Dictatorship, Democracy, and the Provision of Public Goods

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Abstract:

A model of governance implies that democracies provide public goods at different levels than dictatorships. Systems of governance are characterized by inclusiveness—the degree to which public good decisions reflect the interests of all citizens versus an elite subset. The theory indicates that less inclusive (autocratic) governments will under-provide public consumption goods relative to more inclusive (democratic) governments. Governance indicators are formed from data on attributes of governments, e.g., the method of selecting the chief executive, the power of the legislature, and the openness of political competition. Autocratic governments are found to provide public schooling, roads, safe water, public sanitation, and pollution control at levels far below democracies. Public goods provision is strongly related to per capita income in democracies, but not in autocracies.

JEL classifications: H4, D7, Q2

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1 Introduction

Government policies regarding pollution control and public goods result from political processes that aggregate citizen preferences. Democracies accomplish this by voting in a context where the voting franchise is very broad. In autocracies, policies are set by a single individual or by a small group who control the government. Autocrats presumably select policies that benefit groups whose support is crucial to the autocrat's survival. Clearly, the form of government that rules a country must affect the levels of public goods it provides. While the economics profession certainly is aware of this fact, most of the attention focused on governance and public goods provision concerns democracies and the effect of variations in democratic institutions.[1]

All non-democratic governments provide public goods, but the levels differ sharply from those found in democracies. For example, in countries where the legislature is either nonexistent or only a rubber stamp, secondary school enrollment is only 28 percent of the school age population; for countries with fully effective legislatures the figure is 81 percent.[2] Environmental protection tends to be lax in dictatorships. During the 1970s and 1980s countries with open political systems reduced lead concentrations in gasoline by roughly 60%. Virtually no lead reduction occurred in countries that allow only a single,

[1] See Persson and Tabellini (2000).

'official' political party to operate. Of course, incomes also differ across political regimes so these comparisons are only suggestive.

Understanding how dictatorships provide public goods is important in part because non-democratic governance is not at all rare. Using criteria and data described later, 54% of the post-1970 country-year observations examined are non-democratic,[3] 50% do not have legislatures that exercise significant power independent of the executive, and 46% allow, at most, only a single official party. It is also important because the U.S. and other western nations actively promote democratization in relations with poorer nations. At present we know little about the practical consequences of such reform on public goods provision.

2 Motivation and Related Literature

The main goal of this paper is to test the hypothesis that public goods provision varies systematically with governance. Estimates of the size of the governance effect for different public goods are a byproduct of these tests. Attempts to analyze public good provision by autocracies in empirically tractable ways are rare. Rarer yet are attempts to quantify how much difference democratic versus autocratic government makes to public goods provision. McGuire and Olsen (1996) provide an economic model of public good provision by non-democratic

[2] Sources of data for these comparisons are described later.

[3] This is the percentage of country-year observations exhibiting a political attribute deemed incompatible with democracy—a 'red flag' to use a term defined later.

governments and the approach taken here owes much to the way they frame the question. They provide no empirical analysis, however. Congleton (1992) and Murdoch, Sandler, and Sargent (1997) both include governance issues in studying participation in international environmental agreements, but they do not examine the effect of governance on public goods provision in broad terms.[4] The political science literature on governance and public goods provision is broader. For examples, see Putnam 1993), Lake and Baum (2000), and Bueno de Mesquita *et al* (2001). The research questions and measures of government behavior political scientists examine are often different than those that seem natural to economists, however.

A second goal is to untangle the effect of income on public goods provision from the effect of governance. This is motivated by empirical research indicating that poor countries generally can 'grow their way out of' environmental degradation. Evidence supporting this view comes from reduced form empirical relationships between income and pollution, christened 'environmental Kuznets curves' (EKCs) because several types of pollution seem first to increase as per capita income increases and then to decline.[5] It is claimed that growth in an

[4] The economics literature on corruption, regime transitions and other aspects nondemocratic government behavior is extensive. See Marcouiller and Young (1995) and Acemoglu and Robinson (2001).

[5] Grossman and Krueger (1995) and Shafik and Bandyopadhyay (1992) both specified pollution to be second or third order polynomials in per capita income. The early literature examined ambient concentrations of air and water pollutants, access to clean water and sanitation, deforestation, and solid waste generation in a cross-country panel of monitoring sites. Subsequent studies extended the analysis to emissions rather than ambient concentrations, to different pollutants, and to indicators of natural resource use. See Selden and Song (1994), Selden and Holtz-Eakin (1995), and Cropper and Griffiths (1994). Thompson and Strohm (1996), Stern, *et al* (1996), and Stern

extremely poor country causes pollution to grow because (i) increased production generates pollution emissions and (ii) the country's initial poverty renders pollution control effort a low priority. After a nation attains a degree of affluence, however, its priorities naturally turn toward pollution abatement. If growth proceeds far enough, it is argued, a turning point is reached beyond which increases in GNP cause pollution to decline. International agencies responsible for promoting aid, lending, and trade have found this evidence persuasive, leading them to conclude that economic growth will, if carried far enough, bring environmental benefits.[6]

The research underlying these conclusions has not explicitly modeled the political process underlying pollution control, however, and has not controlled for differences in political systems.[7] Governance and income are strongly correlated.[8]

(1998) survey this literature. Common complaints are the lack of a theoretical structure to guide policy inferences and doubts that the 'inverted U' shape is a valid generalization. Hilton and Levinson (1997) made progress in identifying a policy response for the case of lead emissions. Antweiler, Copeland, and Taylor (2001) developed a rigorous structural framework that includes an endogenous policy response and allows examination of the impact of trade. Attempts to address the effect of governance have been limited.

[6] The World Bank in its 1992 World Development Report, commenting on growth and the environment, concluded that: "There are strong 'win-win' opportunities that remain unexploited. The most important of these relates to poverty reduction: not only is attacking poverty a moral imperative, but it is also essential for environmental stewardship." Commenting on the environmental implications of growth, GATT (1992) noted that: "Concentrations of SO_2 have risen with income at low levels of per capita GDP, fallen with income at higher levels of per capita GDP, and eventually leveled off in the most advanced economies. The estimated turning point comes at about $5,000. The conclusions for smoke pollution are much the same."

[7] Lopez and Mitra (1997) provide a theoretical treatment of governance effects, but no empirical analysis. Barrett and Graddy (1997) introduce measures of freedom in empirical models, but do not provide a theoretical framework. Torras and Boyce (1998) are concerned with the effect political regimes have on pollution, but do not control explicitly for the form of government. While some empirical studies of the income-pollution relationship have included fixed or random effects for countries, this does not capture governance effects because political regimes vary over time within countries. Even if regimes were unchanging within countries, there is no reason to believe that pollution in a dictatorship will differ from pollution in a democracy by a fixed

An empirical model that treats pollution as a function of income but omits governance as a determining factor will produce biased results—the estimated correlation between pollution and income will partially reflect the influence of political factors. A practical consequence of this specification bias is that policy makers might focus on the wrong policy instrument. Countries with high levels of environmental quality tend to be relatively rich, but the same countries also tend to have democratic governments. If their environmental quality mainly reflects their political institutions rather than their incomes, then the key to environmental improvement in the third world is to foster political change rather than relying on economic growth alone. The second goal of this paper is to shed light on this possibility, by untangling the effect of governance from the effect of income growth on public goods provision.

3 A Model of Public Goods, Pollution Control, and Governance

A simple, intuitive argument suggests that autocracies under-provide public consumption goods relative to democracies. Governments of all types set public goods policies by balancing the costs and benefits that are politically relevant, i.e., those that accrue to the group who controls the political process. In an ideal democracy the controlling group is the entire citizenry and the relevant balancing

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amount, regardless of income and other factors. It may not even suffice to insert an explanatory variable representing political freedom, corruption, or regime type, because the effect of political institutions on pollution may be non-additive, as the model of Lopez and Mitra (1997) implies.

equates marginal cost and marginal benefit to the median citizen. If political control is vested in a small, presumably rich elite, as in a monarchy or autocracy, however, then the policies adopted will reflect a balancing of costs and benefits to this elite group. Because control of an autocratic country's resources is concentrated among the elite, the elite group necessarily bears a disproportionately large share of public goods costs.[9] For non-exclusive public goods, however, the elite receives only a pro-rata share of the services produced. Even if the benefits these goods confer are income elastic, the elite arguably enjoy only a tiny fraction of economy-wide benefits. The uneven capture of costs and benefits by the elite causes non-democratic governments to under-provide public goods relative to democracies.[10]

Two clarifying comments are appropriate. First, the elite is the group who participates in policy choice and whose preferences *potentially* count. Each elite member need not get the policy he or she prefers, however, as their preferences presumably differ. In an ideal democracy the preferences of all citizens count because all citizens have the right to vote. Second, the elite's income in an autocratic regime may take several forms, including bribes, corruption, and the return to confiscated assets. These separate income sources are not modeled individually. Rather, I simply assume that income is more densely concentrated

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[8] See Barro (1991), Levine and Renelt (1992), Easterly and Rebelo (1993).

[9] See McGuire and Olson (1996).

[10] Other outcomes are possible, of course. For example, if the marginal benefits that public goods provide progress with individual income in exactly the same fashion as taxes, there will be

among the elite than the non-elite.

3.1 A Model of Governance and Policy Choice

Consider a small, static, open economy that produces a single output, *X*, that generates pollution or 'waste', *W*, as a byproduct. The economy's output can be consumed domestically, sold abroad at price *P*, or transformed at constant cost, and without deadweight loss, into a public good, *Z*. The marginal cost of *Z* is set at unity. The public good can benefit production as a public input and/or enter directly into utility as a public consumption good.[11] For example, a public road benefits both consumers and producers.

The economy is endowed with a fixed primary input, *R*, and the production function for output and pollution is

$$f(X,W,Z,R,T) = 0. \tag{3.2}$$

T represents the production technology and is suppressed in what follows. $f(\cdot)$ is taken to be convex in *X*, *W*, *Z*, and *R*, decreasing in *X*, and increasing in *W*, *Z* and *R*.

The country trades *X* at the fixed world price *P*. The country's environmental policy is a constraint on pollution, $W \leq W^e$. The revenue of a representative firm is

$$p = PX. \tag{3.3}$$

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unanimous agreement on how much public good to provide. In this Lindahl-esque case, rule by the richest, poorest, or median income citizen would produce the same public good outcome.

[11] The exact story of how Z is produced is awkward in a static model because *Z* is simultaneously an input and an output of production. Resolving this by explicitly incorporating timing and dynamics would add complexity without providing new insights, however.

Producers take Z as given and choose X to maximize (3.3) subject to the production constraint (3.2) and the environmental policy. The resulting output is $X(P,W^e,Z,R)$.

The elite make policy decisions regarding public good provision and environmental protection to maximize aggregate elite utility.[12] The utility of an elite individual, i, is

$$u = u(x_i,Z,W) \tag{3.4}$$

where x_i is i's consumption of the private good. $u(\cdot)$ is assumed to be concave, increasing in x_i and Z, and decreasing in W. Pollution and the public good are assumed to be non-congestable, so Z and W enter each person's utility.[13]

Regarding the elite group's budget constraint, I assume that the elite receive share, s, of economy-wide income, where s is determined by the inclusiveness of the country's government. The first ingredient in this budget constraint, economy-wide income, equals the value of output minus the cost of the public good, or $PX(P,W^e,Z,R) - Z$. The second ingredient, the elite's income share s, depends on the inclusiveness of its government.

The inclusiveness of government is measured by E/N, the ratio of the number of elites, E, to the total population, N. 'Pure democracy' corresponds to $E/N=1$,

[12] This characterization of differential political power is stark, assigning zero political power to non-elites. Torras and Boyce (1998) examine a more general formulation wherein political power varies continuously among individuals and policies are chosen to maximize 'power-weighted' net benefits.

[13] Non-congestabililty is assumed for expositional convenience but is not essential. If a public good is congestable the variable entering the individual's utility is Z/N, where N is the number of consumers.

'pure dictatorship' to $E/N=1/N$, and intermediate cases lie between these extremes. The elite's share of total income is thus $s(E/N,q)$, where q represents nonpolitical determinants of the elite's income share. In a democracy, $s=1$ because the elite is the entire population. The elite in a non-democratic government captures a disproportionately large share of income due to its special status, so $s(E/N)>E/N$ when $E/N<1$. I assume s to be strictly increasing, implying that a move toward democracy increases the elite's share of the economy's total income. This is necessarily true as one approaches complete democracy where $s=1$. I also assume s to be concave, meaning that $s(E/N)/(E/N)$ increases as E/N falls. Concavity implies that the elite's share of total income diverges more and more from the elite's population share, E/N, as E/N gets smaller.

The elite's total income is s times economy-wide total income, or $s(PX(P,W^e,Z,R) - Z)$. Let $e(P,W,Z,u^E)$ denote the minimum expenditure an individual elite member requires to achieve utility level u^E, given price P, pollution level W, and public good level Z. For interpretive reasons it is useful to write the elite's budget constraint as

$$s(PX(P,W^e,Z,R) - Z) = Ee(P,W^e,Z,u^E). \qquad (3.5)$$

The elite's policy choice problem can now be cast as choosing u, W^e, and Z to maximize Eu^E subject to (3.5). The Lagrangian is

$$L = Eu^E + l\{s(PX(P,W^e,Z,R) - Z) = Ee(P,W^e,Z,u^E)\}. \qquad (3.6)$$

The first-order conditions are

$$\frac{\partial L}{\partial u} = E - \lambda E \frac{\partial e}{\partial u} = 0 \tag{3.7}$$

$$\frac{\partial L}{\partial W} = \lambda\{\sigma(P\frac{\partial X}{\partial W} - E\frac{\partial e}{\partial W})\} = 0 \tag{3.8}$$

$$\frac{\partial L}{\partial Z} = \lambda\{\sigma(P\frac{\partial X}{\partial Z} - 1] - E\frac{\partial e}{\partial Z})\} = 0 \tag{3.9}$$

and the budget constraint (3.5). Equation (3.7) identifies $1/\lambda$ as the marginal cost of utility. After simplifications, (3.8) and (3.9) become

$$\frac{(E/N)}{\sigma} N\frac{\partial e}{\partial W} = P\frac{\partial X}{\partial W} \tag{3.10}$$

$$P\frac{\partial X}{\partial Z} - \frac{(E/N)}{\sigma} N\frac{\partial e}{\partial Z} = 1. \tag{3.11}$$

In (3.10) $\partial e/\partial W$ is the marginal damage an elite individual incurs from pollution and $P\partial X/\partial W$ is the marginal benefit to producers from being allowed to pollute. Assume for a moment that marginal damage functions are identical for everyone, elite and non-elite alike. Pareto efficiency then requires $N\partial e/\partial W = P\partial X/\partial W$, aggregate marginal damage equals marginal benefit. From (3.10) this occurs only when the government is perfectly inclusive, so $(E/N)/\sigma = 1$. In (3.11) $P\partial X/\partial Z$ is the marginal benefit Z provides to producers as a public input, $-\partial e/\partial Z$ is the marginal benefit Z provides to each elite as a public consumption good, and Z's marginal cost is 1. Again assuming identical marginal benefit functions, Pareto efficiency requires $P\partial X/\partial Z - N\partial e/\partial Z = 1$; the aggregate marginal production and consumption benefit of Z should equal its marginal cost. From

(3.11), this is satisfied only if government is perfectly inclusive or if *Z* is a pure public input and delivers no consumption benefit. In the latter case, Pareto efficiency requires $P\P X/\P Z = 1$. The under-provision effect of autocracy in (3.10) and (3.11) is captured by the term $(E/N)/s$. It is always less than unity when government is non-democratic government. It would be a tiny fraction for a true dictatorship.[14]

Public inputs are provided efficiently by dictatorships (and other forms of government) because the elite captures a fixed share of the economy's total income. Given this, they naturally set the level of a pure public input to maximize the value of economy-wide net output. As a practical matter, public goods that benefit firms and provide no benefit to consumers seem rare, so the prediction of under-provision by autocracies is unlikely to be overturned.

Two other caveats should be noted. First, if marginal public good benefits increase with income, the elite, who are relatively rich, will have relatively intense demands. This force favors greater provision when the elite is a small, rich group and undermines the prediction of under-provision by dictatorships. There is a practical consideration that mitigates this, however. Rather than satisfying their intense public good demands by raising provision economy-wide, the elite might set up a protected enclave with its own water and sanitation and private schools for their children. The elite may even enjoy clean air if enclaves are

[14] If *Z* and *W* are congestable, the isloated "*N*" terms on the left-hand sides of (3.10) and (3.11) vanish.

located away from urban centers.[15] In effect, the cost of a private supplement places a ceiling on the marginal benefit the elite derives from public provision and limits the income effect that might undo the over-provision result.

Second, the struggle that often takes place among political factions seeking to control government, particularly under autocracy, creates uncertainty regarding the future course of government policy and this can affect investment decisions. A dramatic policy change might eliminate the future return the investor receives and the anticipation of such change raises the cost of capital.[16] Empirically, the probability of regime change, and hence the cost of capital, is likely to be high in less inclusive regimes. This link to political risk is not controlled for separately in estimation, so the estimated effect of governance on public goods provision may reflect both variations in governance and political risk.

4 Data

4.1 Defining Political Regimes

The problem of representing variations in governance, interpreted as inclusiveness, is approached from three different perspectives to see if a single empirical strategy dominates. Data on the political attributes of countries were

[15] Torras and Boyce (1998, p. 150) agree. Zaire provides a case in point. During much of his reign, Mobutu avoided the capital city of Kinshasa, choosing instead to live at his palace in the northern ancestral village of Gbadolite and at his several luxurious residences in South Africa and Europe.

[16] See Bohn and Deacon (2000).

taken from the *Cross-National Time Series Data Archive* (Arthur S. Banks, 1997) and the *Polity IV* data base (Monty Marshall and Keith Jaggers, 2000.) Both databases provide annual observations on countries from the early 19th century forward. Information in *Polity* is oriented mainly toward subjective judgements, e.g., on the degree to which institutions of government are responsible to the populace.[17] Banks focuses more on objective information, including: legislative powers, the existence or nonexistence of a legislature, the presence or absence of political coalitions, the degree to which parties are excluded from political participation, whether the government is controlled by civilians or the military, the method of selecting the chief executive, and the method of selecting the legislature. A given political attribute generally can be assigned to several different categories.[18]

The first method for representing governance relies on Democracy and Autocracy Scores assigned by *Polity.* These scores are computed from information on the degree of political competition, the openness and competitiveness of executive recruitment, and the extent of legislative and judicial

[17] *Polity IV* also reports data on other political characteristics. These include procedures for transferring executive power, the degree of competition in the electoral process, the openness of executive recruitment, the institutional independence of the chief executive, the openness of political expression, the general openness of competition for government office, and the degree of centralization of state authority.

[18] For example, a country's legislative effectiveness can be designated as nonexistent, ineffective, partially effective, or effective, and there are criteria for each designation. A legislature is *effective* if it has significant autonomy, including the power to tax, spend, and override executive vetoes. A legislature is *partially effective* if it lacks one or more of the powers needed to be an effective legislature. A *non-effective* legislature is one that cannot implement legislation due to domestic turmoil, cannot meet because the executive prevents it, or is essentially a 'rubber stamp.' A *nonexistent* legislature is self-explanatory.

constraints on the chief executive.[19] Each attribute arguably reflects the inclusiveness in a country's system of governance. Following common practice, a net democracy score, called the *Polity Index*, was formed by subtracting Autocracy from Democracy and scaling the result to the unit interval.[20] A higher *Polity Index* indicates greater inclusiveness, with 1.0 being a perfect score. The mean *Polity Index* for all countries over 1970-1999 is 0.44.

Identifying signals of inclusiveness and non-inclusiveness, from data in Banks, is the basis for the second method of defining governance systems. Proceeding intuitively, the following political attributes are taken as *indicators of non-inclusive government*: (i) an ineffective or nonexistent legislature, (ii) a noncompetitive nominating process for the legislature, (iii) no opposition to the party in power, (iv) significant exclusion of some political groups or parties, (v) a government controlled by the military, (vi) a non-elected chief executive, e.g., military ruler or monarch, (vii) a non-elected legislature, (viii) parliamentary government in which the premier is not responsible to the legislature, and (ix) the completion of a successful coup d'etat in the preceding year. Each of these attributes is called a 'red flag,' a signal of non-inclusiveness.

In similar fashion, certain political attributes were taken to be *indicators of inclusiveness in government*. These are: (i) an effective, elected legislature (possessing substantial power to tax, spend, and override executive vetoes) in a

[19] Gleditsch and Ward (1997) review the empirical properties of these indexes.

[20] The correlation between Democracy and Autocracy scores for the period 1970-1999 is -.80.

system in which no major groups in society are prevented from political participation, (ii) direct popular election of the chief executive, also in a system in which no major groups in society are prevented from political participation, and (iii) elected parliamentary government in which the premier is fully responsible to the legislature. Each of these attributes is called a 'green flag,' a signal of inclusive or democratic government.

These red and green flags were then used to define governance systems. Any country that has at least one green flag and no red flags in a given year is labeled a Democracy. Any country that has no green flags and at least one red flag in a given year is labeled an Autocracy. Observations not falling into either group, i.e., those that have both red and green flags, are labeled Mixed.[21] Over the period 1970-1995, the percentage breakdown of observations is: Democracy 36%, Autocracy 54%, and Mixed 10%.

The third method also uses data from Banks, combining attributes to represent common descriptions of political regimes, such as parliamentary democracy, monarchy, and so forth. These 'Descriptive Regimes' are based on: (i) whether or not the chief executive was elected, (ii) the type of chief executive, e.g., premier, president, monarch, military officer, etc., and (iii) the existence and/or effectiveness of the legislature. A country with an effective or partially effective legislature and an elected chief executive is defined to be a Parliamentary

[21] Finer political divisions were also examined by splitting the Democracy and Autocracy groups into subgroups, based on finer criteria. Empirically, it was found that these finer distinctions had no statistically significant effect so the simpler categorization was retained.

Democracy or Presidential Democracy, depending on whether its chief executive is a premier or a president. A government with an elected chief executive, either president or premier, but an ineffective legislature or no legislature is called a Strong Executive regime. A regime in which the chief executive is not elected is called a Military Dictatorship if the chief executive is a member of the military and a Monarchy if the chief executive is a monarch. When a country's chief executive is non-elected but neither a monarch nor a member of the military, the regime is labeled Other. The Other group includes protectorates, communist countries effectively ruled by a party secretary, and countries in anarchy. Parliamentary and Presidential Democracy are expected to be the most inclusive systems of governance, followed by the Strong Executive. Military Dictatorships and Monarchies, with non-elected executives and no effective legislature, are expected to serve the interests of elite minorities and be the least inclusive regimes. Inclusiveness in the Other category is unclear a priori. For the period 1970-1995 the frequency of these Descriptive Regimes is: Parliamentary Democracy 24%, Presidential Democracy 15%, Strong Executive 22%, Military Dictatorship 5%, Monarchy 6%, and Other 28%.

All three methods of representing governance are examined empirically.[22]

[22] Communist governments were assigned to the regimes defined in the text, depending on the details of their systems of governance. Most are characterized by executives who were not elected or elected only indirectly, by chief executives who are either military officers or political party heads (rather than presidents, premiers, or monarchs), and by ineffective legislatures. In the *Red Flags/Green Flags* scheme, all are categorized as *Dictatorships*. In the Descriptive Regime definitions they are classified as *Strong Executive* regimes if the chief executive is elected and carries the title of president or premier or *Other* if the effective chief executive is the head of the communist party.

4.2 Data on Public Goods and Environmental Protection

Two of the public goods examined are environmental in nature, the percent of the population having access to *sanitation* facilities and *safe drinking water*. These data are reported by the World Health Organization and provide one observation per country for 90 countries for the mid-1990s.[23] Two non-environmental public goods are examined, *roads* and *public education*. Data on paved and unpaved road mileage, from the International Road Federation, are not sufficient to form a panel. Instead, I used the available observations to form a cross section giving each country's mean road density (kilometers of road per square kilometer of land) during the 1970s. The public education measure, from UNESCO, is secondary school enrollment divided by the population of secondary school age. The available observations form a panel of approximately 130 countries over 1980-1996.[24]

The lead content of gasoline, measured in grams per gallon, is examined as an indicator of environmental policy. Lead is a cheap source of octane in gasoline. When burned it collects near roads. If ingested, lead leads to well-known health problems. Imposing a limit on lead in gasoline is the most common way to control it. Lead concentrations are reported by Octel Corporation, and are available for 48

[23] An urban family has 'access to safe water' if there is piped water or a public standpipe carrying safe water within 200 meters. Access is defined less precisely in rural areas. Adequate sanitation is defined as a human waste disposal system that prevents contact by humans, animals, and insects. Actual sanitation systems vary widely, even for those whose sanitation is characterized as adequate.

countries for even years between 1972 and 1992.[25]

5 Empirical Specification and Estimation Strategy

5.1 Specification

A simple linear specification that forms the starting point for estimation is:

$$Z_{it} = a_0 + a_1 I_{it} + a_2 Y_{it} + a_3 X_{it} + e_{it}, \qquad (5.1)$$

where i and t are country and time subscripts, Z_{it} is the public good level, I_{it} is the degree of inclusiveness in a country's political system, Y_{it} is per capita GDP, X_{it} is a set of additional exogenous variables, and e_{it} is an error term representing unmodeled shocks to public good provision. To allow for the possibility of unmeasured heterogeneity at the country level, country fixed effects are included in all models estimated with panel data. For models estimated with cross section data, I test for fixed effects at the level of continents and include them if warranted.

The model in (5.1) separates the effect of governance from the effect of income on public goods provision, which was a goal for estimation. It is based on the first-order conditions for W and Z, equations (3.10) and (3.11), respectively. For example, (3.11) in the case where Z is a public consumption good rather than a public input is

[24] Secondary school enrollment is examined because primary education is nearly ubiquitous.

[25] Thanks are due to Arik Levinson for making the Octel data available.

$-N?e(P,W^e,Z,u^E)/?Z = s/(E/N)$. To simplify, I ignore any complementarity between the public good and pollution, which removes W^e from this condition. I thus treat Z as a function of $s/(E/N)$, u^E, and P. The term $s/(E/N)$ is the governance effect. It corresponds to I_{it} in (5.1) and is captured by the political variables described in section 4.

The terms u^E and P in the first-order condition represent the income effect. This is captured by Y_{it}, real per capita GDP, in (5.1). [26] Real per capita GDP is a natural measure of u^E in a democracy because the elite is the entire population. Per capita GDP is not expected to be a good measure of u^E in a dictatorship, however, because the elite's income is much higher than the population average. Rather than attempt to measure elite income in dictatorships and then estimate the income response directly, I simply include per capita GDP in all models and allow for different income responses in different regimes. Given the model, I expect that per capita GDP will not be a strong determinant of public goods provision in autocracies. This approach has two advantages. First, because per capita GDP is a common measure of economic growth, it is of interest to know how public goods provision responds to it in autocracies. Second, testing for different responses to per capita GDP in different regimes amounts to an indirect test of one of the of the model's prediction.

Recent literature on public goods provision suggests considering additional control variables. According to Alesina, *et al* (1999) ethnic fragmentation causes

[26] The income variable is GDP per capita in constant 1985 dollars from Summers and Heston.

disagreement over the specific features of public goods that a government should provide, and this in turn leads to lower levels of provision. A natural measure of ethnic fragmentation at the country level is ethnolinguistic fractionalization, a variable used by Mauro (1995) and others in studies of growth. This variable, literally the probability that two individuals randomly selected from a given country do not belong to the same ethnolinguistic group, was measured for each country at a point in time in the early 1960s. An alternative measure of potential disagreement is the degree of skewness in the income distribution. This suggests adding each country's Gini coefficient as an additional regressor. Both variables are measured at a point in time for each country, so each can be considered as additional determinant of public goods provision in models estimated with cross section data. For panel data models, their influence will be absorbed by country fixed effects.

It is unlikely that public good levels respond instantly to changes in political or economic conditions. Time may be required to recognize and respond to a new set of circumstances and bureaucratic inertia may cause the response to be sluggish. Costs associated with adjusting capital such as roads, schools, and sanitation facilities, may also cause a gradual response. For these reasons lagged rather than contemporaneous values of income and governance are used in estimation. This also mitigates the potential for simultaneity.

5.2 Measurement error

A potential concern in estimating (5.1) is that I_{it}, the variable representing inclusiveness in a country's government, might be measured with error. Inclusiveness—the fraction of the population whose preferences count in political decisions— is not something political scientists attempt to measure directly. The variables used to represent it empirically are arguably correlated with inclusiveness, but the correlation may be imperfect.

If I_{it} is measured with error the OLS estimate of α_1 will be biased toward zero, making it more difficult to reject the null hypothesis that political regime has no effect. In this sense the OLS estimate of α_1 is conservative. The natural approach is to find an instrument for I_{it}, a variable that is correlated with inclusiveness but uncorrelated both with I_{it}'s measurement error and with the error term ε_{it} in (5.1). Lagged values of political indicators are attractive as potential instruments. Putnam's (1993) research and the empirical work of Acemoglu *et al* (2001, Section 4.1 and Table 3) demonstrates that political conditions persist, so it is plausible that lagged political variables are correlated with current inclusiveness.[27] Lagging the political variable lowers the chance of correlation between the instrument and the current error in the public good equation.[28]

[27] Acemoglu *et al* (2001) showed that three historic measures of democracy are strongly associated with governance conditions in 1985-1995.

[28] In a causal sense, a current shock to Z cannot affect political conditions in the past. It is also difficult to see why the historic value of a political indicator would be correlated with current

The requirement that the instrument, a lagged political variable, be uncorrelated with the error in measuring current inclusiveness would be violated by a measurement error that is both country-specific and persistent. Two steps were taken to minimize this possibility. First, as already noted, country fixed effects are included in all models that are estimated with panel data. This will neutralize any constant, country-specific measurement error. Second, the political variables used to represent I_{it} in the public goods model are taken from a different data set than the lagged political variables used as instruments. This is possible because two sources of detailed political information are available, the Polity and Banks datasets, allowing lagged values from one to be used as instruments for current values from the other. The two datasets are compiled separately by different organizations and, while both sources seek to describe systems of governance, their approaches are distinct.[29] This arguably reduces the possibility that measurement errors in one are correlated with values of the other.

5.3 Endogeneity

Two of the independent variables in (5.1), I_{it} and Y_{it}, are determined by economic and political processes, so it is appropriate to consider what implications this might have for estimation. Research on economic growth suggests that a

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public goods provision, except via effects on current income or political conditions which are already controlled in the model.

[29] Variables in the Polity IV data set are mainly based on judgments about governance, e.g., ordinal measures of the degree of centralization of state authority. Variables in the Banks data set

country's current aggregate income is determined by institutions and by the level of income at a historic reference date as implied by the convergence hypothesis. A parsimonious model that captures these effects is:

$$Y_{it} = b_0 + b_1 I_{it} + b_2 Y_{it-j} + d_{it}. \quad (5.2)$$

Putnam (1993), Acemoglu et al (2001) and others provide strong evidence that a country's current political system is determined by deep, historical factors. Accordingly, it is reasonable to specify that the determinants of I_{it} are factors and events that occurred far in the past, i.e.,

$$I_{it} = g_0 + g_1 V_{it-k} + w_{it}, \quad (5.3)$$

where k is likely large and V may include historical events, geography, religion, etc.

The system (5.1)-(5.3) is fully recursive. Assuming no measurement error or misspecification it can be estimated by single equation methods (Greene, 1997, p. 732). Thus the possibility that income and governance are determined by other factors does not necessarily present a problem.

If Z_{it} belongs in the income equation, however, the system is simultaneous and endogeniety is potentially a problem. It is entirely plausible that certain public goods, e.g., roads or education, determine income. It is implausible, however, that the effect is immediate. School enrollment adds to human capital formation, which eventually increases output, but the effect happens with a delay. Similarly,

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are focused more on objective attributes of government, e.g., whether or not a legislature can override executive vetoes.

the existence of a road network enhances production opportunities, but it is implausible that a jump in the extent of roads in year *t* will cause output to jump in the same year. Rather, the effect of such infrastructure on output is likely to be lagged and cumulative. Collapsing these effects into a single lagged value of a public good implies an income model of the following form

$$Y_{it} = r_0 + r_1 I_{it} + r_2 Y_{it-j} + r_3 Z_{it-m} + x_{it}. \quad (5.2a)$$

Solving (5.1) and (5.2a) yields the reduced form:

$$Y_{it} = f_0 + f_1 I_{it} + f_2 I_{it-m} + f_3 Y_{it-j} + f_4 Y_{it-m} + f_5 X_{it-m} + (r_3 e_{it-m} + x_{it}). \quad (5.4)$$

Equation (5.4) implies that Y_{it} is determined in part by e_{it-m}, the unobserved shock to Z_{it-m}, rather than e_{it}. This presents no problem for estimation unless cov(e_{it},e_{it-m})≠0. In other words, endogeneity of Y_{it} is a problem for estimating the public goods equation only if unobserved shocks to Z_{it-m} are correlated with unobserved shocks to Z_{it}. The most plausible source of such persistent, county-specific shocks is an unobserved country-specific factor. For all models estimated with panel data, this potential problem is eliminated or mitigated by including country fixed effects. For models estimated with cross section data, no obvious remedy is available. It is worth noting, however, that the likely result of correlation between Y_{it} and e_{it} in (5.1) is to bias the coefficient on Y_{it} toward zero.

6 Empirical Results

Alternative specifications and estimation methods were considered for each of the

public goods examined. The discussion of results focuses on OLS and fixed effects estimates for expositional clarity. At various points I comment on the results obtained when variants to the models reported in tables were estimated. Complete results are available on request.

6.1 Summary statistics

Table 1 reports mean income and public good levels by political regime using the three alternative political classifications. In cases where the relative inclusiveness of different regimes seems clear on a priori grounds, these comparisons show that incomes are consistently lower in less inclusive regimes.[30] A plausible reason is that weak property rights in less inclusive regimes depress investment. A related explanation is that such regimes often suffer from corruption that can drain away both the economic surplus and the incentives that would otherwise be present in a private economy. The observation that regimes and income are highly correlated confirms an earlier claim: failing to control for differences in political systems will lead to bias in the estimated relationship between a country's income and its level of environmental quality.

Comparisons of public good and public bad levels in Table 1 are generally consistent with the basic hypotheses: public good levels are higher, and public bad levels lower, in more inclusive regimes than in less inclusive regimes. Of

[30] To keep oil revenues from confounding governance-income comparisons, countries classified as 'oil dominated' (OPEC nations as of 1980 plus Bahrain and Oman) are excluded from Table 1. These countries are not excluded from data sets used in estimation, however.

course, the fact that income and politics are correlated means that this ordering of public goods and politics might just reflect differences in incomes.

6.2 Access to Safe Water and Sanitation

Per capita income, political regime, and regime-income interactions are included as determinants of these public goods. I also consider including two additional independent variables. One is the fraction of the population residing in urban areas, which would be relevant if scale economies cause the cost of providing safe water and sanitation to be lower in urban than in rural areas. The second is is entholinguistic fractionalization, which was explained earlier. Lagged values of income, urbanization, and political regime are used.[31]

Table 2 gives OLS regression results for models that exclude income-governance interactions and compares the performance of the three methods for representing governance. The income effects are positive and highly significant. Percent Urban enters positively but is significant in only one of the six regressions.[32] Excluding urbanization had little effect on the political coefficients.

The Polity Index is a continuous variable, ranging from 1 to 0. The three regimes in the Red Flags/Green Flags categorization are captured by two dummy variables, with the excluded regime being Autocracy. The Descriptive Regime

[31] The dependent variables are measured in the mid 1990s and 1989 values of right-hand side variables were used in estimation. Using independent variable values from 1987-1991 made little difference.

[32] The same reasoning suggests controlling for population density, but this variable was never significant.

designations are captured by five dummy variables, with Military Dictatorship excluded. All six equations indicate greater public goods provision in more inclusive regimes. The political coefficients are generally smaller for safe water than for sanitation, indicating that governance has a weaker effect on safe water. This may reflect the availability of private sector sources for safe water, and hence a lesser role for politics in determining overall provision levels.

The magnitudes of governance effects are discussed in some detail after estimates have been presented for all public goods. I make only brief comments on the size of governance coefficients as they are first presented for each public good. Regarding the Polity Index coefficients in Table 2, a change from Polity=0 (least democratic) to Polity=1 (most democratic) is associated with a 15 percentage point increase in access to safe water and a 24 percentage point increase in access to sanitation. For comparison, the unconditional means of safe water and sanitation in the sample are 66% and 59%, respectively. The coefficients for other methods of representing governance have similar interpretations.

In the models that use the Polity index to represent governance, I tried including ethnolinguistic fractionalization to represent heterogeneity in preferences for public goods. This variable was not significant for either safe water or sanitation. Including it reduced the coefficient for Polity by about one-third for both public goods.[33] This is due to the relatively high correlation between

[33] The significance levels for Polity became 12% for safe water and 5% for sanitation.

ethnolinguistic fractionalization and Polity (corr. = .54) and to the fact that including it reduced the sample size.[34] For models that use Polity to measure inclusiveness, I also followed the instrumental variables (IV) approach described in Section 5 to correct for possible measurement error in inclusiveness. Ten-year lags of the Banks descriptive regimes were used as instruments for Polity. Estimating by IV increased the size of the Polity coefficients for both public goods, to 22.71 (t=2.52) for safe water and to 43.46 (t=4.04) for sanitation. The Hausman test failed to reject the null of no measurement error for safe water, but rejected it at 6 percent for sanitation.

The hypothesis that responses to per capita income differ by regime was first tested by including income-politics interactions in the OLS regressions. They were not significant, however, due to high correlations between the interaction terms and political regime variables.[35] An alternative approach was tried: grouping countries into more inclusive and less inclusive subsets, estimating the models separately for each group, and then comparing income coefficients in the separate regressions. The countries were grouped according to whether the Polity Index is less than or greater than one-half. OLS estimates (with t-statistics in parentheses) are as follows:

[34] I also tried including Gini coefficients to control for differences in the skewness of income. These terms did not enter significantly, however, and including them reduced the sample size by about one-half.

[35] The simple correlation between the Polity Index and the interaction is .73; simple correlations with the regime dummies were generally above .75.

Less inclusive: Safe water = 41.2863 + .0019 Income + .4171 Urban Percent

(6.95) (1.56) (2.13)

N = 53 Adj. R^2 = .31

More inclusive: Safe water = 64.8920 + .0039 Income - .0372 Urban Percent

(10.21) (3.24) (0.25)

N = 31 Adj. R^2 = .30

Income elasticities evaluated at mean values for the sub-samples are .076 for the less inclusive group and .341 for the more inclusive group. Results for sanitation are:

Less inclusive: Sanitation = 19.6351 + .0009 Income + .8131 Urban Percent

(2.74) (0.77) (3.43)

N = 51 Adj. R^2 = .41

More inclusive: Sanitation = 63.8226 + .0054 Income - .1446 Urban Percent

(7.43) (2.85) (0.75)

N = 31 Adj. R^2 = .20

Income elasticities for sanitation are .046 for the less inclusive group and .502 for more inclusive group.

Results in Table 2 show that governance clearly matters for safe water and sanitation, with provision significantly higher in more inclusive than less inclusive regimes. The regressions in the text show that part of this effect operates through a differential response to income. Provision of safe water and sanitation

in autocracies is far less responsive to per capita income than in democracies.[36]

6.3 Road Networks

Road density was specified to be a log-log function of per capita income and population density. The log-log specification was used because it seemed likely that the relationship between population density and road density is multiplicative rather than additive. Governance was entered linearly in the case of the Polity Index and as dummy variables for the other methods of defining regimes. The dependent variable is the average density of road networks during 1971-1980 and I used 1970 values of income, population density, and political regime to allow for lagged responses.

Table 3 reports OLS and fixed effects estimates, where the latter allow for heterogeneity at the level of continents. The continent level fixed effects are significant at 1% or better in all three specifications and these estimates are emphasized in the following discussion. Population density and per capita income coefficients, interpreted as elasticities, are highly significant in all models and are very similar for all three methods of representing governance.

The Polity Index coefficients are highly significant. The Polity coefficient from the fixed effects model indicates that, controlling for income and population

[36] Access to safe water and sanitation both are truncated at 0% and 100%, so censoring is a potential problem. Tobit results are nearly identical to the OLS results, however, because only two observations are at the upper limit for each dependent variable. Thus censoring is of little practical importance. The possibility of unobserved heterogeneity at the level of continents was also checked by including continent fixed effects. This had only modest effects on the political

density, road networks are roughly 134% more extensive in democracies (Polity=1) than autocracies (Polity=0). This strong effect is consistent with the differences in the summary statistics in Table 1. The Red/Green Flags estimates tell much the same story—road networks are roughly twice as dense under Democracy as under Autocracy. Provision of roads is not significantly different under Autocracy vs. the Mixed regime, however. The results obtained from the Descriptive Regime indicators of governance are similar, though not quite as sharp. Only one of the Descriptive Regimes, Parliamentary Democracy, is significantly different than the excluded regime, Monarchy, but they are jointly significant at 1% in OLS and at 7% in fixed effects models.

I considered including ethnolinguistic fractionalization in the models that use Polity to represent governance. It was insignificant in both OLS and fixed effects specifications and including it had only minor effects on the Polity coefficient.[37] In the 'Polity' models I again used instrumental variables to correct for the possibility that Polity is not a perfectly accurate measure of governance.[38] Estimating by IV increased the size of the Polity coefficients, to 1.44 (t=2.64) in the version without fixed effects and to 1.13 (t=2.48) in the model with fixed effects for continents. In both cases, however, the Hausman test failed to reject the null of no measurement error.

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coefficients and the fixed effects were marginally significant at best. In the end, the OLS results were reported for simplicity.

[37] Again, I tried including the Gini coefficient to control for likely differences in the skewness of income, but found it was not significant and including it reduced the sample size by nearly one-half.

To examine the possibility of different income responses under dictatorship and democracy I again started by including politics-income interactions. As before this yielded insignificant results due to the limited data set and strong correlations between the interaction terms and political variables.[39] The alternative approach, estimating separate models for sub-samples in which the Polity Index is less than or greater than 0.5, produced the following OLS estimates:

Less inclusive: Roads = -4.6300 + .3089 Income + .6617 Popul'n Density

(3.62) (1.85) (5.81)

N = 48 Adj. R^2 = .42

More inclusive: Roads = -8.1707 + .8174 Income + .6643 Popul'n Density

(7.85) (6.99) (9.75)

N = 40 Adj. R^2 = .76

All variables are in logs so the coefficients are elasticities. The hypothesis that public good provision is less responsive to per capita income in more inclusive than less inclusive regimes is again strongly supported. The respective income elasticities are .31 and .82. The constant term is actually smaller in the less inclusive regime, but this is an artifact of the functional form. For income levels greater than $1,054, which is roughly one-third of mean income in the sample, the predicted density of roads is greater under the more inclusive regime.

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[38] Ten-year lags of the Banks descriptive regimes were again used as instruments for Polity.

6.4 School Enrollment

The independent variables for this service are per capita income, governance, and income-governance interactions. Country fixed effects are included, which rules out the consideration of ethnolinguistic fractionalization and income inequality as additional determinants.[40] The independent variables—income and governance—are lagged two years.[41] It is possible to estimate regime-specific income responses because the data set is relatively extensive. To highlight the difference this makes, two sets of results are reported for each method of representing governance, one with a common income coefficient for all regimes and another that interacts income and regime.

Results are presented in Table 4. The dependent variable is a percentage, with a range from 0 to 100. Columns (1) and (2) use Polity to characterize governance. Both income and Polity are significant and positive when entered separately (see column 1). A reasonable inference from these results is that income is the strongest determinant of school enrollment and that governance, while statistically significant, will matter by at most a modest 6.8 percentage points. Column (2) includes an income-Polity interaction. The income coefficient now gives the

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[39] The simple correlation between income interacted with the Polity Index and the Polity Index itself is above .99. Correlations between interactions and political dummies in the Red/Green Flag and Descriptive Regime categorizations are also above .99.

[40] The F-tests for fixed effects indicate significant country-level heterogeneity in all models estimated.

[41] Using contemporaneous values of independent variables, two-year lags, or even 5-year lags, made very little difference to the estimates.

income response for an autocracy (Polity=0); the sum of this coefficient and the interaction coefficient gives the income response for a democracy (Polity=1). The point estimate of the income response for autocracy is actually negative but not significant, so the provision of public education under autocracy is not responsive to per capita income. By contrast the per capita income response under democracy is highly significant. To allow easier interpretation, income elasticities evaluated at sample means are reported in Table 5. The income elasticity of secondary school enrollment for autocracies (Polity$\leq$0.1) is -.03; the income elasticity for democracies (Polity>0.9) is .41.[42]

Columns (3) and (4) give results for the Red Flags/Green Flags system of regimes and the story is largely the same. In the model without interactions, income is a strong determinant of enrollment. Enrollment is significantly higher under Democracy than Autocracy, but the effect is only 5.3 percentage points. When the income response is allowed to differ by regime, the income responses under Autocracy and the Mixed regime vanish, while the income response for Democracy becomes stronger.[43] Table 5 reports income elasticities of enrollment.

[42] The coefficient for the Polity Index alone is negative (-6.3446) in the model with interactions. This is an artifact of the linear functional form and the strong positive association between enrollment and Polity in rich, democratic countries. The interaction coefficient is sufficiently large that predicted school enrollment is an increasing function of Polity so long as per capita income exceeds $1,441. Countries with incomes below this level tend to be nondemocratic, with Polity values clustered between 0 and .2. Overall, the point estimates imply a slightly negative relationship between enrollment and Polity for poor, autocratic countries. The magnitude of the effect of governance is examined more systematically after results for all public goods examined have been presented.

[43] Again, the negative coefficient for the Democracy dummy variable results from the linear specification and the strong positive relationship between income and enrollment under Democracy.

They are .40 for Democracy and .02 for Autocracy.

Results for the Descriptive Regimes models, shown in columns (5) and (6), are similar. Absent interactions, enrollment is modestly but significantly higher in the more democratic regimes and there is a strong association between enrollment and per capita income. When regime-specific income responses are allowed, significant income effects are present for the Parliamentary Democracy, Presidential Democracy, and Strong Executive regimes. The effect of per capita income is small and/or insignificant for Military Dictatorship, Monarchy, or the Other regime. The magnitudes of the income effects are more clearly seen in the income elasticities in Table 5.

I re-estimated, using instrumental variables, the two education models that used 'Polity' to represent inclusiveness (columns 1 and 2 in Table 5). Ten-year lags of the Descriptive Regimes were used as instruments for Polity in the model of column 1. Estimation by IV approximately doubled the size of the Polity coefficient, from 6.9 to 12.5, but the standard error increased causing the significance level to fall to 8%. For the model in column 2, which interacts income with Polity, I added ten-year lags of interactions between per capita income and descriptive regimes as additional instruments. In this case, the IV estimate of the Polity term increased from –6.34 to 4.66 (t=0.4) and the Polity-income interaction term changed from .0043 to .0038 (t=1.7). Although the significance levels of individual coefficients fell with IV estimation, the two are

jointly significant at 0.5%.[44]

6.5 Lead in Gasoline

The empirical model for lead concentrations includes per capita income and governance as determinants. It also includes the percent of the population living in urban areas as a way of capturing cross-country differences in the likelihood of human exposure and related health effects.[45] To see why this is sensible, consider the effects of emitting a pound of lead into a country whose population is rural. Because the country is rural, both gasoline consumption and lead emissions will be spatially dispersed. This will result in low lead concentrations per unit land area and correspondingly low exposures by residents. By contrast, emitting a pound of lead in an urbanized country would cause greater exposure because gasoline consumption and human habitation are both concentrated in the same areas. Following this reasoning, lead regulations are expected to be stricter in urbanized countries.

The recent history of lead regulation indicates that dynamics are likely to be important. Lead in gasoline was first widely recognized as a health problem in the late 1960s. Prior to this lead levels did not vary with income or political regime.[46]

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[44] Hausman tests for measurement error could not be performed. Some countries had only one observation, so a standard error for the corresponding fixed effect dummy coefficient could not be estimated.

[45] The urbanization variable is taken from the World Bank's *World Development Indicators*.

[46] A simple regression of lead concentrations on political regime variables and income was estimated for the single year, 1972. The F statistic for the entire regression was insignificant, no matter which set of political regime measures was used.

Health concerns, together with new technologies for raising octane without lead, caused a general decline in lead use after the early 1970s. The phase-down proceeded at different rates in different countries, however, and in some countries not at all. The political model predicts that lead phase-down would have proceeded more slowly (if at all) in autocracies than in democracies. To capture these features empirically, lead concentrations are specified to follow phase-down trends that are regime specific. The starting points for these trends are assumed to be the same for all regimes, since there were no regime-specific differences in lead concentrations when phase out began.

Income is included as a determinant, since the demand for protection from environmental health hazards is expected to be a normal good. In keeping with earlier discussions, income responses are also allowed to differ by regime. Allowing both trends and income responses to be regime specific makes the model unwieldy, however, particularly when the six-category Descriptive Regimes are used to represent politics. To restore some simplicity, I use the Polity Index to form regime-income interactions in the Red/Green flags and Descriptive Regimes models.

Table 6 shows fixed effects results for lead concentrations.[47] To demonstrate the importance of regime-specific trends and income effects, I start with a simple

[47] The dependent variable is a policy indicator, lead per gallon of gasoline. If the focus were on total lead emissions or ambient concentrations, the environmental Kuznets curve literature would suggest using a specification that allows for a non-monotonic income effect. The inclusion of fixed effects rules out considering ethnolinguistic fractionalization and income inequality as independent variables.

model that excludes interactions—it just includes urbanization, a trend, a political regime variable (Polity Index,) and income as regressors. Interactions are then introduced to see how the results change. Column (1) presents the simple model. The coefficients indicate a significant inverse relationship between lead and per capita income, a significant autonomous downward trend of .043 grams per gallon per year, and a significant but modest political effect. The Polity Index coefficient indicates that lead concentrations are generally 0.53 grams per gallon lower under democracy than autocracy, which is modest in light of the fact that the average lead concentration in the sample is 2.08 grams per gallon. A reasonable interpretation of these results might run as follows. Lead will eventually be phased out in all countries simply through the passage of time and growth of income, and complete phase out should occur sooner under democracy than autocracy.

In column (2) the Polity Index is replaced by an interaction between the trend and Polity, allowing democracies and autocracies to phase out lead at different rates. The trend coefficient now represents the phase out rate for autocracies (Polity Index=0); it is one-third as large as in the simple specification and is not significantly different from zero. The phase out rate for democracies is the sum of coefficients on Trend and Polity*Trend. It is larger, -.066 grams per gallon per year, and is highly significant. In other words, lead phase out was relatively rapid in democracies and slow to nonexistent in autocracies.

Column (3) adds an income-Polity interaction, allowing the income effect to

vary by political system. The income coefficient for autocracy (-1.240e-5) is now only one-tenth as large as in the simple (column 1) model and is not significant. The income effect for democracy is now -.0001417 (-1.240e-5 – 1.293e-4) and highly significant. The associated elasticities of lead with respect to income are -0.02 for autocracy and –0.73 for democracy.[48] Accordingly, growth of per capita income does not motivate environmental cleanup in autocracies, but it is a strong motivating factor in democracies.

The next two columns of Table 6 report results for the Red/Green flags model. Column (4) allows the trend to vary by regime but has a common income term. The trend for Autocracy is small (.0158 grams per gallon per year) and insignificant; the trend for Democracy is about four times as large and is highly significant. Column (5) adds an interaction between politics and income. The income effect for Autocracy (the income coefficient -1.89e-5), is small and not significant. The income coefficient for Democracy is -.000132 (the sum of the income coefficient and the coefficient for the Income-Polity interaction) and is highly significant. Income elasticities are now -0.03 for autocracy and -0.68 for democracy. Once again, in autocracies there is no significant trend toward lead phase out and no significant response to increases in per capita income.

Using the Descriptive Regimes generates the results in columns (6) and (7). These coefficients largely confirm the results already obtained. Column (6) allows

[48]Elasticities were computed simply by multiplying the effective income coefficient from column (3) for a given political system by income/lead. In these computations income and lead are evaluated at mean levels for Polity>.9 to represent democracy and Polity<.1 to represent autocracy.

for regime-specific trends but has a common income term. The trends for Military Dictatorship, Monarchy, and Other are relatively weak, 0.2-0.3 grams per gallon per year, and are not significant. The trends for Parliamentary and Presidential Democracy are much more rapid, 0.6-0.7 grams per gallon per year, and are highly significant. The Strong Executive trend is significant, but relatively slow. Adding the regime-income interactions in column (7) has no marked effect on the regime specific trends, but the income response changes. Under autocracy the income response (income coefficient) is small and insignificant. Under democracy the income response (the sum of coefficients for income and the Polity-income interaction) is positive and highly significant. The elasticities of lead with respect to income are now -0.01 for autocracy and -0.71 for democracy.

The models using Polity to represent governance, shown in columns (1)-(3) of Table 6, were re-estimated using IV for Polity and its interactions with the trend and income.[49] In all three cases, the Hausman test failed to reject the null hypothesis of no measurement error. The most consistent effect of IV estimation was to increase the standard errors of the Polity coefficients. IV estimation of the simple model of column (1) caused the Polity coefficient to become positive, but insignificant. In the column (2) model the polity-trend coefficient changed only slightly, from –0.52 to -.054, but the standard error more than doubled, causing the significance level to fall to 5%. In the column (3) model the polity-trend

[49] The instruments used are as follows: 10-year lags of the Descriptive Regimes for Polity, interactions between the trend and descriptive regimes lagged 10 years for the trend-Polity interaction, and interactions between income and descriptive regimes lagged 10 years for the income-polity interaction.

coefficient increased in absolute magnitude, from -.0.028 to –0.039, and the polity-income coefficient fell in absolute magnitude, from -.00013 to -.00009. The two terms were jointly significant at 7%.

6.6 Magnitudes of Political Effects

The effect of political regime on public good provision and environmental protection is consistently large. Table 7 reports absolute and percent differences in public good and environmental policy levels under the most versus least democratic regimes.[50] The regime effect for the public bad, *lead in gasoline*, is consistently strong. The figures in Table 7 are predicted lead levels in 1992, the last year for which the lead variable is available. All methods for representing regimes indicate that lead concentrations are over twice as high under autocracy as under democracy. In most models *road density* is also over twice as great under democracy as under autocracy. This is somewhat surprising because intuition suggests that roads serve as a public input and thus should not differ much by regime.[51] *Secondary school enrollment* rates are roughly 25-50% higher under

[50] To compute these differences, the dependent variable for each observation in the sample was predicted under each possible regime. For each good, the percent difference in mean provision for each regime was then computed. Road density was expressed in logs in estimation. For the comparisons in Table 7, means of predicted values of log(roads) were computed for different regimes and antilogs of these means are reported in Table 7. For estimates that used the Polity Index to characterize government, predicted values were computed by setting Polity=0 for least democratic and Polity=1 for most democratic. Models of lead concentrations used Polity interacted with income. The value of the interaction term used for lead predictions was computed as follows. The mean of Polity for the regime under consideration, e.g., Parliamentary Democracy, was first computed. This mean was then multiplied by income and inserted into the estimated equation to represent the interaction term for the purpose of calculating predicted values.

[51] As mentioned earlier there is presumably a strong correlation between political regime and political risk, so the cost of capital may well be higher in more autocratic regimes and capital

democracy than autocracy. Access to *sanitation* exhibits regime effects of similar magnitude. The regime effect is weakest for access to *safe water*. A plausible explanation is that water is widely supplied by the private sector as well as government, so individual consumers are not constrained to rely on what is provided publicly. This partially uncouples the individual's consumption decision from the political process.

The percentage differences in provision under autocracy and democracy are consistently weaker for the Red Flags/Green Flags method of defining regimes than for other methods. The Red Flags/Green Flags system was an attempt to define regimes by imposing only minimal structure *a priori*. For example, it rules out democratic governance when at least one clear signal of autocracy is present, but ignores the number of autocratic signals. Each autocratic signal can effectively veto a verdict of democracy and conversely for autocracy. The relative weakness the Red Flags/Green Flags results may indicate that this approach imposes too little structure on regime definitions, and thus cannot capture differences in inclusiveness as sharply as the other two methods.

7 Conclusions

The primary goal of this paper was to test the hypothesis that a country's system

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formation may be penalized as a result. If so, the regime coefficient will reflect a combination of inclusiveness and cost of capital components. The strong regime effects for roads, which are long lived items of capital, may be partially due to this effect.

of governance affects its provision of public goods and environmental protection. The empirical results provide strong confirmation and provide estimates of the size of the governance effect. Dictatorial governments consistently under-provide public goods and pollution control relative to democracies. The differences are large—provision is twice as high under democracy as under autocracy for roads and environmental protection and differences generally range from 25% to 50% for other public goods.

A second goal was to untangle the effect of income from the effect of governance on the provision of environmental protection and other public goods. The empirical literature on environment-development relationships—environmental Kuznets curves—has focused on income as the driving force, concluding that income growth eventually results in environmental protection. Environmental benefits are said to result from growth because more affluent citizens will demand that their governments provide a cleaner environment. The implied message for policy makers seems clear—growth-enhancing policies will, if successful, eventually result in environmental protection. For this to be true, however, the political process must actually respond to the demands of the citizenry at large. While this income response was clearly confirmed for democracies, it was soundly rejected for autocracies. Indeed, when regime-specific income effects are allowed, the income response under autocracy is generally insignificant. This is important because most of the poor countries that might potentially grow their way into a cleaner environment—according to the

environmental Kuznets curve story—are presently autocracies.

The presence of regime specific income responses has implications for the structure of empirical models of the determinants of pollution levels. Including country fixed effects in such models will not adequately capture the effect of governance because the governance effect is nonlinear. For the same reason, simply inserting a governance variable in pollution-income regressions does not suffice.

The finding that public goods provision responds to income growth differently in democracies than in autocracies complicates the task of predicting the welfare effects of democratization. It also makes the likely prediction more optimistic, however. The models estimated in this paper regard income as predetermined. In a more general model democratization should lead to stronger economic growth. Taking this endogenous income response into account, a move from autocracy to democracy would enhance both components of the regime-income interaction term.

This analysis clearly could be extended. A richer model of political outcomes in non-democratic governments might look beyond the notion of inclusiveness and examine how regimes respond to threats from challengers. This might provide insights into some of the more interesting public expenditure behaviors autocracies seem to display. One is an apparent tendency to spend heavily on military and police functions, possibly to defend the elite's favored position. Another extension would be to incorporate the effect of political risk on capital

formation, to distinguish this from the effect of governance on public goods provision.

The summary statistics in Table 1 describe a dismal reality. Some countries seem to be stuck in the worst of all worlds. They experience exceedingly low incomes and poor levels of public services and environmental protection. They also endure governments that cater to elite subgroups while ignoring the welfare of large segments of society. More than half of the country-year observations examined in the post-1970 period fall into this group, i.e., their Polity Index is less than 0.5, they are in the Mixed or Autocracy regime in the Red/Green Flags system, or their Descriptive Regime is Strong Executive, Military Dictatorship, Monarchy, etc. Low levels of public goods in such countries are not the result of mistakes by the host government. Rather, they are systematically related to the type of government in power. Exhorting a country stuck in the worst of all worlds to raise environmental protection or secondary education to levels found in countries that are better off is not likely to bring change. A more fruitful approach might flow from a recognition that the policies a country adopts are a consequence of its system of governance. With this recognition, improved governance emerges as the key ingredient for changes in public services and living conditions in general. Unfortunately, the determining forces and causal chains that allow democracy to thrive in some parts of the world, but not in others, are poorly understood. Accordingly, it is not at all clear what steps would be needed to cause democracy to flourish in a nation that is presently autocratic.

Research to develop better knowledge of these factors deserves to be a high priority for those who seek to raise living standards in some of the world's poorest and most troubled nations.

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Table 1. Variable means by political regime

Regimes:	GDP per cap.	Safe water	Sani-tation	Road density	School enrollm't	Lead in gas
Polity Index						
Polity $\geq$ .5	6,951	77.6	74.9	6.96	69.8	1.72
Polity < .5	1,737	58.6	45.5	1.62	33.5	2.37
Red Flags/Green Flags						
Democracy	7,186	77.8	73.6	8.35	73.9	1.55
Mixed	2,429	70.5	62.2	1.13	40.4	2.17
Autocracy	1,957	57.8	44.3	1.94	32.2	2.42
Descriptive Regimes						
Parl. Democracy	7,440	79.8	78.4	8.35	80.3	1.66
Pres. Democracy	4,258	78.7	73.3	3.61	53.1	1.91
Strong Executive	1,784	58.0	43.8	2.07	35.9	2.40
Military Dict.	1,701	53.2	39.6	0.85	26.1	2.46
Monarchy	1,997	68.4	56.0	0.63	35.5	2.19
Other	1,944	54.7	42.2	2.67	32.4	2.22

Samples: 1970-1992 for GDP, 1990s average for safe water and sanitation, 1970s average for road density, 1980-1995 for school enrollment, 1970-1992 for lead.
Variables: GDP per capita in 1985 prices, percent of population having access to safe water and sanitation facilities, road density in km. of roads per square km. land area, secondary school enrollment as percent of school age population, and lead content in grams per gallon of gasoline.
Sources: See text.

Table 2. Provision of safe water and sanitation

Independent Variables:	Access to safe water: (1)	(2)	(3)	Access to sanitation: (4)	(5)	(6)
Income	.0029	.0029	.0032	.0031	.0029	.0029
	(3.3)	(3.2)	(3.2)	(3.1)	(2.8)	(2.6)
Polity Index	15.31			24.21		
	(2.8)			(3.6)		
Red Flags/Green Flags						
Democracy		10.39			16.26	
		(2.4)			(3.0)	
Mixed		10.05			12.18	
		(2.0)			(2.0)	
Descriptive Regimes						
Parl. Democracy			11.31			26.90
			(1.3)			(2.6)
Pres. Democracy			15.36			20.57
			(1.9)			(2.1)
Strong Executive			1.61			3.03
			(0.2)			(0.3)
Monarchy			9.71			9.55
			(0.9)			(0.8)
Other			0.82			2.47
			(0.1)			(0.3)
Percent Urban	.1716	.2002	.1137	.2643	.3270	.2646
	(1.34)	(1.59)	(0.8)	(1.60)	(2.0)	(1.46)
Constant	45.14	45.83	47.07	30.45	31.72	30.77
	(10.78)	(10.87)	(6.51)	(5.69)	(5.8)	(3.51)
Adj. R^2	.42	.40	.41	.44	.41	.45
N	84	84	85	80	80	81

OLS estimates, t-statistics in parentheses. The dependent variables are the percent of the total population having access to safe water and sanitation facilities. The Descriptive Regime dummies are jointly significant at 7% for safe water and at 1% for sanitation.

Table 3. Density of road networks

Independent	OLS estimates:			Fixed effects estimates:		
Variables:	(1)	(2)	(3)	(4)	(5)	(6)
Income	.4371	.4817	.5580	.3042	.3150	.3933
	(3.8)	(4.4)	(5.7)	(2.4)	(2.5)	(3.2)
Polity Index	.9032			.8511		
	(2.9)			(3.2)		
Red/Green Flags:						
Democracy		.6701			.6816	
		(2.7)			(3.3)	
Mixed		-.1513			.1448	
		(0.4)			(0.4)	
Descriptive Regimes:						
Parl. Democ.			1.3676			.7172
			(3.6)			(2.1)
Pres. Democ.			1.0967			.5144
			(2.9)			(1.4)
Strong Exec.			1.0047			.3854
			(2.7)			(1.1)
Military Dictatorship			.6850			.1812
			(1.7)			(0.5)
Other			0.6442			-.0437
			(1.5)			(0.1)
Popul'n Density	.6387	.6469	.6541	.6772	.6887	.6991
	(9.5)	(9.8)	(10.0)	(10.0)	(10.7)	(10.4)
Constant	-5.64	-5.80	-7.18	-4.74	-4.68	-5.49
	(6.6)	(6.8)	(8.4)	(4.6)	(4.6)	(5.0)
Adj. R^2	.69	.69	.70			
F				49.7	39.5	21.6
N	86	88	88	86	88	88

Figures in parentheses are t-statistics. Fixed effects estimates allow for unobserved heterogeneity at the level of continents. The dependent variable (kilometers of roads per square kilometer of surface area), income, and density are in logs.

Table 4. Secondary school enrollment

Indep. variables:	Dep. variable: % of school age population enrolled in secondary school (1)	(2)	(3)	(4)	(5)	(6)
Income	.0014	-.0003	.0014	.0002	.0015	-.0001
	(8.4)	(1.3)	(8.3)	(1.2)	(8.6)	(0.4)
Polity Index	6.8959	-6.3446				
	(5.9)	(4.4)				
Polity Index*Income		.0044				
		(14.0)				
Red/Green Flags:						
Democracy			5.2946	-6.3655		
			(6.1)	(5.1)		
Mixed			3.6759	3.4862		
			(4.2)	(2.4)		
Democracy*Income				.0036		
				(12.3)		
Mixed*Income				-.0000		
				(0.0)		
Descriptive Regimes:						
Parl. Democ.					7.5278	-1.9957
					(1.9)	(0.5)
Pres. Democ.					11.9311	6.2933
					(3.2)	(1.7)
Strong Exec.					7.9294	3.6609
					(2.2)	(1.0)
Military Dictatorship					6.1665	3.2087
					(1.7)	(0.9)
Other					3.9502	1.7589
					(1.1)	(0.5)
Parl. Democ.*Income						.0044
						(11.7)
Pres. Democ. *Income						.0022
						(4.9)
Strong Exec. *Income						.0022
						(3.9)
Military Dictatorship*Income						.0009
						(1.8)
Other*Income						.0007
						(1.8)
F	53.84	105.85	39.38	56.1	22.40	32.01
N	1599	1599	1645	1644	1656	1649

Fixed effects estimates; constant terms not reported to save space.

Table 5. Income elasticities for secondary school enrollments

Political regime	Income Elasticity
Polity Index	
Democracy (Polity > 0.9)	.41
Autocracy (Polity < 0.1)	-.03
Red/Green Flags:	
Democracy	.40
Mixed	.01
Autocracy	.02
Descriptive Regimes:	
Parliamentary Democracy	.48
Presidential Democracy	.18
Strong Executive	.10
Military Dictatorship	.04
Monarchy	-.02
Other	.05

Mean income and enrollment for countries with the indicated political attributes were used for computing elasticities.

Table 6. Lead content of gasoline

Independent Variables:	Dependent variable: lead content of gasoline (grams per gallon) (1)	(2)	(3)	(4)	(5)	(6)	(7)
Income	-1.282e-4	-6.880e-5	-1.240e-5	-7.120e-5	-1.890e-5	-6.240e-5	-3.550e-6
	(3.4)	(1.8)	(0.3)	(1.9)	(0.4)	(1.5)	(0.1)
Percent Urban	-.0128	-.0251	-.0219	-.0217	-.0233	-.0186	-.0187
	(1.1)	(2.2)	(1.9)	(1.9)	(2.1)	(1.6)	(1.6)
Trend (year-1970)	-.0432	-.0137	-.0213				
	(5.3)	(1.3)	(2.0)				
Polity Index	-.5343						
	(3.3)						
Polity Index*Trend		-.0523	-.0285				
		(4.9)	(2.0)				
Polity Index*Income			-1.293e-4		-1.134e-4		-1.348e-4
			(2.6)		(2.5)		(3.1)
Red/Green Flags:							
Democracy*Trend				-.0631	-.0484		
				(7.1)	(4.7)		
Mixed*Trend				-.0549	-.0498		
				(5.6)	(5.0)		
Autocracy*Trend				-.0158	-.0139		
				(1.7)	(1.5)		
Descriptive Regimes:							
Parliamentary Democ.*Trend						-.0688	-.0505
						(6.3)	(4.1)
Presidential Democ.*Trend						-.0596	-.0471
						(6.3)	(4.7)
Strong Executive*Trend						-.0271	-.0272
						(2.8)	(2.8)
Military Dictatorship*Trend						-.0214	-.0131
						(1.7)	(0.9)
Monarchy*Trend						-.0283	-.0333
						(1.2)	(1.4)
Other*Trend						-.0242	-.0267
						(1.6)	(1.7)
F	53.74	58.67	48.94	53.25	44.26	31.09	27.71
N	497	497	497	514	497	518	497

Fixed effects estimates. Constant terms not reported to save space.

Table 7. Differences in public good provision and environmental protection under most and least democratic regimes

Regimes:	Safe water	Sani-tation	Road density	School enrollm't	Lead (1992)
Polity index					
Most Democratic (*Polity*=1)	75.08	73.25	2.14	55.13	1.03
Least Democratic (*Polity*=0)	59.77	49.04	.91	40.23	2.31
% difference (Aut. vs. Dem.)	25%	49%	135%	37%	124%
Red Flags/Green Flags					
Democracy	71.76	68.15	2.15	52.91	1.10
Autocracy	61.37	51.90	1.09	42.20	2.27
% difference (Aut. vs. Dem.)	16%	31%	97%	25%	106%
Descriptive Regimes					
Parl. Democracy	71.35	75.63	1.87	54.21	1.12
Military Dictatorship	60.03	48.73	.91	35.37	2.40
% difference (Aut. vs. Dem.)	19%	55%	105%	53%	114%

Estimates for roads are from fixed effects models in columns 4-6 of Table 2. Estimates for school enrollment come from columns 2, 4, and 6 of Table 4. Estimates for lead come from models in columns 3, 5, and 7 of Table 6.