Winning Coalition Size, State Capacity, and Time Horizons: An Application of Modified Selectorate Theory to Environmental Public Goods Provision*

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Selectorate theory proposes that authoritarian regimes supply fewer public goods than democracies. Smaller winning coalitions make it less costly for autocracies to maintain support among critical groups by providing private goods. Democracies, with large winning coalitions, find it cheaper to provide public goods. In contrast, we argue for a conditional effect of winning coalition size on public good provisions: Many public goods require considerable state capacity to plan, legislate, and implement. Moreover, leaders with short-term horizons are unlikely to invest in public goods that take considerable time to provide. Therefore, our modified selectorate theory suggests that governments will provide public goods if the size of the winning coalition is large enough, state capacity is great enough, and \textit{a priori} regime durability is long enough. We test our theory on air pollution. While selectorate theory receives little empirical support, our findings cohere with modified selectorate theory. In particular, core democracies—defined as those with large winning coalitions, considerable state capacity, and high regime stability—perform better than autocracies in controlling air pollution.

Bueno de Mesquita, Smith, Siverson, and Morrow’s selectorate theory (2003) argues that as the size of the coalition that rulers must build to stay in power increases, the coalition provides more public goods. This follows from the logic of pure public goods: Because all can benefit from their provision without diminishing the enjoyment that others derive from them, the relative price of providing them falls in comparison with buying support with private good transfers. The theory predicts that democracies will typically provide more public goods because they have large winning coalitions. We argue that many public goods require considerable state capacity to plan, legislate, and implement if they are to be provided. Moreover, leaders who face potential shocks which are likely to change the rules of the political game will not invest in public goods that take considerable time to provide. The expected benefits that they derive from them will be too low to justify their cost. Thus, we suggest that, all else equal, regimes will provide public goods if the size of the winning coalition is large enough, state capacity is great enough, and \textit{a priori} regime durability is long enough.

In response to critics (such as Clarke and Stone 2008), Morrow, Bueno de Mesquita, Siverson, and Smith (2008) test selectorate theory on 31 types of public goods—including numerous indicators of public education and public health, civil liberties and political rights, war, and conflict. For the first test of modified selectorate theory, in contrast, we gain more from dealing with a single class of public goods (i) where an existing literature already suggests necessary controls and (ii) where the political processes involved are relatively similar. This should be the case with environmental regulation. The size argument implicitly assumes pure public goods that are fully non-rival and non-excludable. Yet, in reality, many public goods suffer from a degree of rivalry and some crowding effects. Examples considered in the existing literature testing selectorate theory include infrastructure, education, health, and social welfare. Because enjoyment of a unit of such an impure public good goes down with the number consuming it, it remains unclear—on purely theoretical grounds—whether they actually provide a relatively cheap way of maintaining support with large winning coalitions. We focus specifically

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1 In addition to variables directly related to the selectorate theory (winning coalition size \(W\), selectorate size \(S\), and loyalty ratio \(W/S\)), in empirical tests, Bueno de Mesquita et al. (2005) and Morrow et al. (2008) also control for democracy (either by the residualization of the Polity score or by executive constraints), and some additional variables such as per capita income and population size. Fixed country effects are sometimes included, but it is unlikely that they are able to deal with all potential omitted variable biases.

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on air pollution, where cleanup is often less subject to crowding or rivalry such that the size argument clearly applies well.\(^2\)

Substantive considerations also justify an initial focus on environmental public goods. Environmental protection has become a priority in many societies—even in the developing world.\(^3\) A vital question for our time concerns what sort of political system is best able to provide environmental public goods. Considerable literature, reviewed below, explores whether democracies best provide such goods, but we still lack a consensus answer. Our paper seeks to clarify some issues by arguing that it is not democracy, *per se*, that accounts for variation in the ability to provide environmental public goods. In addition to having large winning coalitions, core democracies enjoy considerable state capacity and high regime stability. We show that core democracies display distinctively better environmental performance than other systems for two forms of air pollution—sulfur dioxide (SO\(_2\)) and suspended particulates less than 10 microns in diameter (pm\(_{10}\)).

The following sections of the paper first present our modified selectorate theory. Because it should apply generally over time and space, we seek observations for as many countries and years as possible. Our empirical analysis therefore follows those who have used a range of environmental indicators and a pooled research design (for example, Li and Rueveny 2006).\(^4\) Our empirical findings show that modified selectorate theory receives strong empirical support: In particular, core democracies—defined as those with large winning coalitions, considerable state capacity, and high regime stability—perform better than other types of regimes. We conclude and discuss directions for future research at the end.

**Modified Selectorate Theory and the Environment**

*Selectorate Theory and Public Good Provisions*

Bueno de Mesquita et al. (2003) argue that the size of the coalition that leaders have to build in order to continue to hold power underlies observed variation between the range of public goods provided by autocracies and democracies. Based on this idea, they provide a parsimonious, unified account spanning all types of political systems over the millennia. They picture incumbent leaders and challengers vying for office and attempting to build winning coalitions through tax and spending packages. Only incumbents can enjoy rents deriving from the difference between what they spend and their tax revenue. Leaders aim to maximize expected rents, which requires maintaining power. The selectorate is the subset of the population “whose endowments include the qualities or characteristics institutionally required to choose the government’s leadership and necessary for gaining access to private benefits doled out by the government’s leadership” (2003:42). Furthermore, the winning coalition constitutes a subset of the selectorate “who control enough instruments of power to keep the leader in office” (2003:51). In addition to the selectorate, societies also include a disenfranchised part of the population that enjoys no influence over the leadership-selection process. Winning coalitions are of size \(W\), drawn from a selectorate constituted of potential members of winning coalitions—size \(S\). \(S\) is, in turn, a subset of the populace.

According to Bueno de Mesquita et al. (2003), the values of \(W\), \(S\), and the “loyalty ratio" \(W/S\) tend to vary between systems: In democracies, both \(W\) and \(S\) are large; among autocracies, single-party systems have small \(W\), but may have relatively large \(S\). monarchies and military regimes often have small \(W\) and small \(S\) (2003). Selectorate theory predicts that the larger the size of the winning coalition, the higher the relative cost of building it through private rather than public goods: Public goods are jointly supplied and non-excludable; thus, in principal, everyone can enjoy the benefits from any unit provided, whereas only one citizen can enjoy a unit of a private good. They predict that, other things equal, the level of provision of public goods increases with \(W\), decreases with \(S\),\(^5\) and increases with \(W/S\).\(^6\) As we have already noted, it remains unclear whether these predictions hold for impure public goods.

**Motivating Modified Selectorate: The Case of Environmental Public Goods**

Critical attention largely focuses on whether Bueno de Mesquita et al. (2003) convincingly demonstrate the key variable \(W\) performs better than standard measures of democracy in empirical tests. We return to this issue in the empirical section. For the moment, we focus on the theory’s relatively neglected theoretical underpinnings (Gallagher and Hanson 2009). Following suggestions in the existing literature, we use environmental public goods as a motivating example to develop the theory (Ward 2008; Bernauer and Koubi 2009). A great deal of empirical work and anecdotal evidence suggests that this provides a fruitful area of inquiry. Selectorate theory implies that regimes with small winning coalitions will prove especially prone to cronyism and corrupt practices as a way of transferring private goods to key supporters (Bueno de Mesquita et al. 2003:164–168). On theoretical grounds, high corruption should lead to lax environmental regulation. But high political instability should reduce the effect of corruption, because actors have less incentive to bribe a government when it is unlikely to survive (Fredriksson and Svensson 2003). Case studies (McCargo 2005) and large-n research (Koyuncu and Yilmaz 2009) also suggest that leaders of personalist and military regimes (typically small \(W\) systems) often directly exploit forest resources for personal gain or corruptly benefit from others doing so.

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2 Selectorate theory assumes a public versus private goods trade-off. If the government stops an economic agent generating a negative environmental externality by making him change his activities or pay a tax, for instance, his profit and/or consumption is reduced. In a dynamic framework, some might conceptualize environmental protection as a trade-off between two types of public goods: economic growth vs. environmental protection. However, many of the benefits of growth derive from excludable private goods.

3 In online Appendix S1, we discuss some evidence about the priority that citizens place on the environment.

4 Another reason that we choose to focus on measures of air pollution is that there is good quality and relatively abundant data.

5 Spending falls with \(S\) for fixed \(W\) while the ratio of private to public goods remains constant.

6 In equilibrium, incumbents spend less both on public and on private goods as \(W/S\) falls, because their existing supporters become more loyal. Challengers may promise better tax and spending packages to entice away some of the incumbent’s supporters, but these promises are not credible because, after the transition, they are liable to build a winning coalition based on their *real* allies, and who these are is a largely unknown factor. The smaller \(W/S\) is the lower the *a priori* probability any member of the incumbent’s coalition would actually be rewarded.
Although selectorate theory has considerable face validity for environmental public goods, it also has its limitations. Private goods can be delivered to the selectorate at a relatively low transaction cost through close personal ties, party apparatuses, and other connections between the ruler and key constituencies. But such costs are generally higher for environmental public goods. Their provision therefore becomes infeasible without the requisite state capacity. Providing environmental public goods requires sophisticated forms of regulation and, most notably, enforcement. Many countries with significant bodies of environmental law on the statute book largely fail to implement them due to a lack of regulatory capacity. For example, China suffers from this problem despite the regime having greater state capacity than many other developing countries (Schwartz 2003; Economy 2004). While ideas about efficient environmental regulation diffuse through international networks (Ward and Cao 2012), states need a degree of sophistication to make use of this information. Enforcement is the Achilles’ heel of many international environmental treaties (Young 1999) and may prove a particular problem for low-capacity states—even if signing the treaty signals intent to protect the environment (Simmons 2010). Uncoupling economic growth from further environmental damage, let alone reversing damaging trends, requires considerable scientific, bureaucratic, and implementational capacity (Weale 1992; Janicke 2002; Weidner 2002).

Moreover, selectorate theory provides a largely static model in which rulers maximize rents over the short run. Besley and Persson (2010) argue that rulers must make optimal choices about how much rent to rake off in the short run versus investment in state capacity. It would be futile for a ruler to propose a package including environmental public goods in the absence of such past investment—as they would not be able to credibly deliver on it. Moreover, relevant forms of state capacity often develop over a long period of time. We therefore cannot treat state capacity, at least in the short run, as exogenous. Thus, we expect that environmental public goods will be provided if $W$ is large enough and state capacity is high enough. Conversely, if state capacity is low, the size of $W$ should not affect the level of provision of public goods.

Next, we argue that rulers are less likely to supply environmental public goods if their estimate of the likelihood of regime durability is low. Bueno de Mesquita and Smith (2009) extend selectorate theory to allow for the possibility of revolutionary ruptures changing the rules of the game, but they maintain the assumption that supply of public goods can be altered at will and instantaneously. This might be considered a modeling simplification, capturing the idea that supply can be changed rapidly compared to the potential rate of political change. Short of a full transition, though, when the chances of a challenger’s successful rebellion are high, authoritarian rulers may reduce rent extraction or even co-opt the opposition within limited forms of democracy (Gandhi and Przeworski 2006). When one part of the ruling block appeals for support outside the selectorate, negotiation may lead to relatively rapid formal institutional change, though full ‘extrication’ from autocracy takes time (Przeworski 1992; Casper and Taylor 1996). For some public goods, rulers may be able to adjust supply relatively quickly. For instance, President Hugo Chávez of Venezuela brought in large numbers of doctors from Cuba to bolster his public health program. The British government has also expanded the British National Health Service with doctors and nurses in from abroad. It is questionable, however, whether levels of provision of complex packages of many types of public goods can be altered as fast as rent extraction, taxation, or even some aspects of formal institutional change. For instance, it may take a considerable period of time to provide any increment in infrastructural public goods and to deliver environmental improvement. It has taken decades for developed democracies to start to get grips with air pollution, and progress is by no means uniform over pollutants and across all countries (Economic Commission for Europe 2007:19–23). In a regime with low expected durability, a ruler will place low probability of being able to deliver programmes with long time lags during his own period of tenure and within the time horizons of those with whom he must cooperate. If a regime is not expected to endure, it is also less likely that others will cooperate with the ruler.

Rulers cannot get desired outcomes automatically. They have to cooperate with ruler’s agents such as powerful bureaucrats, corporations, and the military. Going forward, this requires that actors anticipate stable conditions. It also requires that they trust each other. First, we focus on stable conditions. The ruler often gets agents to do things by offering an inter-temporal bargain: Agents implement preferred policies, and the ruler will make something desirable available to agents through time. With a certain probability, agents expect continuities in policy. The probability that policy will stay the same from period $t$ to $t+1$ is higher according to the following order: The ruler stays in power; the ruler does not stay in power, but the regime endures; and the regime collapses. Within a given regime, agents expect continuity in policy because, though the ruler may change, the new ruler is likely to have similar goals and to “inherit” policy because of path dependence within a given set of institutional institutions, which are part of the “rules of the game” under the regime. On the other hand, if the regime collapses, the probability they put on the bargain with the ruler “rolling over” is much lower. Because of policy rollover, agents focus on the probability that the pattern will survive, which is higher the greater the durability of the regime. If agents believe that the probability of regime survival is low enough, they may distance themselves from the present ruler so as to position themselves to enjoy benefits under another regime. So regime durability determines whether rulers will be able to get agents to conditionally cooperate in providing public goods important to legitimacy that requires long programmes to supply, including environmental public goods.

As is generally the case in relation to collective action, trust between the ruler and agents is important (Taylor 1987; Kydd 2000). Rulers must attempt to forge cooperative deals in conditions of incomplete information. It is always possible that agents are of the type who will state that they wish to conditionally cooperate but actually intend not to do so, reaping short-term advantage from the ruler. The prior probability that others will not renege in this way, or the trust the ruler places in them,
matters. If it is too low, rulers will not gamble on initiating cooperation. Equally, agents have to trust the ruler sufficiently. Among other factors, regime durability matters to trust. Trust takes time to build up after a regime is disrupted, bringing new players to the table. As the regime endures, successful cooperation in one area builds trust in other areas, so that trust cumulates. Also, regimes are more prone to endure if leaders successfully deliver benefits to the selectorate, and thus we could expect trust to be higher the longer a regime has enjoyed stability.

In stable democracies, leaders risk losing office every few years, but the fact that the rules of the game stay the same increases their time horizon because they may be re-elected. To win election as leader, they also need to consider their party’s long-term interests. Similar logic can be largely applied to nondemocratic context. In single-party regimes, because of the logic of “Stag-hunt” games (Geddes 1999:16-17), leaders must consider the survival of the party, which makes their time horizons more or less in line with that of the regime. Similar arguments can be made for military regimes and monarchies. The exceptions among authoritarian regimes are the personalist types; but here, a change in leadership is often essentially a change in the regime. The fact that rulers typically have to look beyond their own tenure to consider regime durability matters because programmes to provide public goods may have long-term payoffs to the regime from productivity increases.

In selectorate theory, public goods do not enter the production function, implying that rulers have no long-run incentive to invest in them due to improved future revenues (Knack 2005). Yet a range of public goods relating to public health, education, and environmental quality clearly do increase national productivity (Porter and Van der Linde 1995; Ambec and Lanoie 2008). Again, a ruler who believed it was quite likely that the regime would fall in the short term would be less responsive to increasing productivity in the long term because there would be lower expected benefits both to the ruler and to close allies whose interests in regime durability they must consider.

In other words, rulers consider their personal payoffs. However, we have argued that this requires that they look beyond their own tenure to consider expected regime durability because this conditions their own payoffs. Thus, in summary, we expect the following:

**Hypothesis:** Pollution emissions will decrease with the size of winning coalition so long as state capacity and expected regime durability are high enough.

We expect this hypothesis to be most strongly applicable to public goods with long lead times between decisions to supply and actual provision, but it should apply broadly. Moreover, we argue that a certain level of state capacity and sufficiently long-term policies are among plausible sets of necessary conditions for (environmental) public goods provisions. That is, neither large W, high state capacity, nor long time horizons on their own will result in provision. This suggests that the causal impact of these variables is interactive.*

* Specifying multiplicative interaction terms between variables does imply some degree of substitutability between these factors. It would be reasonable to expect this as long as state capacity and time horizons were beyond minimal necessary levels.

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**Modified Selectorate Theory, Democracy, and the Environment**

It is widely believed outside the academic community that democracies are better placed to deal with environmental problems than autocracies and that further democratization is a necessary condition for saving the environment. A notable proponent of this position is former US Vice President Al Gore (1992). Concern for broad democratic participation over environmental issues is built into key international statements, such as principle 10 of the 1992 Rio Declaration on Environment and Development (UNCED 1992). Over recent years, a number of mechanisms have been proposed in the academic literature linking a country’s regime type to its environmental performance (Li and Rueveny 2006; Ward 2008). The bulk of the proposals favor democracy. The principle reason is that democracy allows citizens to have greater influence. In a liberal democracy, environmentally concerned citizens have multiple channels to influence political outcomes through the ballot box, pressure groups, social movement activity, the free media, and local political structures (Payne 1995). Moreover, environmental pressure groups will have significant influence (Binder and Neumayer 2005) if there is enough political competition for office (Fredriksson, Neumayer, Damania, and Gates 2005). Autocracies’ failure to protect human rights, on the other hand, disables environmental social movements (Barret and Graddy 2000). Democratization also gives a political voice to the poor, and if this helps to alleviate poverty, it may aid sustainability (UNDP 2003:17). Democracies educate citizens better, which may increase demand for a clean environment (Binder and Neumayer 2005:529–531). Finally, if failures of environmental policy arise, democratic politicians may be called to account (Payne 1995).

While the literature favors democracy on theoretical grounds, the evidence is much more ambiguous. Results depend on the particular performance indicators used, choices of control variables, how democracy and liberal freedoms are measured, the sample chosen, whether levels or rates of change are considered, and how outliers are dealt with (Congleton 1992; Midlarsky 1998; Barret and Graddy 2000; Grafton and Knowles 2004; Binder and Neumayer 2005; Fredriksson et al. 2005; Gallagher and Thacker 2008; Bättig and Bernauer 2009; Bernauer and Koubi 2009; Scruggs 2009). While a consensus exists that democracies are more prone to make international environmental commitments (Bernauer, Kalbhenn, Koubi, and Spilker 2010), it is questionable whether this always translates into improved environmental outcomes (Bättig and Bernauer 2009).

The ambiguities may partly arise from the close to total neglect of supply-side factors in this literature (but see Congleton 1992). According to our hypothesis, it is core democracies, that is, those with large winning coalitions, considerable state capacity, and regime stability that should perform better than other systems, other things being equal. These factors reflect supply-side considerations. Of course, supply-side and demand-side arguments cannot be rigidly separated, because it would be irrational for rulers to provide public goods for which demand is relatively weak. If democracy delivers what the average voter desires, it may deliver unsustainable economic growth (Midlarsky 1998:343–347), so wise democratic leaders might attempt to change citizens’ views so the environment becomes a higher priority.
Table 1. Summary Statistics Based on All Available Observations

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. Observations</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2 per capita (kilograms, after taking logarithm)</td>
<td>6,447</td>
<td>1.84</td>
<td>1.68</td>
<td>-5.41</td>
<td>6.74</td>
</tr>
<tr>
<td>PM10 per M³ (micrograms, after taking logarithm)</td>
<td>2,775</td>
<td>5.91</td>
<td>0.99</td>
<td>1.87</td>
<td>6.12</td>
</tr>
<tr>
<td>Winning coalition size</td>
<td>7,264</td>
<td>21.52</td>
<td>28.06</td>
<td>0.00</td>
<td>196.00</td>
</tr>
<tr>
<td>Regime durability (years)</td>
<td>6,121</td>
<td>1.00</td>
<td>0.52</td>
<td>0.00</td>
<td>6.95</td>
</tr>
<tr>
<td>Relative political capacity</td>
<td>5,934</td>
<td>1.00</td>
<td>0.52</td>
<td>0.00</td>
<td>6.95</td>
</tr>
<tr>
<td>GDP per capita (constant $)</td>
<td>6,821</td>
<td>72.41</td>
<td>19.34</td>
<td>25.33</td>
<td>135.09</td>
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<tr>
<td>Relative political capacity</td>
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<td>0.52</td>
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<td>6.95</td>
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<td>GDP growth (% of GDP)</td>
<td>6,546</td>
<td>3.84</td>
<td>6.56</td>
<td>-51.03</td>
<td>106.28</td>
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<tr>
<td>GDP growth (% of GDP)</td>
<td>5,934</td>
<td>1.00</td>
<td>0.52</td>
<td>0.00</td>
<td>6.95</td>
</tr>
<tr>
<td>Real oil price (constant $)</td>
<td>8,924</td>
<td>35.84</td>
<td>19.32</td>
<td>24.59</td>
<td>99.11</td>
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<tr>
<td>Urban population (% of total)</td>
<td>8,924</td>
<td>46.58</td>
<td>24.59</td>
<td>2.00</td>
<td>100.00</td>
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<td>Population density (people per sq. km)</td>
<td>8,486</td>
<td>206.70</td>
<td>975.09</td>
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<td>16317.80</td>
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<td>Communist regime</td>
<td>8,924</td>
<td>0.13</td>
<td>0.34</td>
<td>0.00</td>
<td>1.00</td>
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Table 2. Correlation Statistics Based on All Available Observations

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<th>Variable</th>
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<th>2</th>
<th>3</th>
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<th>9</th>
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<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: SO2</td>
<td>1.00</td>
<td>-0.20</td>
<td>0.30</td>
<td>0.22</td>
<td>0.19</td>
<td>0.42</td>
<td>0.60</td>
<td>-0.04</td>
<td>0.06</td>
<td>0.49</td>
<td>-0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>2: PM10</td>
<td>-0.20</td>
<td>1.00</td>
<td>-0.35</td>
<td>-0.24</td>
<td>-0.09</td>
<td>-0.29</td>
<td>-0.37</td>
<td>-0.04</td>
<td>-0.09</td>
<td>-0.24</td>
<td>-0.01</td>
<td>0.13</td>
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<tr>
<td>3: Winning coalition size</td>
<td>0.30</td>
<td>-0.35</td>
<td>1.00</td>
<td>0.32</td>
<td>0.20</td>
<td>0.30</td>
<td>0.46</td>
<td>-0.03</td>
<td>-0.04</td>
<td>0.36</td>
<td>0.08</td>
<td>-0.13</td>
</tr>
<tr>
<td>4: Regime durability</td>
<td>0.22</td>
<td>-0.24</td>
<td>0.32</td>
<td>1.00</td>
<td>0.08</td>
<td>0.45</td>
<td>0.47</td>
<td>-0.00</td>
<td>0.04</td>
<td>0.34</td>
<td>0.01</td>
<td>0.00</td>
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<tr>
<td>5: Relative political capacity</td>
<td>0.19</td>
<td>-0.09</td>
<td>0.20</td>
<td>0.08</td>
<td>1.00</td>
<td>0.12</td>
<td>1.00</td>
<td>-0.04</td>
<td>0.08</td>
<td>0.15</td>
<td>-0.05</td>
<td>0.01</td>
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<tr>
<td>6: GDP per cap</td>
<td>0.42</td>
<td>-0.29</td>
<td>0.30</td>
<td>0.45</td>
<td>0.12</td>
<td>1.00</td>
<td>0.86</td>
<td>-0.00</td>
<td>0.05</td>
<td>0.62</td>
<td>0.11</td>
<td>-0.11</td>
</tr>
<tr>
<td>7: GDP per cap²</td>
<td>0.60</td>
<td>-0.37</td>
<td>0.46</td>
<td>0.47</td>
<td>0.16</td>
<td>0.86</td>
<td>1.00</td>
<td>0.01</td>
<td>0.05</td>
<td>0.79</td>
<td>-0.14</td>
<td>0.13</td>
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<tr>
<td>8: GDP growth</td>
<td>-0.04</td>
<td>-0.04</td>
<td>-0.03</td>
<td>-0.00</td>
<td>-0.04</td>
<td>-0.00</td>
<td>0.01</td>
<td>1.00</td>
<td>-0.06</td>
<td>-0.03</td>
<td>0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td>9: Real oil price</td>
<td>0.06</td>
<td>-0.09</td>
<td>-0.04</td>
<td>0.04</td>
<td>0.08</td>
<td>0.05</td>
<td>0.05</td>
<td>-0.06</td>
<td>1.00</td>
<td>0.05</td>
<td>0.00</td>
<td>0.08</td>
</tr>
<tr>
<td>10: Urban population</td>
<td>0.49</td>
<td>-0.24</td>
<td>0.36</td>
<td>0.34</td>
<td>0.15</td>
<td>0.62</td>
<td>0.79</td>
<td>-0.03</td>
<td>0.05</td>
<td>1.00</td>
<td>-0.26</td>
<td>-0.02</td>
</tr>
<tr>
<td>11: Population density</td>
<td>-0.10</td>
<td>-0.01</td>
<td>0.08</td>
<td>0.01</td>
<td>-0.05</td>
<td>0.11</td>
<td>0.14</td>
<td>0.05</td>
<td>0.00</td>
<td>0.26</td>
<td>1.00</td>
<td>-0.05</td>
</tr>
<tr>
<td>12: Communist regime</td>
<td>0.12</td>
<td>0.13</td>
<td>-0.13</td>
<td>0.00</td>
<td>0.01</td>
<td>-0.11</td>
<td>-0.13</td>
<td>-0.05</td>
<td>0.08</td>
<td>-0.02</td>
<td>-0.05</td>
<td>1.00</td>
</tr>
</tbody>
</table>

(Gore 1992). However, supply-side considerations should still intervene. It would be irrational for leaders to attempt to create demand if it is costly to meet it. Our theoretical and empirical focus is on the supply side, unlike the bulk of the literature on autocracy, democracy, and the environment, although we also consider demand side factors.

**Measurement and Estimation Strategy**

**Size of Winning Coalition**

Bueno de Mesquita et al. (2003:134–135) assign the lowest score to military regimes on the assumption that military regimes have particularly small W. The value of W goes up by a fixed amount if the executive is not chosen by heredity or in rigged or in unopposed elections. An additional increment is added if the executive is not recruited from a group based on heredity. If there are relatively stable groups that regularly compete for political influence, W is also increased. Their data on W only extend to 1999. We extend it to 2005 using Cheibub, Gandhi, and Vreeland’s (2010) coding of military regimes and Polity IV data (Marshall, Gurr, and Jaggers 2010). We recalculated W using Cheibub, Gandhi, and Vreeland’s coding throughout, for consistency. Over the cases where the two measures of W are available, the correlation between them is .94 (n = 5875). To make sure that the empirical support for our theory is not a function of an extension of the winning coalition size data, we re-ran all our models based on Bueno de Mesquita et al.’s original data. The results are almost the same (both short-term and long-term effects). These results are available upon request.

**Minority**

*Minority* theory makes some distinct predictions for the ratio of the size of the winning coalition and the selectorate. We focus on the size of the winning coalition because the correlation between W and W/S is so high that it is not possible to distinguish the effects empirically: With our extended coding, the correlation is .9968 (n = 7246); with Bueno de Mesquita et al.’s original coding, it is .9963 (n = 5784).
Chang and Golden (2010) argue that the lack of direct correspondence between the concepts of selectorate and winning coalition with political institutions that are observed in real-world polities is an evident weakness of selectorate theory.12

State Capacity

There are several alternative measures of state capacity in the literature, but all of them tend to focus on tax or government expenditure data to ensure wide coverage and comparability (Thies 2010). Arbetman-Rabinowitz and Johnson (2007) view states’ relative political capacity as the “the ability of a government to extract resources from a population given their level of economic development” (2). The capacity measure is accordingly the ratio of the actual level of tax extraction to a predicted level of extraction. A government is relatively efficient if it can extract more than might be predicted. Predicted levels are a function of per capita GDP and the size of extractive industries like oil production and mining which are relatively easy to tax. For poor countries, the size of the agricultural sector is also deemed to affect predicted ability.13 The measure capacity depends on the size and the sign of residuals: Large positive residuals promise relative efficiency.

At first sight, states’ relative capacity to extract is not the most obvious proxy for their relative ability to plan and to execute programmes to provide public goods. However, Besley and Persson’s (2010:4–10) model indicates investments in fiscal capacity, and legal capacity will be positively correlated because they are compliments in producing greater expected returns to office holding. Besley and Persson (2010:3–4) discuss much evidence that broadly supports this correlation. So we expect on theoretical grounds that fiscal capacity will be a good proxy for states’ ability to provide public goods. Empirically, the bureaucratic and administrative capacity of the state, which we think is the key to states’ ability to provide public goods, is often measured by using surveys relying on estimates of states’ revenue-generating capacity (Hendrix 2010). Survey-based approaches suffer from low temporal and spatial coverage compared to relative political capacity. Measures of capacity such as the total tax to GDP ratio and the total revenue to GDP ratio are often endogenous to other factors such as the level of economic development and economic structure.

Regime Durability

We argue that leaders generally will not provide public goods that have long lead times if they expect the regime to collapse by the time that they are produced or their beneficial knock-on effects become available. Leaders’ expectations could be captured in several ways.14 Personal tenure data do exist (Goemans, Gleditsch, and Chiozza 2009), but our theory suggests leaders consider regime durability not just their own likely tenure. Discussion in the theoretical section has emphasized that first, regime durability conditions whether rulers will be able to get important agents in the society to conditionally cooperate in providing public goods. Second, trust between the ruler and agents is important for their cooperation and trust is more likely to build (cumulatively) in durable regimes. Third, institutional settings constrain leaders, even those in authoritarian regimes, so that their time horizons are often associated with regime stability.

There are also empirical justifications to use regime durability. Duration measures at the leadership level have limitations. Duration measures often assume that the longer power has been controlled (either by a political regime or by a single leader), the longer the ruler’s time horizon is. Note this only makes sense for regime duration; leadership tenure duration is problematic because one can only live for so long that at the end of a ruler’s life, even though the tenure is long, the ruler might have a very short time horizon.15 Finally, we argue that leaders are likely to use empirical guides to regime durability and that the representativeness and availability heuristics apply (Kahneman and Tversky 1972). Specifically, leaders use recent experience of regime (in)stability in their own country because such information is available and is likely to be seen as most applicable. Thus, we use a measure based on the assumption that leaders’ expectations of regime durability are lower if the rules of the game have changed substantially and recently. We use the Polity IV regime durability measure which captures the length of

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12 In the context of authoritarian states, they turn to Geddes’s classification of authoritarian regimes (which they consider intuitively more meaningful, thereby generating results that are easier to interpret). Rank authoritarian regime types by the size of winning coalition and selectorate, and use regime type dummy variables to test the effects of the size of the winning coalition on corruption. Recent studies following this strategy also include Peeren and Butler (2004) and Pickering and Kisangani (2010). However, this approach is not without controversy. Scholars seem to have different rankings of authoritarian regime types by the size of winning coalition and selectorate. We have controlled for the effects of authoritarian regime types in Appendix S2 of the manuscript and found no consistent (across different pollutants and model specifications) and significant effects associated with regime types variables.

13 The specific variable we use is rpc2, which controls for agriculture and energy production but not mining, for which data are lacking for many authoritarian systems.

14 We have to admit that there is no perfect way to capture ruler’s time horizon as it might depend on regime types, issues under concern, and many other external factors. For our particular purpose, we believe regime duration is a better measure. In the recent literature, both duration measures and predicted probability or hazard rate measures of regime durability exist. We choose not to use predicted probability measures because first, predicted probability/hazard rate measure implicitly assumes that the leader knows his/her chances of survival and behaves accordingly. It therefore misses (potentially many) important cases in which leaders miscalculate (for example, Saddam Hussein and more recently Muammar Gaddafi). Second, as Cheibub (1998:361) puts it, it is entirely backward looking and it ignores the government’s perceptions of its ability to alter its future chances of survival. Third, the predicted probability/hazard rates measures ultimately depend on the covariates included in the prediction models, which vary across different studies (for example, Cheibub 1998; Wright 2008; Goldstone, Bates, Epstein, Gurr, Lustik, Marshall, Ulfelder, and Woodward 2010). Finally, the measures of predicted probability/hazard rates for regime/leadership failure are simply point estimates. They cannot account for the degree of uncertainty from prediction models—this essentially assumes that leaders know exactly their chances of losing power at a given time; ideally, we should also take into account uncertainties associated with prediction models, for example, by 95% confidence intervals associated with predictions—but this makes hypothesis testing much more complicated. We have written online Appendix S3 that has more detailed discussion on the pros and cons associated with common types of time horizon measures.

15 Therefore, if we want to use leadership tenure duration, its relationship with time horizon might be nonlinear, maybe an inverted U-shaped one. However, testing a variable in a nonlinear fashion and also in three-way full interactions is too complicated to interpret. Bueno de Mesquita et al. find that average tenure goes up with 95%. If tenure is endogenous, it is methodologically advantageous to focus on regime durability. We did run all our models using leader tenure and found no evidence of its conditional effect on winning coalition size.
time since a three-point change in the Polity score over a three-year period (Marshall et al. 2010). 

**Two- and Three-Way Interactions**

Our hypothesis is that provision of environmental public goods will increase with W as long as regime capacity and regime durability are high enough. To test this, we need to include interactions between W and capacity and W and durability in the model, alongside each of these three variables. We also include the three-way interaction between these terms, as we expect the modifying effect of capacity and durability on W to be synergistic. In fact, we employ a fully interactive model (Kam and Franzese 2007), also including the interaction between capacity and durability, given the possibility that these variables count independent of the level of W: Actors like bureaucrats may have some influence over public good provision independent of the logic of survival facing leaders, relating to their own interests, capacity to deliver, and likely tenure.

**Control Variables**

The environmental Kuznets’ curve posits that the environment is a relatively low priority for citizens in the early stages of development, but it becomes a higher priority as their standard of living increases (Grossman and Krueger 1995:365–365). The evidence suggests that this argument does not hold for all pollutants, for all types of political system, or for all regions (Cole and Neumayer 2005). Where it does, a combination of demand factors and changing industrial structure is probably at work. Nevertheless, it is important to control for relative demand for environmental public goods, even if it is not really possible to proxy the level of demand among the selectorate. Because of lack of cross nationally comparable data on demand, income is the best available proxy. 

We include real GDP per capita calculated using the Laspeyres method from Penn World Tables version 6.2 (Heston, Summers, and Aten 2006). We took the natural log of this variable. To allow for possible nonlinearities, we also included the square term, GDP per capita\(^2\). Rapid economic growth may generate forms of environmental damage that are hard to cope with in the short term, for example, the current situation in China (Economy 2004). We include GDP growth—the annual rate of growth of GDP from the World Bank’s World Development Indicators.

The burning of fossil fuels generates several air pollutants. Other things equal, the higher the price of fossil fuels, the lower the emissions ought to be. It is hard to get consistent time series data on coal and natural gas prices, but changes in these correlate with changes in oil prices because they are partial substitutes. The longest consistent time series data on oil prices are an index of the 2010 dollar price of Illinois crude oil at the production pump, Real oil price. This correlates strongly with other series that exist for shorter time periods such as the real price of Saudi Arabian crude.

Selectorate theory adopts a parsimonious approach in which rulers’ only motive is to maximize the expected surplus they can extract from society, though allowance is made for peculiarities such as spending parts of the surplus they extract in public-spirited ways. Yet rulers’ motives could systematically intervene in the logic of political survival in ways that have consequences for important choices like going to war (Weeks 2011). Such preferences also influence the relative provision of different public goods. We focus on communist regimes, where our theoretical priors are strong. Communist regimes have often adopted a progressivist perspective based on Marx and Engels’ idea of the road to communism as represented by Lenin’s (1965 [1920]:420) dictum that “communism is Soviet power plus the electrification of the whole country.” In practice, communist regimes tended to construe development of the forces of production as building heavy industry, mining, massive irrigation, and hydroelectric projects. The case study literature finds it difficult to disentangle this ideology from other variables such as relative under development, yet it is frequently held to be one factor lying behind such problems as heavy air and water pollution in the Soviet Union (Oldfield 2005). Beside ideology, it is commonly held that Soviet central planning was wasteful of resources because inputs and use of pollution sinks came unpriced to enterprises bent on short-term plan fulfilment, which also led to under-investment in cleaner plants (Ericson 1991). We generally found little reason to include other controls in a fixed-effects estimation framework. However, we provide an online appendix mainly devoted to robustness checks.

**Estimation Strategy**

We estimate models with country-fixed effects. Though this leads to lower efficiency, it is a conservative strategy when there is a possibility of estimation bias due to uncontrolled institutional factors correlated with independent variables. For instance, the rule of law may correlate with W, but it is doubtful whether commonly used measures such as Transparency International’s specifically capture environmental enforcement; so country-fixed effects are necessary to avoid biased inferences. We include suggested dependent variables. Our dependent variables are likely to take years to respond to changes in political structure, because of the time taken to build and implement programmes (Gallagher and Thacker 2008). Thus, dynamics are of central interest here. In effect, we suspect that leaders’ preferences also vary across other authoritarian regime types in ways consequential for public good provision. For instance, if military regimes are less stable and their leaders are prone to short-term personal aggrandizement (Geddes 2004), they may over-exploit renewable and non-renewable resources, as in the case of military regime’s exploitation of gemstones and forests in Myanmar (Myint 2007). If they prefer high spending on military activities, this impacts the environment as the carbon footprint of the military is high (Jorgenson, Clark, and Kentor 2010). We provide models controlling for these regime types in online Appendix S2. Here, we report models controlling for the effect of democracy by including Polity scores because Clarke and Stone (2008) argue that the empirical power of selectorate theory largely evaporates once democracy is properly controlled for (see Morrow et al. 2008 for a rejoinder; also Kennedy 2009). Note that selectorate theory also predicts W will vary systematically with regime type. We therefore control for different regime types (for example, single party, monarchy, military, and personalist regimes). None of these specific regime types systematically affect pollution, and the Polity score only predicts SO\(_2\) emission levels. Our basic findings on the conditional effects of state capacity and regime duration do not change.

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16 We argued above that trust is important to enable rulers to provide public goods with long lead times and that trust accumulates through time in stable regimes. A second justification for using the Polity IV measure is that it proxies the possibilities for trust building.

17 See the online Appendix S2 for a discussion of relevant data.

including the lagged dependent variable results in the estimation of a geometric lag on our central variables $W$, durability, capacity, and their interactions so that observations become less influential with time.\textsuperscript{21} Models with both fixed effects and a lagged dependent variable might be problematic: The lagged dependent variable is correlated with the error term by its correlation with the time-invariant component of that term. When country-fixed effects are included, "Nickell bias" results because the lagged dependent variable is still correlated with the error term. However, Kiviet (1995) shows that panel data models that use instrumental variable estimation often lead to poor finite sample efficiency and bias. Adolph, Butler, and Wilson (2005:16-22) show that Nickell bias is often negligible and that all remedies are worse than the original problem. Judson and Owen (1999), Wilson and Butler (2007), and Beck and Katz (2011) also argue that when $T$ (number of years in time-series cross-sectional data) is relatively large, the bias for the coefficient estimates is not that big. In Beck and Katz (2011:342), for instance, the authors point out the fact that the bias is of order of 1 over $T$ and that "almost all of the work on this problem has been in the context of small-$T$ 'panels'. When $T$ is 2 or 3, the bias is indeed severe (50% or so). But when $T$ is 20 or more, the bias becomes small."\textsuperscript{22} As the number of years gets larger, this bias becomes less of a problem.\textsuperscript{23}

\subsection*{Statistical Results}

Even if the logic is for the ruler to provide more public goods, the question is what sort of public goods? Specifically, the relative demand for different public goods among members of actual or potential winning coalitions, $S$, ought to matter. Besides attempting to control for demand by including real income, we can bring to bear what we know about the immediacy of environmental problems. Rulers should be relatively disinclined to provide public goods that we are more likely to observe clear differences between regimes. However, some have used aggregated sustainability measures (Li and Rueveny 2006; Jorgenson et al. 2010) which have the advantage of addressing broader questions, but at the cost of considerable measurement problems and dangers with aggregation bias. The advantage of considering international commitments (Bätting and Bernauer 2009) or specific policies (Ward and Cao 2012) is that we are more likely to observe clear differences between regimes. However, international commitments are often undemanding and policies fail to get implemented as rulers see no advantage in going beyond political symbolism.

\textbf{Sulfur Dioxide Emissions}

SO$_2$ is a serious air pollutant, implicated in (i) ground-level smog and haze, (ii) associated damage to human health, (iii) reduced agricultural productivity, and (iv) acid deposition (Hill 2004). Around two-thirds of emissions result from fossil fuel-burning electricity generation, particularly from burning of high-sulfur content coal. In developed countries, the trend has been toward reductions in emissions due to changes to less sulfur-containing fuels, deindustrialization, domestic legislation (for example, the US Clean Air Act of 1973), regional arrangements encouraging pollution control technologies (for example, the 1988 EU Large Combustion Plant Directive), and the international Convention of Long-Range Transboundary Air Pollution. Emissions, however, are still increasing in rapidly growing developing countries like China and India. We use Stern’s (2005) data on SO$_2$ emissions, in logged kilograms per capita, per year.

The first two specifications in Table 3 present estimates from models for SO$_2$ emissions. Model 1 tests for unconditional effects of the winning coalition size ($W$), and thus it excludes interaction terms. The mean estimate of the coefficient is positive, suggesting that larger $W$ is associated with greater emissions—the opposite of what selectorate theory predicts. But this estimate is far from being statistically significant (indicated by its $p$-value). In the second model, we added interaction terms to test whether modified selectorate theory is supported. Before

\begin{footnotesize}
\begin{enumerate}
\item Gallagher and Thacker (2008) use a democracy stock variable (the sum of annual observations of Polity 2 scores) after applying a fixed time discount parameter. Other specifications might involve lagging the political variables and then allowing influence to decay.
\item See Beck and Katz (2011:342). Moreover, discussing fixed effects and lagged dependent variable (LDV), they point out that based on their Monte Carlo experiments, OLS with fixed effects and LDV performs about as well as Kiviet and much better than Anderson-Hsiao when T is around 20 or more. They conclude at the end that "we do not hesitate to recommend OLS with country-specific intercepts must be adjoined to the specification of a TSCS model."
\item When dealing with a small $T$, generalized method of moments (GMM) is a better estimation strategy as it is designed for short panels. However, Roodman (2009) cautions the use of GMM estimators in data with relatively large Ts. Roodman (2009) PAGES emphasizes that "as $T$ rises, the instrument count can easily grow large relative to sample size, making some asymptotic results about the estimators and related specification tests misleading." As the $T$ in a time-series and cross-sectional (TSCS) data increases, the Nickell Bias becomes smaller and smaller (it is of the order of 1/$T$); at the same time, the problems associated with GMM estimators become more and more serious. The real risk of using GMM in this situation is that results are invalid, but the normal tests make them appear valid (Roodman 2009). Our data are by no means short panels: The $T$ for the case of SO$_2$ is 44 and the $T$ for PM10 is 16.
\item For an empirical test in the area of environmental politics, see Cao and Prakash (2012).
\item Some have used aggregated sustainability measures (Li and Rueveny 2006; Jorgenson et al. 2010) which have the advantage of addressing broader questions, but at the cost of considerable measurement problems and dangers with aggregation bias. The advantage of considering international commitments (Bätting and Bernauer 2009) or specific policies (Ward and Cao 2012) is that we are more likely to observe clear differences between regimes. However, international commitments are often undemanding and policies fail to get implemented as rulers see no advantage in going beyond political symbolism.
\item This is a measure of anthropogenic organic pollution of waterways. Besides putting stress on eco-systems, the discharges may be a problem for human health.
\end{enumerate}
\end{footnotesize}

<table>
<thead>
<tr>
<th></th>
<th>SO2</th>
<th>PM10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>$\hat{\sigma}$ (p&gt;</td>
</tr>
<tr>
<td>Intercept</td>
<td>-2.552</td>
<td>0.461 (0.00)</td>
</tr>
<tr>
<td>Lagged dependent variable</td>
<td>0.905</td>
<td>0.006 (0.00)</td>
</tr>
<tr>
<td>Winning coalition size ($w$)</td>
<td>0.011</td>
<td>0.023 (0.02)</td>
</tr>
<tr>
<td>Regime durability (durable)</td>
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<td>0.002 (0.64)</td>
</tr>
<tr>
<td>Relative political capacity (rpc)</td>
<td>0.019</td>
<td>0.031 (0.53)</td>
</tr>
<tr>
<td>$w \times$ durable</td>
<td>-0.005</td>
<td>0.002 (0.01)</td>
</tr>
<tr>
<td>$w \times$ rpc</td>
<td>-0.001</td>
<td>0.000 (0.84)</td>
</tr>
<tr>
<td>Durable $\times$ rpc</td>
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<td>0.000 (0.78)</td>
</tr>
<tr>
<td>$w \times$ durable $\times$ rpc</td>
<td>0.000</td>
<td>0.000 (0.78)</td>
</tr>
<tr>
<td>GDP per cap</td>
<td>0.661</td>
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<td>GDP per cap$^2$</td>
<td>-0.038</td>
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<td>GDP growth</td>
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<tr>
<td>Real oil price</td>
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<td>0.000 (0.84)</td>
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<td>Urban population (% of total)</td>
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<td>0.001 (0.02)</td>
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<td>Population density</td>
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<td>Communist regime</td>
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<td>0.968</td>
</tr>
<tr>
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<td>3,899/110</td>
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In Figure 1(a), we show the marginal effects of winning coalition size and associated 95% confidence intervals, conditional on regime duration, across four different levels of state capacity—the 20th, 40th, 70th, and 90th percentiles based on the full sample values of state capacity. The vertical lines correspond to 10- and 20-year durability. The four sub-figures look similar: For the first three where state capacity is at low/medium levels, the effect of winning coalition size on SO2 emissions is only positive at the very low end of regime duration and then only barely so. Detailed inspection of 95% confidence intervals shows that once the regime lasts more than 2 years, any positive effect becomes undetermined. For countries with high state capacity (for example, the fourth sub-figure), the effect of W on SO2 emissions is never both positive and significant. For all four sub-figures, once the regime lasted more than 20 years, the effect of W is negative and also statistically significant; the longer the regime has lasted, the greater the negative effect of W. These findings illustrate the strong conditional effect of regime duration on winning coalition size’s relationship with SO2 emissions.

Figure 1(b) shows the marginal effects of winning coalition size conditional on state capacity across four different levels of regime duration, respectively, the 20th, 40th, 70th, and 90th percentiles. Vertical lines correspond to political capacity of 1 and 2. The four sub-figures clearly demonstrate that the conditional effect of state capacity changes across different levels of regime duration. For regimes that have not lasted long (the first [2 years] and the second [8 years] sub-figures), W has no statistically significant effect on emissions regardless of the level of state capacity. However, for relatively long-lasting regimes such as those represented by the third (24 years) and the last (53 years) sub-figures, we see statistically significant and negative associations between W and emissions up to relative political capacity values of around 2 or 3. Note, however, that relative political capacity rarely exceeds 2 (See Table 1: The mean of relative political capacity is 1 with a standard deviation of 0.52), and the lack of observations beyond this value explains why the 95% confidence intervals include 0 for high levels of state capacity in these two sub-figures. Moreover, the slopes of the dark lines (that is, the mean coefficients estimated) suggest that this negative effect becomes more important with increasing state capacity: For regimes that last relatively long, large winning coalition size reduces emissions and this negative effect becomes stronger with increasing state capacity. In sum, for SO2 emissions, Figure 1 lends support to our hypothesis that the effect of the winning coalition size on pollution is conditional on state capacity and regime duration. Moreover, the conditional effect of regime duration seems to be more dominant than that of state capacity as suggested by Figure 1(a): For non-extreme values of state capacity (20th to 90th percentiles), as long as the regime lasted more than 20 years, winning coalition size (W) always reduces emissions.

As Scruggs (2009) argues, much of the environmental political economy literature fails to go beyond consideration of immediate effects. The models estimated here include the lagged dependent variable, because we do not think that shocks to the political variables are likely to have their full impact in one year. If changes in the nature of the political system are to have an effect, we would not expect this to occur within a single year; therefore, to fully appreciate the effects of winning coalition size, regime duration, state capacity, and their interactions, we need to look at least at the medium term. However, the mean coefficient estimate of an independent variable, say, $\beta$, in a model with lagged dependent variable only captures the short-term effect. The mean long-term effect is $\frac{1}{\beta}$, where $\beta$ is the mean coefficient estimate for the lagged dependent variable (De Boef and Kele 2008).

It is hard though to calculate the confidence intervals for the long-term effect directly, especially in our case where 3-way full interaction terms are involved. To investigate dynamics, we carried out simulations of predicted values as Williams and Whitten (2008) advocate. To make the results graphic, it is best to think in terms of more familiar categories rather than three interval level variables (W, state capacity, and time horizon). We use four categories of political system designed to speak to the debate on democracy, autocracy, and the environment. In scenario 1, we set W, capacity, and durability at their 80th percentile level among democracies in our overall sample. We call these cases core democracies (large W, durable, and high in state capacity, for example, the UK and Sweden). In scenario 2, we set the three main variables at their mean values across democracies (average democracies). In scenario 3, we set the three main variables at their mean value among autocracies (average autocracies). Finally, in scenario 4, we set the three main variables at the 20th percentile level for autocracies: These are fragile autocracies with small winning coalition, subject to recent regime change and with low state capacity (for example, Myanmar and the Republic of the Congo for some years). We set values of other variables at their sample mean among valid cases, with the exception of communist regime variable where values reflect the scenarios. In particular, we construct scenarios to hold the level of economic development constant. In all four simulations, we set the starting value of the lagged dependent variable at its mean value in the valid sample.

Results are shown in Figure 3(a). The central estimates (solid dark dots) and 95% confidence intervals (vertical lines) are shown for predicted values under all four scenarios. We see in all scenarios emissions slowly decline and stabilize around year 20. In scenarios 3 and 4, emissions are barely statistically distinguishable, so fragile

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28 We follow Brambor, Clark, and Golder (2006) in displaying the marginal effects in interaction models.

29 We define democracies and autocracies by their Polity2 scores as follows: democracies $\geq 6$ and autocracies $\leq -6$ (Marshall et al. 2010).

30 In scenarios 1 and 2, communist $= 0$; in scenarios 3 and 4, communist is set at its mean value (that is, frequency among autocracies in the valid sample).

31 Notice that with predicted values, the uncertainty surrounding the lagged value of the dependent variable is not carried forward when calculating confidence intervals (Williams and Whitten 2008), as would be the case if we reported forecasts.
autocracies do not perform significantly worse than average autocracies. In scenario 2, emissions fall to a lower level than those in scenarios 3 and 4, but the 95% confidence intervals overlap. What stands out is scenario 1, core democracies, whose performance is significantly better than average democracy after the first decade. The idea that democracies perform better in relation to SO2 pollution is often found in the literature (Barret and Graddy 2000; Esty and Porter 2005). But our simulation suggests that it is the core democracies that behave significantly differently from other regimes, including average democracies.

**Particulates**

Particulates may comprise mixtures of a number of substances including sulfates, nitrates, metals, dust, and biological matter. Major sources are dust from farms, mines, and roads. Burning fossil fuels contributes most to smaller, more damaging particulates (Hill 2004:107–123). Particulates are implicated in a number of problems: ground-level smog and haze, especially in urban areas; damage to human health, especially from the smallest particles lodging in lungs and even reaching the bloodstream, associated with exacerbation of heart disease and with lung cancer. There has been considerable regulatory action such as the US Environmental Protection Agency’s 1997 measures under the Clean Air Act and also measures under EU directives in 1996 and 1999. We focus on the density of suspended particulates less than 10 microns in diameter, in logged micrograms per cubic meter, \( \text{pm10} \). We use data taken from World Bank Development Indicators for 1990–2005.

We also present two model specifications in Table 3, one to test the unconditional effect of \( W \) and the other for the modified selectorate theory. For both models, we find that \( GDP \) growth, \( \text{real oil price} \), and \( urban \ population \) (\% of total) are associated with lower emissions. Again, communist regime is associated with higher levels of emissions, but the relationship is not robust to the inclusion of the interactive effects in the second model specification. We also only find evidence for an environmental Kuznets’ curve in the first model specification. Figure 2(a) shows the marginal effects of winning coalition

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**Figure 1.** Testing the Short-Term Effects of the Modified Selectorate Theory, SO2. (a) Effects of Winning Coalition Conditional on Time Horizon for Different Levels of State Capacity. (b) Effects of Winning Coalition Conditional on State Capacity for Different Levels of Time Horizon

(Note: The four different levels of state capacity and time horizon are chosen at the 20th, 40th, 70th, and 90th percentiles of the full sample.)
size conditional on regime duration across four different levels of state capacity chosen at the 20th, 40th, 70th, and 90th percentiles. For all four sub-figures, the mean estimates of the effect of W on particulates become more negative with increasing levels of regime duration. These negative effects become statistically significant in the last sub-figure where state capacity reaches a relatively high level: Only when state capacity is high (for example, in last sub-figure where \( \text{Relative state capacity} = 1.65 \)), does winning coalition size reduce emissions after the regime lasted more than about 45–50 years.\(^{32}\) Moreover, this negative effect became stronger as the regime lasted longer. Figure 2(b) looks at the interactive effects from the other angle: The marginal effects of winning coalition size conditional on state capacity across levels of regime duration also chosen at the 20th, 40th, 70th, and 90th percentiles. The four sub-figures clearly demonstrate that the conditional effect of state capacity changes across different levels of regime duration. When the regime is very short-lived, as in the first sub-figure when regime duration = 2 years, W is associated with greater emissions once state capacity reaches a relative high level, and this positive association between W and particulates becomes stronger with higher level of state capacity. One explanation might be that for short-lived states, leaders with short time horizon might only care about current gains; strong state capacity helps them to extract resources from the society as quickly and as extensively as possible, so the incentive to provide environmental public goods would be very small. However, the mean effects of W on particulates shift from positive to negative with increasing regime duration (moving from the first to the last sub-figure). Ultimately for relatively long-lasting regimes such as those represented by the last (53 years) sub-figure, we see a statistically significant and negative association between W and emissions; moreover, the negative association becomes stronger with increasing level of state capacity even though this relationship loses its statistical significance after capacity reaches around 4. In sum, we find that the

\(^{32}\) Examples of countries with relative political capacity larger than 1.65 and with a political regime that has lasted more than 45 years include Belgium, Ireland, Israel, Italy, New Zealand, and the United Kingdom.
case of particulates strongly supports our hypothesis that W only reduces pollution when both state capacity and regime duration are high enough.

Figure 3(b) further illustrates the long-term effects of W, state capacity, and regime duration by comparing the four scenarios discussed in the previous section: core and average democracies as well as average and fragile autocracies. We see in all scenarios that emissions increase in the first few years and stabilize after around year 10. In scenarios 3 and 4, emissions are barely statistically distinguishable: Fragile autocracies do not perform significantly worse than an average autocracy. In scenario 2, emissions do not rise to as high as in scenarios 3 and 4, but 95% confidence intervals still largely overlap. Core democracies, on the other hand, perform significantly better than average and fragile autocracies. Core democracies also seem to do better than average democracies, but there is a little overlap between their 95% confidence intervals. The simulation exercise seems to suggest that the core democracies behave differently from other regimes, especially when compared with autocracies.

Conclusion and Discussion
Selectorate theory derives from a well-specific formal model. It is very parsimonious in terms of the number of key variables. In principle, it explains variance in the provision of a wide range of public goods. Despite the power of this approach, we argue that it requires modification by further modeling the conditional effects of state capacity and time horizons, to the extent that the public good in question requires strong state capacity and long lead times to provide. As demonstrated in this article, doing so extends the empirical domain of application of selectorate theory without adding undue theoretical complexity. With respect to the pollutants we consider, our theory outperforms unmodified selectorate theory and receives empirical support from analyses of both sulfur dioxide and particulate pollutants. Simulation exercises demonstrate that core democracies—those with large winning coalitions, considerable state capacity, and high regime stability—should perform better in the medium and long term in relation to these two pollutants. This result matters a great deal to all those concerned with the debate about democracy, autocracy, and the environment.

Difference in the way that governments finance environmental regulation may also affect the incentives of the selectorate—and eventually of rulers. Selectorate theory assumes that taxation funds public goods provision. While the bulk of the costs of environmental regulation will eventually fall on citizens, much of these costs may not take the form of taxation. For instance, consumers paying a higher price for electricity because of air pollution regulation will not necessarily recognize what proportion of the price they pay results from regulation—they may not even know about the relevant legislation. Where costs to citizens mostly do not take the form of state taxes or charges—as in the case of air pollution—the political costs to rulers will be lower. Syste matically thinking about cost incidence would strengthen selectorate theory. While it will likely prove difficult to obtain comparable data on these factors across countries, we may still make headway by using variance over time within countries or by choosing a range of dependent variables which, on theoretical grounds, we can assume to differ across these dimensions.

Previous studies show that regime durability conditions the relationship between winning coalition size and public goods provisions. Along this line of research, this paper is the first study to modify selectorate theory to allow for both state capacity and time horizon. We feel justified in examining a relatively narrow range of public goods in depth, especially as environmental public goods have yet to receive significant attention in selectorate literature. However, future research should consider other types of public goods. In an online appendix of this paper, we test the modified selectorate theory on 15 types of public goods. We find that when we control for state capacity and regime duration, the original selectorate theory receives empirical support in 6 out of 15 public goods. Modified theory, on the other hand, receives support in 7 out 15 public goods. In 3 other public goods (human capital, health expenditures, and civil liberties), we find partial support for the modified theory: The conditional effect of regime duration is significant, but this is not the case for the conditional effect of state capacity. We emphasize the tentative nature of the previously mentioned comparison of test results between the original and the modified selectorate theory. Future works must consider more control variables for different types of public goods—as implied by potentially different political processes.

We also think that more will be required to establish that, for impure public goods, the relative costs of buying support compared to private transfers fall with coalition size. This will require simultaneous consideration of crowding and externalities, the technology of supply of the good concerned, and economies of scale in its provision (Sandler 1992). Selectorate theory could also consider the advantages to rulers of providing club goods—in joint supply but only to specific members of the selectorate to whom the ruler wants to grant access. For example, national parks in developing countries yield profits to elites through tourism at the cost of displacing poor peoples (Adams and Hutton 2007:154–155). Another possible area of inquiry involves the spatial targeting of public goods when key members of the selectorate reside in identifiable areas. For example, the Chinese government tends to clean up industrial air pollution where there is a significant local protest in

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34 We borrowed data on public goods from Bell (2011). These 15 indicators include education spending, education attainment, adult illiteracy, human capital, health expenditures, infant mortality, life expectancy, death rate, physicians, hospital beds, DPT immunity, measles immunity, welfare expenditures, civil rights, and political rights.

35 We tentatively conclude that the modified theory slightly outperforms the original selectorate theory. We think the lack of success of the modified theory in explaining public goods such as physicians and hospital beds might have to with the crowding effects associated with such public goods. In the case of physicians, some rulers have also drawn on supplies from abroad, as noted in the text. Because of space limit, we only briefly discussed these findings. The detailed results are presented in online Appendix S4.

36 Following earlier research that tests the selectorate theory on a variety of public goods (Bu eno de Mesquita et al. 2003; Clarke and Stone 2008; Morrow et al. 2008; Bell 2011), we ran OLS regressions and the basic model setup largely follows Bell (2011) as well as Morrow et al. (2008) by including population size (logged), GDP per capita (logged), polity score as control variables as well as fixed year and region effects.

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[^5]: These basic findings are robust to the further inclusion of regime type variables (see online Appendix S2) and to the exclusion of the Northern European countries such as Norway, Sweden, Denmark, and Finland (details results available upon request from authors).
important cities (Tilt 2007). Finally, coproduction of public and private goods (Sandler 1992) provides potential additional leverage to rulers by weakening the trade-off between supplying public and private benefits, for example, corrupt placement of contracts with cronies to build public roads (Kenny 2006). We conclude that selectorate theory provides much explanatory power. But it needs further refinement in order to expand the scope of its application. Modified selectorate theory provides a useful first step.

References


Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Public priorities between the environment and economic growth.

Appendix S2. Robustness checks controlling polity and regime types.

Appendix S3. Measuring ruler’s time horizons.

Appendix S4. Testing the generalizability of the modified selectorate theory.