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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 standard deviation of growth rates in the countries with most volatile growth rates are more than seven times larger than in the countries 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 shows 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.

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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 degree of democracy is parameterized by the fraction of the population who share the benefits of power, and the optimal outcomes 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.

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

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

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 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 nu-

[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.

[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.

merous. 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. In this essay we solve three special cases of the general model:

In the first model we solve for the optimal tax policy in the dynamic model where labor is supplied inelastically and where there are only direct transfers but no government provided goods and services to the favored group. This model is sufficiently rich to address our main point that non-democratic countries may find it optimal to follow fiscal policies that tend to amplify volatility through their distortionary effect on capital investment. We get tax rates to be procyclical in highly non-democratic countries. In contrast the tax rates are essentially acyclical in countries which are closer to perfect democracy. 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 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 in the future. This in turn makes the tax rate higher and further drop in investment. This mechanism amplifies the drop in output and hence increases volatility.

In the second model we consider a dynamic model with labor-leisure choice, where government transfers are limited to publicly provided goods and services, and there are no direct income subsidies allowed. This model gives result which are similar to what we had in the previous case, however the difference in growth volatility between democracies and non-democracies is much smaller. This could be due to absence of direct transfers.

In the last case we consider an economy without capital. In that model we show that, if there are only multiplicative productivity shocks, the optimal fiscal policy calls for constant tax rates. This stresses the importance of capital accumulation in delivering volatility differences between democracies and non-democracies. If we introduce additive shocks instead, 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.

Thus our paper not only illustrates how policy differences across countries is the reason for the observed differences in the volatility of growth rates across countries, but also predicts that optimal fiscal policies will be very different in countries that are democratic from those that are not democratic.

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 we solve the model. In section 5, 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

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. This relationship can be seen clearly on the figure (1).

Table 1: Regression of Volatility against Polity

Volatility =	α	$\beta\times$ Polity
Coefficient	0.079	-0.053
t-statistics	(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[4]. 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[5] and log of initial GDP per capita - the only variable that is significant is polity.

[4]. 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.

[5]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 en-

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 [6]. 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 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

rollment 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.

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

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 Init. 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 model of Polity

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 a general version of the model. In the subsequent sections 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 [7]. 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, $\{c^A(s^t), l^A(s^t), k^A(s^t)\}$,

$$\max_{\{c^A(s^t),l^A(s^t),k^A(s^t)\}} \sum_{t,s^t} \beta^t \pi(s^t) \left[u(c^A(s^t), l^A(s^t)) + v(\frac{G(s^t)}{\lambda}) \right] \tag{3.1}$$

Subject to the budget constraint,

$$\begin{aligned} c^A(s^t) + k^A(s^t) \;\; &\leq \;\; [1-\tau(s^t)]\{w(s^t)l^A(s^t) + r(s^t)k^A(s^{t-1})\} \\ &\quad +(1-\delta)k^A(s^{t-1}) + \frac{T(s^t)}{\lambda} \end{aligned} \tag{3.2}$$

and the nonnegativity constraint on capital holdings $k^A(s^t) \geq 0$.

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

[7] 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.

$$c^A(s^t) + k^A(s^t) \leq [1 - \tau(s^t)]w(s^t)l^A(s^t) + R(s^t)k^A(s^{t-1}) + \frac{T(s^t)}{\lambda} \tag{3.3}$$

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, $\{c^B(s^t), l^B(s^t), k^B(s^t)\}$

$$\max \sum_{t,s^t} \beta^t \pi(s^t) u(c^B(s^t), l^B(s^t)) \tag{3.4}$$

Subject to,

$$c^B(s^t) + k^B(s^t) \leq [1 - \tau(s^t)]w(s^t)l^B(s^t) + R(s^t)k^B(s^{t-1}) \tag{3.5}$$

and the nonnegativity constraint on capital holdings $k^B(s^t) \geq 0$.

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.

$$r(s^t) = F_K(K(s^{t-1}), L(s^t), s_t) \tag{3.6}$$

$$w(s^t) = F_L(K(s^{t-1}), L(s^t), s_t) \tag{3.7}$$

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,

$$T(s^t) + G(s^t) = \tau(s^t)[w(s^t)L(s^t) + r(s^t)K(s^{t-1})] \tag{3.8}$$

Feasibility

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

$$C(s^t) + K(s^t) + G(s^t) = F(K(s^{t-1}), L(s^t), s_t) + (1-\delta)K(s^{t-1}) \tag{3.9}$$

Where,

$$\lambda c^A(s^t) + (1-\lambda)c^B(s^t) = C(s^t) \tag{3.10}$$

$$\lambda l^A(s^t) + (1-\lambda)l^B(s^t) = L(s^t) \tag{3.11}$$

$$\lambda k^A(s^t) + (1-\lambda)k^B(s^t) = K(s^t) \tag{3.12}$$

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, 3.1, subject to the sequence of budget constraints 3.3.
- the allocation maximizes agent B's utility 3.4 subject to the sequence of budget constraints 3.5.
- price system satisfies 3.6 and 3.7 and
- the government's budget constraint 3.8 is satisfied.

Notice, as in representative agent problems, the feasibility constraint 3.9 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 faces in maximizing the utilities of agents in group A. Thus, the government's policy choice must satisfy the government budget constraint

$$T(s^t) + G(s^t) = \tau(s^t)[w(s^t)L(s^t) + r(s^t)K(s^{t-1})], \tag{3.13}$$

plus all the implementability constraints:

$$c^A(s^t) + k^A(s^t) = [1 - \tau(s^t)]w(s^t)l^A(s^t) + R(s^t)k^A(s^{t-1}) + \frac{T(s^t)}{\lambda}, \tag{3.14}$$

$$u_c^A(s^t) \geq \beta \sum_{s^{t+1}|s^t} \pi(s^{t+1}|s^t)u_c^A(s^{t+1})R(s^{t+1}), \tag{3.15}$$

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

$$\frac{-u_l^A(s^t)}{u_c^A(s^t)} \geq (1 - \tau(s^t))w(s^t), \tag{3.16}$$

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

$$c^B(s^t) + k^B(s^t) = [1 - \tau(s^t)]w(s^t)l^B(s^t) + R(s^t)k^B(s^{t-1}), \tag{3.17}$$

$$u_c^B(s^t) \geq \beta \sum_{s^{t+1}|s^t} \pi(s^{t+1}|s^t)u_c^B(s^{t+1})R(s^{t+1}), \tag{3.18}$$

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

$$\frac{-u_l^B(s^t)}{u_c^B(s^t)} \geq (1 - \tau(s^t))w(s^t), \tag{3.19}$$

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

$$r(s^t) = F_K(K(s^{t-1}), L(s^t), s_t), \tag{3.20}$$

and,

$$w(s^t) = F_L(K(s^{t-1}), L(s^t), s_t). \tag{3.21}$$

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. The government budget constraint ensures that the chosen policy is resource feasible and satisfies the balanced budget restriction.

Now we need to specify whether the choice of the fiscal policy is further constrained by the luck of commitment. In the spirit of Klein and Rios-Rull (2003), we assume that there is only one-period commitment technology available in the economy: Each period the government inherits a commitment to a certain feasible fiscal policy rule specifying the current income tax rate and income transfers as functions of the current realization of the productivity shock.[8] The government observes current realization of the productivity shock s_t and applies the inherited fiscal rule. Then the government chooses and announces fiscal policy rules to be honored by the government in the next period. This rules specify the next period income tax rate and transfers as functions of the next period productivity shock, s_{t+1}. In choosing next period policies government takes in account the entire current state of the economy, which is determined by the current realization of the shock s_t, the inherited income tax rate and transfers, and the distribution of capital between households of both types. Given the announced rules and the current state of the economy households of both types make their consumption/investment and

[8]To be feasible the income transfer $T(s)$ can not be negative or exceed the total amount of tax revenue collected. To ensure that the fiscal policy rule may specify income transfers as a share of total tax revenue, the remainder will be allocated to government provided goods $G(s)$.

leisure/labor decisions and then the situation repeats itself next period. Thus we restrict attention to time-consistent fiscal policies with one period commitment.

To be more precise about policy choice problem we will follow Klein and Rios-Rull (2003) in defining a *Political Equilibrium* problem. Let $\pi(s'|s)$ be the conditional probability of state s' if the previous state was s. The minimal aggregate state vector in period t is the current realization of exogenous shock s_t, the capital holdings of both types of agents (K^A_{t-1}, K^B_{t-1}), and the inherited taxes, transfers (τ_t, T_t). Let $q_t = \{s_t, K^A_{t-1}, K^B_{t-1}, \tau_t, T_t\}$ be the aggregate state vector. For individual agents of type i $(i = A, B)$ there is an additional state variable, individual capital, k^i_t. We first characterize the behavior of an economy with an arbitrary law of motion for the fiscal policy variables $(\tau(s'), T(s')) = \psi(q)$. This should be interpreted as giving the fiscal policy for next period if shock s' occurs given that today's state is q.

An individual of type A solves the following problem:

$$v^A(q, k^A; \psi) = \max_{\{c^A, l^A, k^{A'}\}} \left[u(c^A, l^A) + \beta \sum_{s'} \pi(s'|s) v^A(q'(s'), k^{A'}; \psi) \right] \quad (3.22)$$

subject to

$$c^A + k^{A'} = [1-\tau](w(s,K,L)l^A + r(s,K,L)k^A) + (1-\delta)k^A + \frac{T}{\lambda}, \quad (3.23)$$

$$K^{A'} = D_{K^A}(q; \psi), \quad (3.24)$$

$$K^{B'} = D_{K^B}(q; \psi), \quad (3.25)$$

$$L^A = D_{L^A}(q;\psi), \tag{3.26}$$

$$L^B = D_{L^B}(q;\psi), \tag{3.27}$$

$$K = \lambda K^A + (1-\lambda)K^B, \tag{3.28}$$

$$L = \lambda L^A + (1-\lambda)L^B, \tag{3.29}$$

$$(\tau(s'), T(s')) = \psi(q), \tag{3.30}$$

where D_{K^A}, D_{K^B} are the equilibrium laws of motion for capital holdings, and D_{L^A}, D_{L^B} are the equilibrium aggregates of labor supply for each type of agents.

Similarly, an individual of type B solves:

$$v^B(q, k^B; \psi) = \max_{\{c^B, l^B, k^{B'}\}} \left[u(c^B, l^B) + \beta \sum_{s'} \pi(s'|s) v^B(q'(s'), k^{B'}; \psi) \right] \tag{3.31}$$

subject to

$$c^B + k^{B'} = [1-\tau](w(s,K,L)l^B + r(s,K,L)k^B) + (1-\delta)k^B, \tag{3.32}$$

$$K^{A'} = D_{K^A}(q;\psi), \tag{3.33}$$

$$K^{B'} = D_{K^B}(q;\psi), \tag{3.34}$$

$$L^A = D_{L^A}(q;\psi), \tag{3.35}$$

$$L^B = D_{L^B}(q;\psi), \tag{3.36}$$

$$K = \lambda K^A + (1-\lambda)K^B, \tag{3.37}$$

$$L = \lambda L^A + (1-\lambda)L^B, \tag{3.38}$$

$$(\tau(s'), T(s')) = \psi(q), \tag{3.39}$$

Note that the value functions as well as some other functions are indexed by ψ, to recognize the fact that these functions may vary when ψ varies.

Notice, that this is a optimal policy choice 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, Kehoe and Christiano (1995) 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 make 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.

4 The Outcome

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 $G(s^t) = 0$ for all s^t. We assume the following utility function for agents of type $i = A, B$,

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

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

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

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:

$$\max_{c^A(s^t), k^A(s^t)} E_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{c^A(s^t)^{1-\nu}}{1-\nu} \right] \tag{4.1}$$

subject to constraints:

$$c^A(s^t) + k^A(s^t) \leq (w(s^t) + r(s^t)k^A(s^{t-1}))(1 - \tau(s^t)) + (1-\delta)k^A(s^{t-1}) + \frac{T(s^t)}{\lambda} \tag{4.2}$$

$$k^A(s^t) \geq 0 \tag{4.3}$$

The problem which the group B agents solve is quite similar, except that they do not receive transfers $T(s^t)$. Since, $T(s^t)$ 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 $i = A, B$,

$$(c^i(s^t))^{-\nu} \geq \beta E_t \left\{ (c^i(s^{t+1}))^{-\nu} [1 - \delta + r(s^{t+1})(1 - \tau(s^{t+1}))] \right\}, \tag{4.4}$$

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

The government's problem is:

$$\max_{\substack{\{c^A(s^t), c^B(s^t), \\ k^A(s^t), k^B(s^t), \\ \tau(s^t), T(s^t)\}}} E_0 \left[\sum_{t=0}^{\infty} \lambda \beta^t \{ \frac{\left(c^A(s^t)\right)^{1-\nu}}{1-\nu} \} \mid k_{-1} \right] \tag{4.5}$$

subject to constraints:

$$(c^A(s^t))^{-\nu} \geq \beta E_t \left\{ (c^A(s^{t+1}))^{-\nu} [1 - \delta + r(s^{t+1})(1 - \tau(s^{t+1}))] \right\}, \tag{4.6}$$

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

$$c^A(s^t) + k^A(s^t) = (w(s^t) + r(s^t)k^A(s^{t-1}))(1 - \tau(s^t)) + (1-\delta)k^A(s^{t-1}) + \frac{T(s^t)}{\lambda}, \tag{4.7}$$

$$(c^B(s^t))^{-\nu} \geq \beta E_t \left\{ (c^B(s^{t+1}))^{-\nu}[1 - \delta + r(s^{t+1})(1 - \tau(s^{t+1}))] \right\}, \tag{4.8}$$

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

$$c^B(s^t) + k^B(s^t) = (w(s^t) + r(s^t)k^B(s^{t-1}))(1 - \tau(s^t)) + (1-\delta)k^B(s^{t-1}), \tag{4.9}$$

$$T(s^t) = \tau(s^t)(w(s^t) + r(s^t)K(s^{t-1})). \tag{4.10}$$

Next we describe our computation strategy for this problem.

4.1 Simulation of the model

To solve this problem we, actually, numerically compute the optimal policy functions in a finite horizon model. We recursively solve the T period model backward. Starting from period T-1, we find the optimal fiscal policy, to be applied in period T, period T-1 policy functions for both types of agents, and the value function for the government's problem. Next we approximate the policy functions using Chebyshev polynomials and use these approximated functions to find the same objects in period T-2. We continue till the value and policy functions converge. Using the optimal policy functions so obtained we simulate the model for sufficiently many periods, and report values from the invariant distributions to which

Table 3: Correlation between Output and Tax Rates

λ	Correlation Coefficient
0.1	-0.1442
0.9	0.0087

the economy converges. Note that by solving the problem backward we are ensuring that the choice of policies in every period satisfies the time-consistency restriction stated above.

In our computations we use the following set of parameters:

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

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 values to simulate our model.

We simulate the model for various values of λ to compare across different regimes. We report results for two very different λ values - $\lambda = 0.1$, a highly non-democratic country, and, $\lambda = 0.9$, a very 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 $\lambda = 0.1$. This implies that tax rates are high when output is low and vice versa. On the other hand, when $\lambda = 0.9$, the tax rate and the output are essentially uncorrelated. Thus, our model predicts that tax rates will be procyclical in non-democracies and acyclical in democracies.

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	Investm.	Cons.A	Cons.B	Tax rate	Gr. rate
$\lambda = 0.1$							
Mean	0.061	0.396	0.061	2.610	0.082	0.650	0.080
Std.D.	0.005	0.018	0.005	0.323	0.040	0.121	4.139
Min	0.041	0.337	0.041	1.316	0.028	0.134	-14.186
Max	0.065	0.413	0.065	2.805	0.241	0.957	10.624
$\lambda = 0.9$							
Mean	0.155	0.544	0.155	0.397	0.324	0.119	0.000
Std.D.	0.005	0.019	0.005	0.014	0.011	0.003	1.276
Min	0.149	0.524	0.149	0.381	0.311	0.101	-4.762
Max	0.160	0.563	0.160	0.411	0.336	0.121	5.001

In terms of predictions about the volatility of growth rates we find that the model rightly predicts that volatility will be much higher in the non-democratic countries than in democratic countries. Table (4) lists various statistics for the simulated economies for a particular sequence of realized shocks.[9] In the table

[9]The simulated time series were sufficiently long, so that the values reported in the table changed very little for different sample path realizations of the shocks.

optimal tax rates (in the next to last column) are given in ratio units, while the output growth rate statistics (in the last column) are reported in percentage point units. In the case when $\lambda = 0.1$ the standard deviation of growth rates is 3.24 times larger than when $\lambda = 0.9$. This is despite both economies facing the same sequence of shocks. The range of growth rates is also much wider when $\lambda = 0.1$. It should be reiterated that all that we assumed here, is that the government cares about a smaller subset of population. In all other respects this is a standard RBC model with endogenous policy choice. We think it is remarkable that this alteration of the government's objective creates such pronounced implications for growth volatility, that accord so well with the data.

The predictions of the model in other fronts are also borne out by facts. Output investment and aggregate consumption are 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. Average tax rates are, however, higher in non-democratic countries in this model. This may strike as a counterfactual prediction. It is a well known fact that official tax rates tend to be higher in developed (and mostly democratic) countries, especially so for redistributional social security and social insurance taxes. It should be noted, however, that here we are looking at taxes which are used, exclusively, to redistribute income from one group of infinitely lived households to the other. Social security taxes may be thought of as a substitute for within household, altruistic transfers. Another important point is that in our model transfers have nothing to do with social insurance and ”warm glove” altruistic motives. They are effectively, transfers from poor households to the rich.

In this section we also completely abstract from publicly provided goods. In short, here we abstract from all such legitimate taxes and transfers and focus on pure rent seeking activities facilitated by biased fiscal policies. In fact, when $\lambda = 1$ (in a perfect democracy) the model collapses to a standard representative agent RBC model, which is pareto-optimal and where optimal taxes and transfers are always equal to zero.

In this section we did not allow for leisure or government provided goods. We think that this is a sufficiently rich environment to make our main point: non-democracy may optimally pursue fiscal policies which will amplify volatility through their dynamic effect on capital accumulation decisions. It is interesting to see, however, whether introduction of leisure and government procured good will change the results. We do that in the next section, but for computational tractability we dispense with direct income transfers.

5 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.

6 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 independent variables with volatility of growth rates as dependent 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 on procyclicality of tax rates helps to solve a puzzle. In the data it has been observed that some poor countries follow a procyclical fiscal policy. This contrasts to what is prescribed by standard theories on optimal taxation, and to the policies 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.

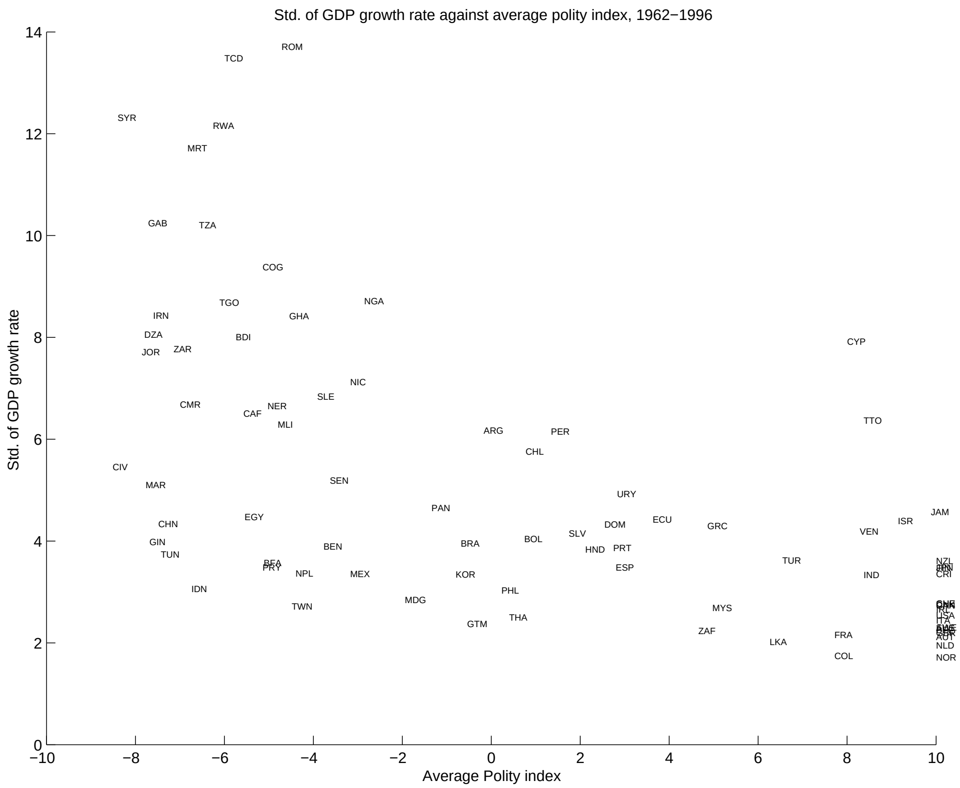

Figure 1: Standard Deviation of per-capita GDP growth rates against Polity index

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