Democracy and Growth Volatility: Exploring the Links

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Abstract

We study the volatility of growth rates and find that it differs systematically across countries. Our empirical investigation reveals that there is a high correlation between disparity in political regimes across countries and differences in volatility. This is not the case for some of the commonly cited reasons like initial income, inequality or instability of regimes. We find that less democratic countries are more volatile. To explain this observation we use a dynamic model in which democracy is parameterized by the fraction of people who benefit from being in power. The government in this model maximizes the utility of the group in power using a redistributive tax scheme - setting uniform income taxes but transferring lump sum amounts and providing goods and services to the favored group only. When there is a bad shock in this economy, the marginal utility of consumption of agents in power is high. When the transfer is divided among a few, gains from increased transfer outweigh distortionary costs of higher tax. Thus, the optimal tax policy in non-democratic countries, in contrast to that in democratic countries, is such that tax rates are high when there is a bad shock and low when there is a good shock (we refer to this as procyclical tax policy). Further, we show that procyclical tax rates will lead to higher volatility of growth rates than under alternative tax policies. Thus, our model is successful in explaining why tax policies are pro-cyclical in some countries, a commonly observed phenomenon, in addition to providing reasons for differences in volatility of growth rates across countries. The model's predictions are borne out by data in a number of other dimensions also.

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1 Introduction

There exist great differences in volatility of growth rates across countries. The growth rates in the country with most volatile growth rates are more than seven times more volatile than in the country with least volatile growth rates for the period between 1961 and 1996. Why do some countries systematically experience more volatile growth rates than others?

In this paper we seek an answer to this question through a comprehensive study of the volatility of growth rates across countries, both empirically and using a stochastic dynamic general equilibrium model, and find that the political structure of a country is the main determinant of the volatility of growth rates in the country. Empirical analysis show that the relationship between the volatility of growth rates and political regimes is robust. We then develop a model in which the political regime of a country influences the choice of fiscal policy, which in turn determines the volatility of growth rates in the country.

How are democracies different from non-democracies? In our view the degree of democracy in a country is determined by the fraction of the population who are a part of the political decision making. This is also the group whose interests are served by the government in power. In a perfect democracy each individual has a say in the political process and no particular group's interest is served over others. More autocratic countries are thus "democracies for a few." As a result there are countries with varying degree of democracies, between perfect democracy and absolute autocracy, and not just two groups - democratic and autocratic. In our model the democracy score of a country is given by the measure of the population who share the benefits of power. Thus, the degree of democracy is parameterized in our model and the optimal outcomes in the model are a function of that parameter. Clearly, in reality countries cannot be divided in two polar groups, rather the degree of democracy varies across countries. Thus our way of modeling regime types allows us to compare our findings with data.

In our model we assume that there is no difference between regimes in the way they can collect revenues from the citizens [1] . This means that no government can extract resources selectively from some group. We however assume that government can selectively transfer resources to its favored group. The government can design government programs or provide public goods, like military and other security forces, educational institutions, health-care system, government employment, compensation package for government employees etc., to benefit a particular section of the people. In the model we assume that the objective of the government is to maximize the utility of that section of the population who are a part of the ruling group by redistributing, using an uniform income tax but transferring to the favored group only. The transfer can take two forms - either the government can provide pure income transfers or the government can provide goods and services that enter the utility functions of the constituents.

Another assumption that needs mention is that government runs a balanced budget in our model. This might seem extreme, but in practice governments do face borrowing constraints. If countries were able to borrow but the limit on borrowing was low, our results will be not much different. In fact often the borrowing limit depends on the current situation in the country - it is more difficult to secure a loan in bad times, when the country is in greater need for a loan, than in good times. If such a borrowing limit were in operation, it would possibly strengthen

[1] Note, that we abstract from conflicts and concentrate on identifying policy differences across countries with differing degrees of democracies.

our results. However, for now we abstract from this and set the borrowing limit for all countries at zero.

So, why do non-democratic countries experience more volatile growth rates in this model? This is because the optimal fiscal policy differs depending on the polity of the country, which in turn results in difference in volatility of growth rates. Thus, institutional differences affect volatility through fiscal policy in our model. To understand how the political regime determine the fiscal policy in this model, let us first consider an economy with low democracy (i.e., a country closer to autocracy). The objective of the government is to maximize the utility of only a sub-set of the population, so the government can increase utility of that ruling group in any period by setting a high income tax rate on everyone and transferring the funds thus received to the members. On the other hand, there is a distortionary cost of any income tax. The government sets the tax such that at the margin the benefit from the tax is equal to the cost. When the country is hit by a bad shock, output is low and the marginal utility of consumption of both private and publicly provided goods is high for consumers belonging to the group in power [2]. Thus the total benefit from additional transfer is high, further so because the transfer gets divided between a few in non-democracies. The government thus sets a high tax rate when output is low. In the good times, on the other hand, marginal utility of consumption is lower and the cost of distortion offsets the benefits of redistribution at a lower level of tax compared to that set in the bad times. Thus, tax policy in any non-democratic country will be such that tax rates will be higher in bad times

[2]Note that marginal utility of all agents in the economy will be high in this case, but since the government is only concerned with the welfare of a fraction of the population, it is their marginal utility that matters.

than in good times. We refer to such a tax policy as procyclical tax policy [3].

In the democratic country the beneficiaries of the government largesse is numerous. As a result the amount of per capita transfer amount is small, and the benefit from high income tax rates is not big enough even in bad periods. Thus tax rates will not be as procylical as that in a more non-democratic country. As a result, in our model, more non-democratic countries follow procyclical tax policies compared to democratic ones.

It is numerically challenging to solve for a general model where there are both direct income transfers and government provided goods and services in the model with heterogenous agents and multiplicative as well as additive shock. We plan to solve that in future versions of this paper. In this paper we solve two different cases, one with multiplicative shocks and the other with additive shocks.

In a model with multiplicative shock, we solve for the optimal tax policy in the dynamic model where labor is supplied inelastically and where there are no direct transfers but the government provides goods and services to the favored group. We get tax rates to be procyclical in highly non-democratic countries as expected. In contrast, again as expected, the tax rates are countercyclical in countries which are perfectly democratic.

This prediction of our model is supported by observations in the literature. There is a growing literature which points out the apparent anomaly in fiscal policies followed by low income countries, particularly those in Latin America (see for example, Gavin and Perotti (1997), Riascos and Vegh (2003), Kaminsky

[3] In the literature there is some confusion about referring to such a policy as either procyclical or countercyclical. In keeping with the view that any policy that amplifies volatility is procyclical, we will call such a tax policy as procyclical tax policy.

et. al. (2004)). Such policies are in contrast to what is observed in developed economies and to what standard theories of optimal tax predict. Our model provides a solution to this puzzle.

The procyclicality of tax rates in non-democratic countries would lead to higher volatility in such economies. If tax rates are high in periods of low output, then it deters investment when a bad shock is anticipated. This in turn makes the tax rate higher and further drop in investment. This mechanism amplifies the drop in output and hence increases volatility.

Our model indeed predicts that non-democratic countries will be more volatile than democratic ones. However, the volatility differences generated is smaller than what is observed in data. This could be due to absence of direct transfers or inelastic labor supply [4]. To check if direct transfers have effect on the volatility we simulate an economy with direct transfers. We solve for the competitive equilibrium with exogenous taxes and find that even small procyclicality of tax rates lead to huge increase in volatility of growth rates.

In the case of an economy with additive shocks, we show that the optimal tax policy will be procyclical. In such an economy difference in volatility between highly democratic countries and highly non-democratic countries is substantial. This suggests that difference in volatility of growth rates is likely to be high in the more general dynamic model when we have transfers, labor-leisure choice in the model and both multiplicative and additive shocks.

Thus our paper not only illustrates how policy differences across countries

[4]It is important to remember though that the results are from a simulation exercise and not a calibration of the model. We chose the parameters according to our belief of what is reasonable. It is to be seen if the volatility differences are large when we calibrate our model.

is the reason for the observed differences in the volatility of growth rates across countries, but also predicts that the nature of fiscal policies will be very different in countries that are democratic from those that are not democratic, a fact supported by data.

The rest of the paper is organized as follows. In the next section we empirically analyze the relationship between volatility and polity. Immediately next, we develop a general model. In sections 4, 5 and 6 we solve various cases of the general model. In section 7, we relate our paper to existing literature. The last section concludes.

2 Volatility and Political Structure: An Empirical Analysis

In this section we empirically establish the relationship between the volatility of growth rates and the polity of a country. We measure the volatility of growth rates as the standard deviation of annual growth rates. We then regress volatility of growth rates on political regime types.

For data on the political regime type in a country we use the polity data from the Polity IV project: "Political Regime Characteristics and Transitions, 1800-2002". In this data the notion of democracy is that a country can be considered democratic if

- political participation is fully competitive
- executive recruitment is elective
- constraints on chief executive are substantial

Using this concept, a "democracy" and an "autocracy" score is assigned to each country. Though, in assigning these two scores the same concept is used, categories used in constructing the scores are different for the two. In fact the two scales do not share any categories in common.

The *polity* data is the difference between democracy and autocracy scores for a given country. Each country is assigned a polity score on a scale of -10 (strongly autocratic) to +10 (strongly democratic) for each year. As a measure of political regime in a country we take the average of polity scores for that country for the relevant period.

For the period of 1962-1996, the average polity scores vary over the whole range of -8.51 to +10 for 84 countries in the sample. Cote d'Ivoire is the country with the lowest polity score and there are 17 countries with a polity score of +10. The mean polity score in the sample is 0.83.

To find if there is any relationship between the volatility of growth rate and the polity, we regress volatility of growth rates against polity scores. As reported in table (1), we find that there is a significant negative relationship between the two.

Table 1: Regression of Volatility against Polity

Volatility =	α	$\beta\times$ Polity
	0.079	-0.053
	(16.223)	(-6.840)

Source: PWT 6.1 and Polity IV project.

To check the robustness of the result we run the regression between the same variables for different time periods, take various sub-samples of countries and also take a different data for political characteristics of the country[5]. In all regressions the relationship is negative and significant. Thus, volatility of growth rate is robustly related to how democratic the country is - less democratic countries are more volatile.

We also check for the robustness of the relationship between the two variables by adding other control variables as independent variables in the regression. In the regression for the period between 1962 and 1996 with a set of Levine-Renelt (1992) controls - average investment as a fraction of GDP, average population growth rate, initial human capital[6] and log of initial GDP per capita - the only variable that is significant is polity.

In the literature some suggested reasons of volatility differences across countries are initial GDP per capita, inequality or stability of regimes. We use various regressions to understand the importance of polity vis-a-vis these variables.

For data on initial income we take GDP per capita in 1961 and for inequality we use average gini index over the period [7]. For stability of regimes, we use data on regime changes from Polity IV dataset and calculate the durability of regimes in a country for a given time-period. We estimate that by calculating the average

[5]. The alternative data is from the Gastil Scales, which give two seven point indices, one for "Political Freedom" and another for "Civil Rights" for each country for each year (from 1972-73 to 2001-2002). In these scales, 1 denotes the best performance while 7 is the worst. We take mean of these indices for each year and take the average of that over the years.

[6]For initial human capital, we use two different sets of data (and run two regressions): the average schooling years in the total population over age 25 in the year 1960 and total gross enrollment ratio for secondary education in 1960. This data is from Barro-Lee data set available at http://www.nuff.ox.ac.uk/Economics/Growth/barlee.htm.

[7]The inequality data is from UNU/WIDER-UNDP World Income Inequality Database, Version 1.0, 12 September 2000.

of the longevity of each regime. In the next few regressions we use a sample of countries for which data was available for all these variables, growth rates and polity for the period between 1962 to 1996. There were 51 such countries.

Using these data, first we regress volatility of growth rates against log of initial income, inequality and durability of regimes individually (in three separate regressions). We find that the coefficient on each of these variables are significant. Next, in each of the three regressions we also add polity as a dependent variable. Now, none of the coefficients on the above mentioned variables are significant, but the coefficient on polity is always significant. The result is the same if we add different combination of these variables with polity as independent variables. The results are reported in table (2).

One thing that needs to be pointed out is that the initial income and polity are quite highly correlated in the sample. The correlation coefficient between them is 0.738. This raises the possibility that there is multicollinearity in regressions featuring both polity and initial income. However, multicollinearity implies that it is less likely that the coefficient on both initial income and polity are found to be significant. The fact that the coefficient on polity is still significant means there is strong correlation between polity and volatility.

To be doubly sure that polity and not the other variables that is important in understanding why volatilities differs across countries, we devise the following procedure:

- We regress volatility on variable X, where X is either log of initial income, or, inequality, or, durability of regimes, and find the residuals.

- In the second stage we regress the residuals on polity.

Table 2: Regression of Volatility against Polity and Other Variables

Independent Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.070 (12.885)	0.131 (5.874)	0.011 (0.835)	0.053 (10.205)	0.080 (3.269)	0.054 (4.061)	0.069 (12.731)	0.054 (1.825)
Polity	-0.042 (-5.754)				-0.039 (-3.562)	-0.039 (-5.183)	-0.046 (-4.798)	-0.043 (-3.366)
Log of Initial Income		-0.011 (-4.060)			-0.002 (-0.448)			-0.0005 (-0.128)
Gini Index			0.001 (2.404)			0.0003 (1.270)		0.0004 (1.411)
Durability of Regimes				-0.001 (-2.690)			0.0001 (0.572)	0.0002 (0.863)

Source: PWT 6.1, Polity IV project, World Bank.

We find that the coefficient on polity, in the second stage, is always significant. We then reverse the sequence of regressions.

- We regress volatility on polity and find the residuals.
- In the second stage we regress the residuals on variable X, where X is either log of initial income, or, inequality, or, durability of regimes.

Now, none of the coefficients on any variable X in the second stage is significant.

Thus, it is apparent that there is a very robust relationship between volatility of growth rates and polity and not so between volatility and other variables considered. This establishes a clear link between political regimes and volatility of growth rates. In the next section we build a theoretical model to explore how polity affects volatility.

3 A general model of Polity and Volatility

To understand how the political regime of a country can influence the economic performance of that country we build a model in which the extent of democracy in the country is parameterized. So the outcomes of the model will be a function of that parameter, which will allow us to compare across regime types.

Here we provide a description of the most general version of the model that we will consider in this paper. Later in the paper we will compute optimal solutions and equilibria for some special cases of this general model.

3.1 The Environment

We consider an infinite horizon economy with uncertainty. The state at time-period t is given by s_t and s^t is the history through time-period t. We assume that s_t follows a finite state markov chain with a unique ergodic distribution. We denote the probability of state s^t occurring in period t by $\pi(s^t)$.

There is a measure one of population. The population is divided into two groups, A and B. There is a measure λ of population in group A and $(1-\lambda)$ in group B. Group A is in power, the government maximizes the utility of agents in group A only. An innovative feature of this model is parameterizing democracy - here λ is also the measure of democracy in the country. Higher λ means a greater fraction of the population is part of the decision making process and are represented in the government. A perfect democracy is that in which each individual's welfare is part of a government decision. That happens when λ is 1, then each individual's utility is a part of the maximization problem the government solves.

The government's decision involves choosing the income tax rates for each period and how much to transfer through direct income transfers and by providing goods and services. We assume that the government cannot vary tax rates across individuals, so each consumer in this economy pays income taxes at the same rate. However, the transfers, both direct income transfers and publicly provided goods and services, are directed towards agents in group A only. This is the process through which the government redistributes income in this economy. Also, the government does not have the ability to save or borrow, i.e., there are no government bonds. Each period the revenue obtained through taxation is fully spent on transfers to group A members and on provision of government goods and services.

Agents in each group take tax $\tau(s^t)$, direct income transfers $T(s^t)$ and government expenditure on publicly provided goods and services $G(s^t)$ as given and choose consumption $c^i(s^t)$ $(i = A, B)$, labor $l^i(s^t)$ and capital $k^i(s^t)$ to maximizes their own utility.

Group A's Problem

Agents in group A by virtue of being part of the ruling group get direct income transfers and also publicly provided goods and services from the government. The goods and services that the government provides is not a pure public good, it is assumed to be a rival good. This good enters the utility of the consumers unlike the income transfer, which appears in the budget constraint of the consumers. Thus, if $G(s^t)$ is the total amount the government spends on providing goods and services to its citizens, each agent in group A gets $\frac{G(s^t)}{\lambda}$ of it [8]. We assume the utility of the consumers are additive in privately procured goods and publicly provided goods and services. They maximize their lifetime expected utility by choosing their own consumption, labor supply and capital, $\{c^A(s^t), l^A(s^t), k^A(s^t)\}$,

$$\max_{\{c^A(s^t), l^A(s^t), k^A(s^t)\}} \sum_{t,s^t} \beta^t \pi(s^t) \left[u(c^A(s^t), l^A(s^t)) + v(\frac{G(s^t)}{\lambda}) \right] \tag{1}$$

Subject to the budget constraint,

$$\begin{aligned} c^A(s^t) + k^A(s^t) \quad &\leq \quad [1 - \tau(s^t)]\{w(s^t) l^A(s^t) + r(s^t) k^A(s^{t-1})\} \\ &\quad +(1-\delta) k^A(s^{t-1}) + \frac{T(s^t)}{\lambda} \end{aligned} \tag{2}$$

Define $R(s^t) = [1 - \tau(s^t)] r(s^t) + 1 - \delta$, then the budget constraint becomes:

$$c^A(s^t) + k^A(s^t) \leq [1 - \tau(s^t)] w(s^t) l^A(s^t) + R(s^t) k^A(s^{t-1}) + \frac{T(s^t)}{\lambda} \tag{3}$$

Group B's Problem

The difference in group B's problem from that of group A's is that group B agents do not receive any direct income transfers or publicly provided goods and services. The income tax, however, is levied on the whole population and so group B agents still have to pay the income tax. They also maximize their lifetime expected utility by choosing their own consumption, labor supply and capital, $\{c^B(s^t), l^B(s^t), k^B(s^t)\}$

$$\max \sum_{t,s^t} \beta^t \pi(s^t) u(c^B(s^t), l^B(s^t)) \tag{4}$$

[8] We assume a linear technology for producing government goods. So the government expenditure on these goods and services is also the amount of that commodity produced.

Subject to,

$$c^B(s^t) + k^B(s^t) \leq [1 - \tau(s^t)]w(s^t)l^B(s^t) + R(s^t)k^B(s^{t-1}) \tag{5}$$

Firm's Problem:

Firms produce the private consumption good in a competitive environment, so returns on capital and labor equals their marginal products in this economy.

$$r(s^t) = F_K(K(s^{t-1}), L(s^t), s_t) \tag{6}$$

$$w(s^t) = F_L(K(s^{t-1}), L(s^t), s_t) \tag{7}$$

Notice, that s_t enters the production function explicitly, but there is no assumption whether the shock is multiplicative or otherwise.

Government budget constraint:

The government runs a balanced budget each period. They tax income of all agents at the same rate and use revenues to provide public goods and services $G(s^t)$ and transfer $T(s^t)$ to group A members. Their budget constraint is given by,

$$T(s^t) + G(s^t) = \tau(s^t)[w(s^t)L(s^t) + r(s^t)K(s^{t-1})] \tag{8}$$

Feasibility

The feasibility equation that must be satisfied in the economy is given by,

$$C(s^t) + K(s^t) + G(s^t) = F(K(s^{t-1}), L(s^t), s_t) + (1 - \delta)K(s^{t-1}) \tag{9}$$

Where,

$$\lambda c^A(s^t) + (1-\lambda)c^B(s^t) = C(s^t) \tag{10}$$

$$\lambda l^A(s^t) + (1-\lambda)l^B(s^t) = L(s^t) \tag{11}$$

$$\lambda k^A(s^t) + (1-\lambda)k^B(s^t) = K(s^t) \tag{12}$$

Competitive Equilibrium

The definition of the competitive equilibrium is standard. Let us define,

- $\eta(s^t) = [\tau(s^t), T(s^t), G(s^t)]$: government policy at s^t; η:policy for all s^t.

- $x(s^t) = [c^A(s^t), c^B(s^t), l^A(s^t), l^B(s^t), k^A(s^t), k^B(s^t)]$: an allocation at s^t; x: an allocation for all s^t.

- $(w, r) = [w(s^t), r(s^t)]$: a price system.

A *competitive equilibrium* is a policy η, an allocation x and a price system (w, r) such that given the policy and the price system:

- the allocation maximizes agent A's utility, 1, subject to the sequence of budget constraints 3.

- the allocation maximizes agent B's utility 4 subject to the sequence of budget constraints 5.

- price system satisfies 6 and 7 and

- the government's budget constraint 8 is satisfied.

Notice, as in representative agent problems, the feasibility constraint 9 is not part of the definition even though this is a heterogeneous agent problem. Standard assumptions on utility functions ensure the budget constraints are satisfied with equality in an equilibrium, and those together with the government budget constraint implies the feasibility condition.

3.2 Optimal Policy Choice

In this model the tax and transfer policies are chosen endogenously by the government. As stated earlier the objective of the government is to maximize the utility of agents in group A only.

However, in choosing its optimal fiscal policy the government must take into account the equilibrium behavior of all agents. The equilibrium can be fully characterized by the first-order conditions derived from the utility maximization problem of the agents A an B, and from the firm's problem. These equilibrium conditions are the implementability constraints the government face in maximizing the utilities of agents in group A. Thus, the government's policy choice problem is given by,

$$\max \sum_{t,s^t} \beta^t \pi(s^t) \left[u(c^A(s^t), l^A(s^t)) + v(\frac{G(s^t)}{\lambda}) \right]$$

subject to the government budget constraint,

$$T(s^t) + G(s^t) = \tau(s^t)[w(s^t)L(s^t) + r(s^t)K(s^{t-1})], \tag{13}$$

and the implementability constraints,

$$c^A(s^t) + k^A(s^t) = [1 - \tau(s^t)]w(s^t)l^A(s^t) + R(s^t)k^A(s^{t-1}) + \frac{T(s^t)}{\lambda}, \tag{14}$$

$$u_c^A(s^t) \geq \beta \sum_{s^{t+1}|s^t} \pi(s^{t+1}|s^t) u_c^A(s^{t+1}) R(s^{t+1}), \tag{15}$$

with equality whenever $k^A(s^t) > 0$,

$$\frac{u_l^A(s^t)}{u_c^A(s^t)} \geq (1 - \tau(s^t))w(s^t), \tag{16}$$

with equality whenever $l^A(s^t) > 0$,

$$c^B(s^t) + k^B(s^t) = [1 - \tau(s^t)]w(s^t)l^B(s^t) + R(s^t)k^B(s^{t-1}), \tag{17}$$

$$u_c^B(s^t) \geq \beta \sum_{s^{t+1}|s^t} \pi(s^{t+1}|s^t)u_c^B(s^{t+1})R(s^{t+1}), \tag{18}$$

with equality whenever $k^B(s^t) > 0$,

$$\frac{u_l^B(s^t)}{u_c^B(s^t)} \geq (1 - \tau(s^t))w(s^t), \tag{19}$$

with equality whenever $l^B(s^t) > 0$,

$$r(s^t) = F_K(K(s^{t-1}), L(s^t), s_t), \tag{20}$$

and,

$$w(s^t) = F_L(K(s^{t-1}), L(s^t), s_t). \tag{21}$$

The implementability constraints guarantee that whatever policies the government chooses, the implied prices and allocations are consistent with the best response of private agents to that policy choice.

Notice, that this is a Ramsey-type problem with heterogenous agents. Heterogeneity makes it rather difficult to solve numerically in two ways. First, it increases the state space. Notice, that we do not have government bonds in our model. As a result, the Chari, et.al. (1994) approach of solving the Ramsey problem cannot be used here. In the alternative approach, suggested by Marcet and

Marimon (1998), the problem we face is that of a huge state space which makes it unwieldy. The second problem that heterogeneity creates is that now interiority of the solution is no longer guaranteed. In a representative agent problem conditions on utility function and production function makes the optimal consumption, labor supply and investment strictly positive. However, now even with the same set of assumptions on the utility and production functions, all the optimal allocations are not necessarily interior. The boundary condition on the utility function makes the consumption of each type of agent strictly positive, but now either individual labor supply or investment or both of any one type of agent can be zero without violating any assumption. This substantially adds to the complications of numerically solving this problem.

As a result, though we plan to solve this general version in the near future, for now we will simplify our model somewhat by assuming that labor is supplied inelastically and that the government redistributes by only providing public goods and services to group A agents, i.e., there is no direct income transfers to the favored group.

4 The Model Without Leisure or Direct Income Transfers

In this section we solve for the optimal policies and allocations in the model with the assumptions, that $l^A(s^t) = 1$ and $l^B(s^t) = 1$, so that $L(s^t) = 1$ and $T(s^t) = 0$ for all s^t. We assume the following utility function for agents of type A,

$$u(c^A(s^t), G(s^t)) = \frac{c^A(s^t)^{1-\nu}}{1-\nu} + b\frac{\left(\frac{G(s^t)}{\lambda}\right)^{1-\nu}}{1-\nu}$$

where $c^A(s^t)$, $\frac{G(s^t)}{\lambda}$ are the individual consumptions of private and government goods and services correspondingly of an agent in group A, and $b > 0$ is the preference weight on the government goods and services.

The utility function of agent B is similar, except that agents in this group do not have any access to government provided goods and services, so it does not enter their utility function.

$$u(c^B(s^t)) = \frac{c^B(s^t)^{1-\nu}}{1-\nu}$$

The production function is Cobb-Douglas with stochastic productivity term:

$$Y(s^t) = \theta(s_t)K^{\alpha}(s^{t-1})L^{1-\alpha}(s^t)$$

For our computation we assume that there two possible states in each period, high (H) or low (L)and the productivity factor $\theta(s_t)$ is assumed to follow a symmetric markov process over two states: θ^H and θ^L. Given the current state, the probability of remaining in the same state next period given by ρ.

The assumption that $T(s^t)$ is zero in each period also changes the government's budget constraint. The government's budget constraint can now be written as,

$$G(s^t) = \tau(s^t)Y(^t).$$

Now we can describe the problems solved by the agents of both types and the government.

Agents of both types ($i = A, B$) take factor prices and government policies as given and solve their respective problems. Agents of group A solve the following problem:

$$\max_{c^A(s^t),k^A(s^t)} E_0 \left[\sum_{t=0}^{\infty} \beta^t \{ \frac{c^A(s^t)^{1-\nu}}{1-\nu} + b \frac{\left(\frac{G(s^t)}{\lambda} \right)^{1-\nu}}{1-\nu} \} \right] \tag{22}$$

subject to constraints:

$$c^A(s^t) + k^A(s^t \leq (w(s^t) + r(s^t)k^A(s^{t-1}))(1 - \tau(s^t)_t) + (1 - \delta)k^A(s^{t-1}) \tag{23}$$

The problem which the group B agents solve is quite similar, except that their utility function does not include $G(s^t)$. Since, $G(s^t)$ is not a part of the individual's choice problem, the euler conditions that result from the first order conditions of both agents in group A and B are same. They are for $i = A, B$,

$$(c^i(s^t))^{-\nu} \geq \beta E_t \left\{ (c^i(s^{t+1}))^{-\nu} [1 - \delta + r(s^{t+1})(1 - \tau(s^{t+1}))] \right\}, \tag{24}$$

with equality whenever $k^i(s^t) > 0$.

Notice that both group A and group B agents face similar budget constraints. Thus, if each agent started with the same initial capital, i.e., $k^A_{-1} = k^B_{-1}$, then given the additively separable utility function that we are using, both types of agents will always make the same consumption and investment decisions, i.e., $k^A(s^t) = k^B(s^t)$ for all t and s^t. Thus, when we write the government's problem, it essentially reduces to that in a representative agent model.

Thus, in writing the government's problem we can drop the superscripts on all variables. However, it is important to remember that only agents in group A get to consume the government provided goods and services.

$$\max_{\substack{\{c(s^t),k(s^t),\\ \tau(s^t),G(s^t)\}}} E_0 \left[\sum_{t=0}^{\infty} \lambda\beta^t \{ \frac{\left(c(s^t)\right)^{1-\nu}}{1-\nu} + b\frac{\left(\frac{G(s^t)}{\lambda}\right)^{1-\nu}}{1-\nu} \} \mid k_{-1} \right] \tag{25}$$

subject to constraints:

$$(c(s^t))^{-\nu} = \beta E_t \left\{ (c(s^{t+1}))^{-\nu}[1-\delta + r(s^{t+1})(1-\tau(s^{t+1}))] \right\}, \tag{26}$$

$$c(s^t) + k(s^t) = (w(s^t) + r(s^t)k(s^{t-1}))(1-\tau(s^t)) + (1-\delta)k(s^{t-1}), \tag{27}$$

$$G(s^t) = \tau(s^t)(w(s^t) + r(s^t)K(s^{t-1})).$$

Next we describe our computation strategy for this problem.

4.1 Simulation of the model without leisure or direct income transfers

To solve this problem we actually numerically compute the optimal policy functions in a T period model. We solve the T period model backward, recursively starting from T. We continue till the value function converges. Using the optimal policy functions so obtained we simulate the model for sufficiently many periods.

In our computations we use the following set of parameters:

ν	b	β	α	θ^H	θ^L	ρ	δ
0.5	0.4	0.95	0.34	1.05	1	0.95	0.08

One point that we should stress is that we are not calibrating our model - we choose some reasonable value for each parameter and then use those parameter

Table 3: Correlation between Output and Tax Rates

λ	Correlation Coefficient
0.2	-0.5523
1	0.8445

values to simulate our model. We choose parameter values mostly from the real business cycle literature.

We simulate the model for various values of λ to compare across different regimes. We report results for two very different λ values - $\lambda = 0.2$, a highly non-democratic country, and, $\lambda = 1$, a perfectly democratic country. The results we get are quite interesting and in line with what our intuition suggested. Before we go into the details of other results, let us first look at the correlation between optimal tax rates and output in the two regimes, reported in table (3).

What we find is that the tax rate is negatively correlated with the output when $\lambda = 0.2$. This implies that tax rates are high when output is low and vice versa. On the other hand, when $\lambda = 1$, the tax rate and the output are positively correlated. Thus, our model predicts that tax rates will be procyclical in non-democracies and countercyclical in democracies. This outcome is supported by data.

The importance of this result lies in the fact that it helps to solve a puzzle in the literature. In the data, the observation that some countries follow procyclical fiscal policy has perplexed many since this is contrary to the predictions of the standard Ramsey problem with homogenous agents. Such policy choice is also in contrast to what is observed in developed countries. However, the standard Ramsey problem fails to take into account the differences in the government's objective dictated by political regimes across countries, which our model does.

Table 4: Simulation Results

Statistic	Capital	Output	Investment	Cons.	Gov.Cons.	Optimal Tax Rate	Growth rate
			$\lambda = 0.2$				
Mean	2.531	1.407	0.202	0.785	0.420	0.298	0.000
Std.Dev.	0.080	0.046	0.016	0.024	0.012	0.003	1.201
			$\lambda = 1$				
Mean	3.677	1.597	0.294	1.140	0.163	0.102	0.000
Std.Dev.	0.101	0.051	0.019	0.030	0.007	0.001	1.198

The predictions of the model in other fronts are also borne out by facts. We observe in table (4), output will be lower in non-democratic countries than in democratic one. As we have already seen in the data the initial GDP per capita is highly correlated with polity, providing support for this outcome in our model. Thus, the cause of poverty in some countries can be traced to the political structure in those countries.

Along with output, investment and consumption are also lower in non-democratic countries according to the results. Government consumption and tax rates are, however, higher in non-democratic countries in this model.

In terms of predictions about the volatility of growth rates we find that the model rightly predicts that volatility will be higher in the non-democratic countries than democratic countries. However, the difference in volatility generated by the model is much smaller than that observed in the data. This could be due to the absence of labor-leisure choice in this version of the model. The lack of much movement of volatility of growth rate with λ could also be because we do not have direct income transfers, $T(s^t)$. It is possible that if there were direct transfers to agents in group A, which enters as a term in the budget constraint, investment will be more responsive to changes in tax rates. This could potentially make volatility differences between various regimes more significant.

Adding labor-leisure choice and direct income transfers will substantially add to the computing complications. While we plan to do that in the future versions of this paper, for now we will compute the competitive equilibrium with exogenous taxes in the next section to verify if these features generate higher volatility differences.

5 Competitive Equilibrium in a Model with Labor-Leisure Choice and Direct Income Transfers

We now introduce labor-leisure choice in the model. Further, now we assume that the government redistributes using lump sum income transfers only, that is the government does not provide any goods or services to the agents. As before income tax is universal but only agents in group A receive transfers. The government is still assumed to run a balanced budget each period. So, the government's budget constraint is now given by,

$$T(s^t) = \tau(s^t)[w(s^t)L(s^t) + r(s^t)K(s^{t-1}) \tag{28}$$

We assume certain tax $\tau(s^t)$ policy as given and compute the competitive equilibrium with exogenous taxes. All agents take the tax and transfer as given and solve their maximization problem. In the problem of agent A, the utility function now does not include any government provided goods and services. The budget constraint now includes transfers and is given by equation 3. There is no change in the problem of an agent in group B. One important difference from the case considered in the last section though is that now the problem cannot be reduced to a single agent problem at any stage. Consumption and investment decisions will be different for agents in group A and B.

In computing the equilibrium for this model we approximate the policy functions using Chebyshev polynomials and use weighted residual method to solve for the equilibrium. We take functional forms and parameter values from Chari, Christiano and Kehoe (1992) and all the parameter values, except γ are the same as in the last section.

We use the following utility function, $U(c,l) = \frac{1}{\nu}[c^{(1-\gamma)}(1-l)^{\gamma}]^{\nu}$ and production function, $F(K(s^{t-1}), L(s^t), s_t) = \theta(s_t)K(s^{t-1})^{\alpha}L(s^t)^{(1-\alpha)}$ in our computations. As earlier there are two possible states, high (H, $\theta = \theta^H$) and low (L, $\theta = \theta^L$), with ρ being the probability of having the same state θ next period as it is now.

The parameter values are given by,

ν	γ	β	α	θ^H	θ^L	ρ	δ
0.5	0.75	0.95	0.34	1.05	1	0.95	0.08

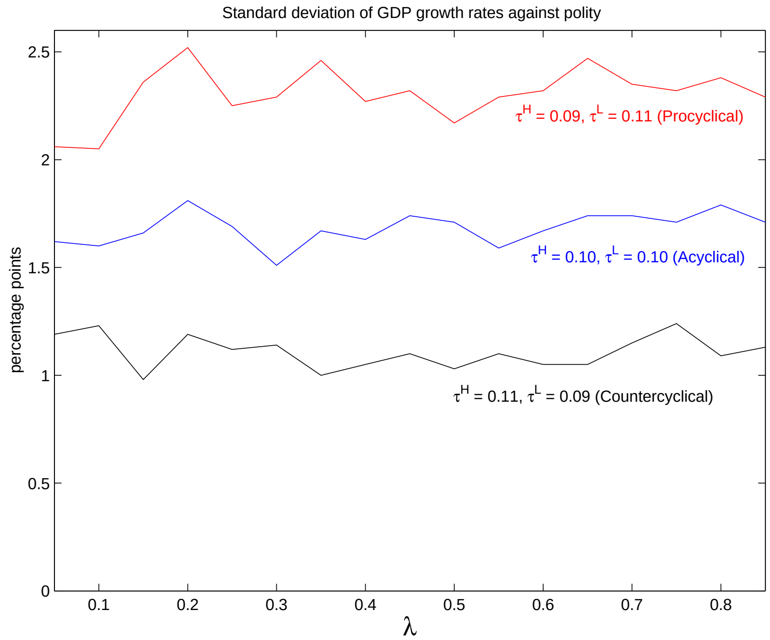
The tax policy is exogenously given in the computation of this equilibrium. The tax policy is current state dependent. We denote by τ_H the income tax rates when current productivity is high (θ^H) and by τ_L the income tax rates when current productivity is low (θ^H).

We are interested to find out if the volatility of growth rates in the economy depends on the tax regime of the country. More specifically we want to find out if the volatility depends on whether the tax rates are pro-cyclic, counter-cyclic or acyclic. To that end we compare volatility for three different tax policies:

- State independent taxes: $\tau_H = \tau_L = 0.1$
- Counter-cyclical taxes $\tau_H = 0.11$ and $\tau_L = 0.09$
- Pro-cyclical taxes $\tau_H = 0.09$ and $\tau_L = 0.11$.

For each tax policy we simulate the economy for each λ value taken from a grid between 0 and 1, and calculate the volatility. In figure (1) we plot the volatilities for different tax regimes against λ. We find that volatility is highest for the pro-cyclical tax policy and the least for the counter-cyclical tax policy.

Figure 1: Volatility for different tax regimes



6 A Model with Endowment Shocks and No Capital

So far, in the versions of the model that we have computed, we have assumed that the uncertainty is through a multiplicative shock in the production function. Will the results be any different if the shock is additive in nature? In this section we use a model in which there is an additive endowment shock each period to explore that possibility.

We consider a simple version of the general model. We assume that there is no capital in the economy and the government does not provide any goods or services, though it transfers income directly to agents in group A. Each consumer chooses how much labor to supply each period. All agents receive labor income, which is taxed at the same rate across all agents. They also get an endowment shock each period, which adds to their post-tax income. For generality, we have assumed the shock to be unform across the population. In addition agents in group A only receive an income transfer from the government.

So, agents in group A solve the following utility maximization problem,

$$\max u(c_A, 1 - l_A)$$

subject to

$$c_A \leq wl_A(1-\tau) + \varepsilon + \frac{T}{\lambda}$$

where ε is an endowment shock to each agent.

Similarly agent in group B solves,

$$\max u(c_B, 1 - l_B)$$

subject to

$$c_B \leq wl_B(1-\tau) + \varepsilon$$

The production function is linear in labor: $y = wl$.

The government is as usual restricted to run a balanced budget and uses labor income taxes to make a transfer to agents A. Its objective is to maximize the utility of agents in group A subject to the government budget constraint and implementability constraints. It solves the following problem,

$$\max_{\tau} u(c_A, 1 - l_A)$$

subject to the budget constraint

$$T = \tau w(\lambda l_A + (1 - \lambda) l_B)$$

and implementability constraints

$$c_A = w l_A (1 - \tau) + \varepsilon + \frac{T}{\lambda}$$

$$c_B = w l_B (1 - \tau) + \varepsilon$$

$$\frac{u_l^A}{u_c^A} \geq w(1 - \tau)$$

with equality whenever $l^A > 0$,

$$\frac{u_l^B}{u_c^B} \geq w(1 - \tau)$$

with equality whenever $l^B > 0$.

We solve this problem and simulate the economy. In the simulation we assumed that for both types of agents the utility function is Cobb-Douglas: $u(c, 1 - l) = c^{1-\gamma}(1 - l)^{\gamma}$, with $\gamma = 0.75$. Given this choice of utility function it is easy to show that with a homogeneous utility function the optimal tax will be the function of $\frac{\varepsilon}{w}$. As a result we normalize $w = 1$. The endowment shock ε_t is assumed to be i.i.d. and is drawn from a normal distribution: $\varepsilon_t \sim N(\mu, \sigma^2)$ where $\mu > 0$. To find out how the volatility of growth rates of GDP (GDP$= wL + \varepsilon$) varies with λ in this model, we follow the steps outlined below:

- For each λ in a grid over $(0, 1]$ we simulate the economy for 40 periods.
- We repeat the simulation for 100 times.
- The volatility of growth rate is calculated for each simulation and the average is plotted against λ in figure (2).

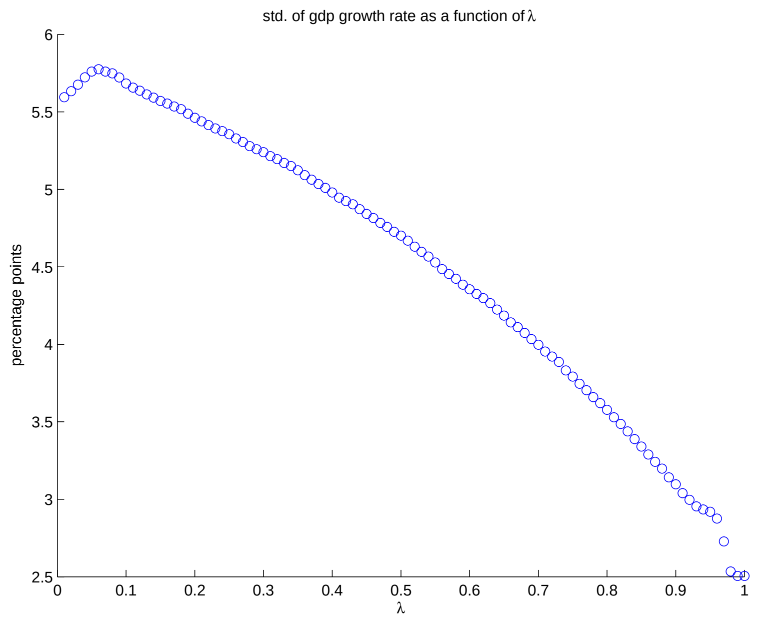


Figure 2: Plot of Volatility against Polity (λ)

In the graph it is evident that the volatility of growth rates decreases as λ increases. Thus, volatility and polity are negatively related in this model, consistent with the data.

The model predicts that tax rates will be highly procyclical in non-democracies. The tax rates in this model are procyclical in economies closer to perfect democracies also, but the procyclicality is weaker when λ is close to 1. Also, the model predicts that tax rates will be higher on an average in non-democracies than in democracies.

Thus, we find that even with additive shocks the model's predictions are more or less the same.

7 Relation to the Literature

In the literature, researchers have showered a lot of attention on studying particular cases of economic collapses or growth "take-offs", but a few in comparison have done a systematic examination of volatility differences across countries. The few who have studied this issue empirically have attributed it to pure chance (Easterly, et. al.(1993)), initial income or poverty (Acemoglu and Zilibotti (1997), Kraay and Ventura (2000)), or, inequality (Rodrik (1998)). Our empirical analysis shows that polity dominates all these suggested causes of volatility differences. Rodrik (1999) links volatility of growth rates to political regimes, but suggests that conflicts in non-democratic regime is the reason between instability of growth rates in such countries. We, however, find in our analysis of the data that there is more to political regimes than just conflicts (or lack of it).

On the theoretical front, Acemoglu and Zilibotti (1997) develops a model in which countries which are initially poor fail to diversify risk as there are certain fixed costs in operating any sector. As a result poor countries have more volatile growth. In Kraay and Ventura (2000) low income countries specialize in a different kind of industry form those in high income countries, which leads to the variation in volatility of growth rates.

There is another strand of literature which stresses the policy stability in democracies. Dixit et. al. (2000) show that repeated interactions between political parties, who are in and out of power with positive probability, will lead to stability in democratic countries. Rodrik (1999) points out different mechanisms through which conflict is avoided in democratic societies (including the one mentioned above). The lack of such mechanisms in non-democratic countries will lead to repression by autocratic rulers and conflict and hence greater volatility. However, none of these papers have a model that encompasses various regimes. In that sense, our paper is unique - it provides a framework in which policy comparisons can be made across countries with varying degree of democracy.

8 Conclusion

In this paper we set out in a quest to find out why are growth rates in some countries more volatile than others. This exploration have yielded interesting results. In analyzing the data we find that volatility of growth rates are related to the political structure of a country - we find that volatility is negatively related to the polity of a country. We show that the relationship is robust to a variety of controls, choice of dataset and period of analysis. We further find that in regressions where we have polity and either initial income, a measure of inequality, or durability of regimes (or all together) as dependent variables with volatility of growth rates as independent variable, only the coefficient on polity is significant. We get similar results using two stages least square regressions.

To understand how polity might affect growth rates, we develop a dynamic general equilibrium in which democracy is parameterized. In the model democracy is measured as the measure of population who gets special benefits from the government. The government taxes the entire population but transfers resources to a selected group only. The transfer can take two forms lump sum income transfer or as provision of goods and services. Government's objective is to maximize the utility of the favored group through this redistribution.

The innovative way of modeling democracy allows us to compare our results from the model with the data as polity takes continuous values between perfect democracy and perfect autocracy. We solve our model for certain cases and find it rightly predicts that volatility increases across countries as we go from more democratic to countries to less democratic countries.

The channel through which the political regime effects growth rates is the fiscal policy. The model suggests that tax policy in a non-democracy will be such that tax rates will be high when output is low and low when output is high, or procyclical. In more democratic countries such an effect would be mild or tax rates could be even countercyclical. The procyclicality of tax rates in low polity countries amplifies the volatility of growth rates in such countries.

The result that about procyclicality of tax rates help to solve a puzzle. In the data it has been observed that some poor countries follow a procyclical fiscal policy in contrast to what prescribed by standard theories on optimal tax and also as opposed to the policy followed by developed countries. Our model sheds light into this problem.

Our model does well in some other dimensions as well. We find output levels, capital stock, investment and private consumption levels are lower in low polity countries compared to more democratic countries, facts borne out by the data.

These results are from various sub-cases of the more general model we plan to solve. Solving the most general model, with both kinds of transfers, labor-leisure choice, capital accumulation and both multiplicative and additive shocks is computationally challenging. There are numerous difficulties and at present we are making progress in overcoming them, but work is not complete. We hope to present the results from that model in the future versions of the paper, which we think will strengthen our results.

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