03		0.01	

*,** and*** denotes significance at 10, 5 and 1 percentage level respectively.

Table 4: Estimates of Three Stage Least Squares of Growth, Education and Tax/GDP ratio: averaged over 5 years.

	Income Inequality		Land Inequality		Nested	
	(1)		(2)		(3)	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
Growth						
Loggdp	-8.376	(1.679)***	-7.604	(1.208)***	-6.077	(1.178)***
Investment	0.203	(0.054)***	0.204	(0.042)***	0.204	(0.043)***
Tax	2.306	(0.610)***	2.538	(0.491)***	2.013	(0.481)***
Tax^2	-0.038	(0.011)***	-0.042	(0.008)***	-0.034	(0.009)***
Govt	-0.219	(0.063)***	-0.235	(0.054)***	-0.201	(0.052)***
Polright	-0.428	(0.132)***	-0.386	(0.110)***	-0.382	(0.108)***
Openness	-0.022	(0.011)***	-0.027	(0.008)***	-0.019	(0.009)**
Constant	7.425	(4.346)	2.074	(3.492)	1.845	(3.465)
Tax						
Corruption	-0.595	(0.335)*	-0.826	(0.284)***	-0.385	(0.343)
Gini	-0.362	(0.123)***			-0.438	(0.128)**
LandGini			0.026	(0.033)	0.061	(0.034)*
Govt	0.638	(0.126)***	0.792	(0.122)***	0.701	(0.126)***
Ethnic	-0.041	(0.020)**	-0.050	(0.019)**	-0.035	(0.021)*
Cons	30.530	(5.265)***	13.597	(3.745)***	27.588	(5.490)***
Education						
Tax	8.815	(3.165)***	7.910	(2.815)***	8.094	(2.626)***
Tax2	-0.138	(0.059)**	-0.122	(0.052)**	-0.130	(0.049)***
Fertility	-6.848	(2.437)***	-8.883	(1.909)***	-8.581	(1.815)***
Land					-0.204	(0.0874)**
Cons	-21.332	(41.715)	-6.285	(36.539)	6.649	(34.076)
Observations	151		161		146	
Countries	53		53		53	
χ^2	93.58/176.16/167.19		99.85/165.77/217.51		80.66/171.98/220.36	

*,** and *** denotes significance at 10, 5 and 1 percentage level respectively.

Table 5: Estimates of Three Stage Least Squares of Growth, Education and Tax/GDP ratio: averaged over 5 years

	Income Gini		Land Gini		Nested	
	(1)		(2)		(3)	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Growth						
Loggdp	-5.822	(1.757)***	-7.730	(2.073)***	-6.169	(1.707)***
Gdi	0.165	(0.042)***	0.155	(0.043)***	0.146	(0.039)***
Educins	0.181	(0.079)**	0.252	(0.093)***	0.196	(0.074)***
Educins2	-0.0006	(0.0004)	-0.001	(0.0005)**	-0.0007	(0.0004)*
Govt	-0.087	(0.039)**	-0.059	(0.039)	-0.074	(0.036)**
Polright	-0.285	(0.121)**	-0.350	(0.138)**	-0.309	(0.121)***
Openness	-0.001	(0.007)	-0.005	(0.007)	-0.0002	(0.006)
Cons	14.261	(4.753)***	19.333	(5.560)***	15.507	(4.657)***
Tax						
corruption	-0.613	(0.335)*	-0.804	(0.285)***	-0.327	(0.344)
Gini	-0.358	(0.123)**			-0.460	(0.129)***
Land			0.029	(0.033)	0.072	(0.034)**
Govt	0.644	(0.126)***	0.800	(0.122)***	0.709	(0.126)***
Ethnic	-0.040	(0.020)**	-0.050	(0.020)**	-0.035	(0.021)***
Cons	30.317	(5.262)***	13.198	(3.754)***	27.030	(5.514)***
Education						
Tax	7.108	(3.109)**	7.618	(3.083)***	9.077	(3.048)***
Tax^2	-.108	(0.057)*	-0.117	(0.057)**	-0.148	(0.056)***
Fertility	-8.358	(2.506)***	-9.685	(2.193)***	-8.707	(2.183)***
Land					-.332	(0.126)***
Cons	3.153	(41.619)	-0.224	(40.525)	4.147	(40.600)
Observations	151		146		146	
Countries	53		53		53	
χ^2	67.48/177.96/191.08		64.45/17062/160.90		61.86/170.27/178.25	

*,** and*** denotes significance at 10,5 and 1 percentage level respectively.

Table 6: Estimates of Three Stage Least Squares of Growth, Education and Tax/GDP ratio.

	Income Inequality		Landgini		Nested	
	(1)		(2)		(3)	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
Growth						
Loggdp	-8.169	(2.492)***	-9.012	(2.089)***	-7.945	(1.766)***
Investment	0.108	(0.062)*	0.151	(0.044)***	0.150	(0.042)***
Tax	2.821	(1.197)**	0.937	(0.563)*	0.618	(0.464)
Tax^2	-0.047	(0.021)**	-0.015	(0.010)	-0.010	(0.008)
Educins	0.076	(0.210)	0.252	(0.113)**	0.236	(0.082)***
Educins^2	-0.001	(0.001)	-0.001	(0.001)**	-0.001	(0.0004)***
Govt	-0.245	(0.069)***	-0.149	(0.051)***	-0.123	(0.046)***
Polright	-0.488	(0.197)***	-0.451	(0.141)***	-0.441	(0.125)***
Openness	-0.024	(0.013)*	-0.013	(0.008)	-0.006	(0.008)
Cons	2.823	10.663	15.886	(7.012)**	15.352	(5.681)***
Tax						
Corruption	0.260	(0.335)*	-0.807	(0.284)***	-0.339	(0.343)
Gini	0.355	0.123			-0.448	(0.129)***
Land			0.028	(0.033)	0.071	(0.034)***
Govt	0.644	0.126	0.799	(0.122)***	0.706	(0.126)***
Ethnic	-0.040	(0.020)**	-0.050	(0.019)**	-0.036	(0.021)***
Cons	30.248	(5.260)***	13.262	(3.752)***	27.129	(5.505)***
Education						
Tax	6.783	(3.122)**	7.451	(3.093)**	8.983	(3.055)***
Tax^2	-0.102	(0.058)*	-0.114	(0.057)**	-0.146	(0.057)***
Fertility	-8.543	(2.502)***	-9.801	(2.192)***	-8.761	(2.181)***
Land					-0.326	(0.125)***
Cons	7.361	41.709	2.131	(40.617)	5.046	40.665
Observations	151		161		146	
Countiries	53		53		53	
χ^2	96.02/178.35/189.84		57.06/165.15/201.17		67.17/170.70/177.23	

*,** and *** denotes significance at 10,5 and 1 percentage level respectively.