UNIVERSITY OF CALIFORNIA, SAN DIEGO

Leviathan in the Tropics?
Environment, State Capacity, and Civil Conflict in the Developing World

A Dissertation submitted in partial satisfaction of the
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Political Science

by

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You can rack up a lot of debts in an eight-year graduate school experience—both figuratively and literally. And while Mastercard and Northstar Lending were unfailing in their readiness to underwrite my dalliances with the music industry and those lean summer months, I'm much more interested in thanking those individuals and organizations that have been instrumental in my development as a political scientist.

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ABSTRACT OF THE DISSERTATION

Leviathan in the Tropics?
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by

Cullen Stevenson Hendrix

Doctor of Philosophy in Political Science

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Professor Stephan Haggard, Co-chair
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I investigate the long term effects of the environment and geography on the capacity of states to generate revenue in the form of taxation and to deter violent, internal challenges to their authority. I argue that environmental and geographic factors affect the incentives for building a fiscal relationship between state and society. The theory casts the emergence of a fiscal contract as the outcome of bargaining between societal actors, who have a collective comparative advantage in the creation of wealth, and a ruler, who has a comparative advantage in coercion and provision of services. I argue that the

environmentally determined resource bases in the preindustrial era of state formation affected this bargaining environment. Where agricultural production was comparatively diffuse, as in temperate zones, the incentives were stronger, whereas when agricultural production was comparatively concentrated, as in tropical zones, the incentives were weaker. In addition, terrain affected the incentives to form a strong fiscal contract by affecting the transaction costs associated with policing any bargain between state and society. As the mountainousness of terrain increases, the fiscal contract is expected to be weaker.

The remainder of the dissertation sets about testing the broad implications of this theory for three empirical questions. First, I use data on 157 countries over the time period 1980-2002, to estimate the impacts of geography and climate on the tax/GDP ratio, finding both to be strong, robust covariates of the tax/GDP ratio. Second, I challenge the conventional discourse relating the environment and geography to civil conflict, arguing and demonstrating that the primary effect of geography on conflict is mediated by its effect on the strength of state institutions, operationalized as the fiscal contract. Using two-stage probit models, I demonstrate that the tax/GDP ratio, as instrumented by measures of climate and terrain, is robustly and negatively associated with civil conflict incidence. Third, I inform conjectures about the future of climate and conflict by estimating the impact of long term and short term sources of environmental variability on the onset of civil conflict in Sub-Saharan Africa.

Chapter One
Introduction

The broadest pattern of history - namely, the differences between human societies on different continents - seems to me to be attributable to differences among continental environments, not to biological differences among peoples themselves.
Jared Diamond, *Guns, Germs, and Steel*

1.1. Introduction

This dissertation investigates the long term effects of the environment and geography on the capacity of states to generate revenue in the form of taxation and to deter violent, internal challenges to their authority. I argue that environmental and geographic factors affect the incentives for building fiscal relationships between state and society. This insight focuses on environmental determinants of resource bases in the preindustrial era of state formation, and the effect of those resource bases on the incentives of states and societies to bargain over revenue and services. Thus the dissertation, in contributing a theory linking the environment and geography to bargaining between the sovereign and society, and testing this argument empirically, contributes to both the theoretical and empirical literatures on comparative state development.

Moreover, I argue that the primary effects of macro-level environmental and geographic factors on civil conflict are mediated by their effects on the capacity of state institutions, specifically, the ability to tax and the development of coercive power to enforce it. This insight is broadly in line with the demand side story common to war-driven arguments for state formation in early modern Europe, as well as opportunity models of civil conflict. Such arguments are linked conceptually but heretofore have

not been unified under a common theoretical framework, or subjected to tests that account adequately for the effects of the environment and geography on state capacity. As such, the dissertation makes valuable theoretical and empirical contributions to the study of the environment, geography, and conflict.

Though the origins, capabilities, and scope of the modern state are among the most studied topics in political science, sociology, and history, the link between the environment and state capacity has become a significant topic of concern only recently. In the past fifteen years, two ostensibly new, nontraditional threats to human security have emerged: failed states and global climate change. The first threat concerns the proliferation of states in which central governments have lost the capacity to provide basic services, up to and including the most basic, definitional service of the state: a monopoly on the legitimate use of physical force within its borders. Such states pose myriad threats to human security, both for their inhabitants, in the form of collapsed institutions of public health and public safety, and the international system, in the form of providing safe havens for transnational insurgent and extremist groups.

The second emerging threat concerns our rapidly changing environment. Global scale, human-forced climate change, perhaps the defining challenge of our time, is evidence that we can affect our environment in profound ways, to the extent of imperiling the sustainability of our way of life (IPCC 2007). The Independent Commission on Human Security identifies three sources of threats: consumption of fossil fuels and increased pollution in urban environments; land degradation due to overuse, erosion, and desertification; and the buildup of greenhouse gases that "threaten widespread climate change" (Commission on Human Security 2003, 17). Since the dawn of agriculture, but

rapidly accelerating in the industrial age, humanity has conducted an uncontrolled experiment in bending nature to fit human needs and desires. As we have become increasingly cognizant of the global consequences of our actions, a broad consensus is emerging that will require humans to adapt to protect the natural environment.

One point of debate within that consensus is whether climate change will lead to state failure in the future. The results of climate forecasting models indicate some of the most dramatic effects of climate change will be felt in precisely those areas least well-suited to mitigate their negative consequences: the failed, failing, and weak states of the developing world (IPCC 2007). Indicating that climate change is beginning to influence policy discussions, political figures such as former Commander-in-Chief of U.S. Central Command General Anthony Zini and British Foreign Minister Margaret Beckett have warned that climate change will alter patterns of access to fresh water, diminish agricultural productivity, and inundate low-lying coastal areas. These changes, they contend, will dramatically alter the capabilities of states to provide order and crucial public services to their populations, raising the specter of state failure. Moreover, as states and their resource bases fail to meet the needs of their populations, mass migrations may lead to renewed resource conflicts, causing both inter- and intrastate warfare (*National Security and the Threat of Climate Change* 2007, Reuveny 2007). Thus, global climate change may affect the capabilities of states relative to their own populations and to other states in the international system.

Though our awareness of the connection between the viability of human societies and the sustainability of our environment may be in its relative infancy (Diamond 2005), I argue that environmental and geographic factors have conditioned the institutional

development of the modern state. In particular, these factors affect its ability to tax the economic resources of the society it governs and deter violent, internal challenges to its authority—two capabilities that are part and parcel to state capacity. Radical differences between states like the Netherlands, the Democratic Republic of Congo, and Pakistan are partly attributable to their radically different physical environments in ways not captured by the extant literature on political and economic development.

Humans exhibit an incredible degree of flexibility in adapting to different systems of environmental constraints. Though some of these adaptations are genetic and phenotypic in nature (variation in skin pigmentation, eye shape, and incidence of sickle hemoglobin are but three clear examples), the overwhelming majority have been technological. By technology, I mean the collection of tools, systems, methods of organization, and techniques humans use to control and adapt to their environment.

I contend that the development of the modern state was a bargained solution to two specific problems. The first was resource extraction, which was necessary to fund early modern European monarchs' war making aims, but subject to a system of environmentally and geographically determined opportunities and constraints imposed by the largely agrarian, rural, cereal grain-producing societies of preindustrial Europe. The second was the provision of public goods, which were necessary for these societies to engage in economic activity. During the ensuing two centuries, colonialism, warfare and the diffusion of international markets brought state-like institutions to the rest of the world. However, the form and scope of these institutions was adapted in order to extract resources and provide services to very different resource bases and geographic realities. To the extent that the environmental and geographic attributes of a state departed from the

agricultural and topographical environment of early modern Europe, the form and capacity of that state diverged as well.

This is not to argue that environmental factors trump all other determinants of political and economic outcomes. The fallacy of such an argument is plainly visible, as Acemoglu, Johnson, and Robinson (2001) point out, when comparing the alternate economic and political trajectories of states like North and South Korea and East and West Germany, states characterized by similar geography and societies but with wildly divergent economic outcomes. Analyses that focus on institutional determinants, however, beg a significant question. Institutions, especially macro-level ones like the rule of law (Weingast 1997, Acemoglu, Johnson and Robinson 2001) and the development of state bureaucracies (Tilly 1992, Ertman 1997), must come from somewhere; they are contingent on the circumstances that attended their creation (Tilly 1984, Pierson 2000). If institutions are endogenous, the question becomes, to what? And, by extension, how?

I argue that environmental and geographic constraints have conditioned the development of the fiscal institutions we associate with the state. Environmental and geographic constraints have emerged as a significant part of the answer to many of the most basic questions in comparative political economy: Why are some countries rich and others poor (Gallup, Sachs, and Mellinger 1999, Acemoglu, Johnson, and Robinson 2001, Sachs and Malaney 2002, Sachs 2003, Rodrik, Subramanian, and Trebbi 2004, Hibbs and Olsson 2004, Olsson 2004)? Why are some countries relatively egalitarian and others massively unequal, both politically and economically (Engerman and Sokoloff 1997, Engerman and Sokoloff 2002)?

To this list, I add two empirical questions: Why do some countries turn a large

portion of private wealth into public resources via taxation, while others do not? Why do some countries experience low levels of internal violence, while others seem to have fallen into the "conflict trap" (Collier et al. 2003)? In answering these questions, I present evidence for the impacts of environmental and geographic factors on state capacity in three empirical chapters. First, I address the ability of the state to levy taxes. Second, I estimate the indirect effect of geography—as mediated through taxation—on the incidence of violent internal conflict. Finally, I address the effects of the environment and environmental change on the onset of civil conflict in Sub-Saharan Africa.

The remainder of the chapter proceeds as follows. Section two elaborates a fiscal-military definition of the state, and addresses my preferred measures of state capacity (the dependent variable) in theoretical terms before briefly addressing some preliminary patterns in the data. Section three previews the theoretical argument before answering some of the potential criticisms of geographically deterministic arguments, and addresses some terminological issues that arise in macro-institutional analysis. Section four discusses the competing operationalizations of geography used in the development literature, and presents my preferred operationalizations and some descriptive statistics. Finally, section five outlines the remainder of the dissertation, and concludes with some preliminary remarks on the relationship between human communities and the environment in a world undergoing rapid climate change.

1.2. The Dependent Variable: State Capacity

As an ideal-type, the state is a territorially-delimited coercive monopolist that

trades local public goods for revenue, which is itself an extension of the more traditional Weberian definition: "The state is a human community that (successfully) claims the monopoly of the legitimate use of force within a given territory" (Weber 1919, 212). This definition is broadly consistent with the microeconomic theory of the state, which holds that the state is a monopoly provider of certain goods and services in exchange for taxation (Lane 1979, North 1981, Bates and Lein 1985, Lake 1992, Timmons 2005).

By state capacity, I mean the degree to which the internationally recognized state is marked by:

1. A monopoly of coercive force with its territorially demarcated borders. I do not construe this characteristic to mean that state actors operate purely through coercion, but merely that the most basic good in which they trade is protection (Lake 1992).
2. The capacity to secure payment for the provision of public goods in the form of taxation. The stronger this fiscal relationship, the more capable the state (North 1981, Timmons 2005).

In focusing on the ability to tax and to deter violent domestic challenge to state authority, my definition is different from that which is common to the conflict literature, where the term state capacity typically means the ability, both potential and mobilized, of states to wage war (Singer and Small 1972, Singer, Bremer, and Stuckey 1972, Waltz 1979, Wayman, Singer, and Goertz 1983, Diehl 1983, Jones, Bremer, and Singer 1996, Powell 1999). For students of comparative political development, state capacity means the ability of states to provide domestic order (Huntington 1968, Skocpol 1979, Thomson 1995, O'Donnell 1996, Holsti 1996, Fearon and Laitin 2003, Walter 2006) and access the resources of the societies they govern, be those resources financial (North 1981, Bates and Lein 1985, Levi 1988, Kugler and Arbetman 1997, Organski 1997, Cheibub 1998, Fauvelle-Aymar 1999, Thies 2004, 2005) or human (Levi 1997). While the impetus for

accessing resources may be the waging of war, the outcome to be explained is the nature of the domestic state-society relationship, rather than the internationally-oriented military capacity of the state *per se*. It is in this branch of the literature that my definition is nested, though my theoretical argument, and empirical findings, have implications for the military capabilities of states as well.

A state is capable to the degree that it can provide the basic service of domestic order (via its effective monopoly on organized political violence) and secure payment from society, in the form of taxation, for the provision of said service. While this is clearly a more minimal definition than some scholars will be comfortable with, it is appealing for two main reasons.

First, the focus on domestic order and taxation is attractive in its universality. Whether mandated by society to provide simple basic infrastructure or an elaborate system of social insurance and public services, the maintenance of order and the generation of resources are the *sine qua non* of statehood. In light of the humanitarian and public health disasters that have attended instances of state failure in Somalia and Afghanistan, it is clear that the provision of public order is, to quote David Mayhew, "the goal that must be achieved over and over if other ends are to be entertained" (1974, 16).

Second, the emphasis on this more minimal definition of statehood sidesteps the complicated task of defining the state according to its market regulating functions (Libecap 1989, Barzel 2002) in an increasingly globalized marketplace. There is significant debate over the degree to which states have lost autonomy by virtue of the rise of global markets (Sassen (1996) and Kapstein (1996) say they have lost a great deal, Garrett (1998, 2005) says not quite so much). At this point it seems prudent to avoid

either position when developing a minimal definition of the state. All of these issues will be addressed at greater length in the next chapter.

My analysis focuses on two primary operationalizations of state capacity. The first, emanating from the fiscal contract theory of the state literature, is the ability of the state to secure payment for the provision of goods and services via taxation—the existence of a strong fiscal contract. My operationalization of choice is total tax share as a percentage of GDP, or the tax/GDP ratio. While some debate exists over the construct validity of this variable (for an insightful discussion, see Lieberman 2002), it is the most widely used measure of the ability of the state to extract resources from private actors, and facilitates the direct comparison of my results with the extant literature.

At the transition to the 21st century, there exist massive cross-country disparities in overall levels of taxation, even controlling for economic development. Among those countries with a GDP per capita of less than 500 USD, there is a striking difference between Moldova, in which taxation accounts for 26 percent of GDP, and the Democratic Republic of Congo, where it accounts for just 4.05 percent. Table 1.1 reports the standard measure of total tax effort, total taxes as a percentage of GDP, for the years 1980-2002. The data indicate that while the industrialized countries of Western Europe, North America, Oceania, and Japan pay, on average, almost a third of the countries' annual economic output in taxes, the countries of the developing world, especially Latin America, Asia, and Africa, pay less than a sixth. Chapter four discusses this operationalization in much greater detail.

Table 1.1. Total Taxes/GDP by World Region, 1980-2002 (non-zero reporting)
Data show large regional discrepancies in total tax effort. Data are from
the *World Bank Development Indicators*, 2005.

	Obs.	Mean Tax/GDP	Std. Dev.	Min	Max
Asia	309	14.09	5.06	2.54	27.37
Latin America & Caribbean	339	15.95	5.56	7.55	33.89
Sub-Saharan Africa	307	16.08	8.2	0.05	42.79
North Africa & Middle East	242	16.49	10.7	0.09	49.39
North America	66	16.63	2.34	11.71	20.26
Oceania	99	21.85	5.38	13.57	35.91
Eastern Europe	177	28.5	9.56	9.38	49.24
Western Europe	299	31.53	6.41	17.24	44.21

The second operationalization of state capacity, emanating from the Weberian tradition, is the ability of a state to deter violent challenge to its domestic authority. Two measures of violent domestic challenge are commonly used: that used by Fearon and Laitin (2003), and that developed by the Uppsala Conflict Data Project/International Peace Research Institute, Oslo (Gleditsch et al. 2002). Fearon and Laitin define insurgency as:

> 1. The presence of groups who sought either to take control of a government, take power in a region, or use violence to bring about a change in government policies.
> 2. A conflict that killed or has killed as least 1000 over its course, with a yearly average of at least 100.
> 3. At least 100 of the dead are on the side of the government (including civilians attacked by rebels) (2003, 76).

The UCDP/PRIO defines conflict as a violent incompatibility which concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths per year. For time series analysis of onset in chapter six, the variable is coded as "1" for all country-years in which civil conflict began and "0" for both non-events and continuing conflicts. Largely due to the lower casualty threshold and the fact that Fearon and Laitin

do not code conflicts as ended if there is even minimal activity in a country-year, the UCDP/PRIO coding includes many more conflicts, with onsets representing 1.7 percent of observations in Fearon and Laitin's data, but 7.35 using the UCDP/PRIO coding (from 1945-1999). For cross-sectional analysis of the incidence of conflict in chapter five, the variable is a dummy that has a value of 1 if the country experienced a civil war that began between 1970 and 2002, 0 otherwise. Conflicts occurred in 54.3 percent of states in the sample according to the UCDP/PRIO coding, but just 33.8 percent according to the Fearon and Laitin coding. Both codings will be used in order to check the robustness of my argument and analysis.

1.3. Geography, Bargaining, and The Fiscal Contract: A Preview of the Theory

1.3.1. Theory

In order to link geography and state capacity, we must look back in time to identify the context in which the modern state developed: the constant territorial wars of 14th, 15th, and 16th century Europe. The major conflicts of the era included the Hundred Years' War (1337-1453), the Anglo-Spanish War (1585-1604), and the Eighty Years' War (1568–1648), which ended in the Peace of Westphalia and the rise of the modern international system populated by territorially sovereign states.

Although scholars differ regarding the mechanisms through which warfare affected the state-building process, there is wide agreement that the technology and costs of warfare in Europe changed fundamentally in the 15th, 16th, and later 19th centuries. The

introduction of the crossbow and the development of mobile canonry diminished the utility of cavalry, precipitating a shift toward large, infantry-based armies (Downing 1992). Several centuries later, a revolution in transport technology centered on steamships and railroads increased the mobility of large armies and more advanced field artillery; a concurrent advance in communications (the telegraph) facilitated the central coordination of these large forces. While these advances increased the war making capacity of European monarchs, they carried extremely high costs, both purely economic (supplies, salaries) and in personnel (the move to standing, conscription- and volunteer-based armies) (Levi 1997).

Coercive models of state development (Tilly 1975, 1992, Downing 1992) address the demand for state institutions, arguing that increasing costs of warfare shaped the incentives of monarchs to develop institutions capable of extracting economic and human resources in order to remain competitive in a context of virtually constant warfare. Comparatively less attention has been given to the supply side of the equation: explaining why some states were more successful than others in meeting this increased demand via taxation and territorial consolidation of their rule.

Emanating from the bargaining analogy, I cast the emergence of the fiscal contract as a problem of delegation (Kiewiet and McCubbins 1991, Miller 1992, Weingast 1997, Lake and McCubbins 2006). A corporate principal, society, can choose to contract with an agent, the state, for the provision of public goods, in return for revenue, provided in the form of taxation. This revenue is payment above and beyond what the state, a specialist in coercion, can extract through coercive capture. I assume that both states and societies value autonomy. In the case of the state, this means simply that states will not

bargain with society unless compelled to by economic necessity. The contractual relationship curtails its autonomy as an actor; being reliant on society for revenue gives it pecuniary incentives to defer to their preferences in order to generate quasi-voluntary compliance, which occurs when individuals choose to comply with requests for revenue even when the probability of being punished for non-compliance is extremely low (Levi 1988). Quasi-voluntary compliance is more important the less feasible coercive capture is as a strategy for generating revenue.

From the state's perspective, incentives to enter a fiscal contract with society emanate from its demand for revenue, but more importantly from limitations on internal or coercive revenue generation. The demand for revenue can be assumed; for the state to exist, it must be able to generate resources to fund its bureaucratic and military apparatus. Less well understood are the factors that affect the ability of the state to monopolize economic resources or extract revenue from private actors in a coercive manner.

From society's perspective, incentives to enter into a fiscal contract with the state are a function of its demand for public goods, but also of coordination problems in self-provision. The provision of public goods is the canonical collective action problem: precisely because the goods are non-excludable, individuals have considerable incentives to free ride, leading to chronic underprovision (Olson 1965, Ostrom 1990). What must be identified are the circumstances under which society can be expected to overcome collective action problems without contracting to an outside agent.

A fundamental factor that affects both 1) limitations on the coercive power of the state and 2) the coordination problems faced by society in the production of public goods is the diffuseness of the economic resource base. Auty (2001) distinguishes between

point-source and diffuse resources. Point-source resources are resources that are geographically concentrated and typically exploited by capital- and labor-intense enterprises. Diffuse resources are those that are typically exploited by low capital- and labor-intense enterprises, and whose cultivation/exploitation takes place over comparatively large tracts of territory.

For the state, point-source resources are more easily monopolized or extracted coercively because of several factors relating to their geographic concentration. Diffuse resources, however, greatly enhance the costs of coercion, giving the state incentives to generate quasi-voluntary compliance. For society, the diffuseness of resources increases the costs of collective action in the self-provision of public goods, increasing the incentives to contract with an outside party. *Thus, resource diffusion is positively associated with the fiscal contract.*

Having incentives to enter into a Pareto-improving bargain is not a sufficient condition for the emergence of strong a strong fiscal contract. For any given distribution of bargaining strength and preferences, transaction costs affect the outcome. Transaction costs are those costs that arise from 1) information gathering, 2) bargaining, and 3) policing and enforcement costs. As these costs increase, the fiscal contract will become weaker. Mountainous terrain is significant for the fiscal contract because it increases the transaction costs associated with gather information, bargaining, and finally monitoring and enforcing cooperation. While there are factors that might affect the degree to which societies can overcome these difficulties—shared religion, culture, economic institutions like regional marketplaces—mountainous terrain has been demonstrated to exert an impact on the strength of these non-state institutions as well. *Thus, mountainous terrain*

is negatively associated with the fiscal contract.

In preindustrial times, the vast majority of humanity was involved in agriculture, with a small percentage involved in mining, craftsmanship, and trade, a trend that continued in many parts of the developing world until shockingly recently. Mining is the quintessential point-source resource, but it has agricultural analogs. Auty (1997) distinguishes between plantation and peasant agriculture. Plantation agriculture, such as the production of cotton, sugar, and other sub-tropical and tropical staples requires relatively large initial investments of capital and requires large, concentrated inputs of labor (1997, 653-4).

In contrast, the temperate, peasant-farmed, cold-season cereals of the tribe *Triticeae*, wheat, millet, barley, rye, and oats, did not exhibit scale economies in production until the introduction and widespread adoption of the thresher in the late 18th and early 19th centuries, which further decreased labor density. The former—plantation agriculture—approximates a point-source resource, the latter—peasant agriculture—a diffuse resource. The main tropical and sub-tropical staple grains, maize and rice, are characterized by low capital intensity, but comparatively high labor intensity, and have much higher yields per acre under cultivation and therefore can sustain much higher population densities (Pomeranz 2000). As such, I argue they are closer to the point-source end of the spectrum.

In the ensuing centuries, war, economic integration and colonialism brought state-like institutions to the rest of the world. In some places, such as the United States, Canada, New Zealand and Australia (the so-called "Neo-Europes" (Crosby 1986)), agroclimatic and geopolitical conditions favored the more-or-less faithful application of

the agrarian, cold-cereal grain-based economies and societies of North-West Europe, and the development of territorially sovereign states that would come to successfully enforce domestic order and levy taxes. In places where either colonial powers or local actors did not encounter the mixture of diffuse resource endowments and open terrain that characterized Europe, they were more likely to install rentier institutions that were less likely to raise significant resources from taxation. Moreover, because these state institutions were both costly to create and endowed important political and economic actors with incentives to perpetuate their existence, these large differences in state capacity persist in the modern era, even in the presence, of clearly Pareto-superior institutional frameworks.

This argument is similar to that of Acemoglu, Johnson, and Robinson (2001), who argue that the feasibility of European settlement, as measured by settler mortality, determined the institutional form of the colonial state. The principal differences in our arguments are two. First, my argument hinges on agroclimatically-determined factor endowments, for which data are more widely available (and less subject to debate about interpretation; see Albouy 2006). As such, the argument is more closely aligned with the factor endowment-based arguments of Engerman and Sokoloff (1997, 2002) and Shafer (1994). Second, looking at the state from the perspective of a general bargaining framework helps to explain why we would expect these patterns to be present in areas that did not fall under colonial rule during the past 500 years, which expands significantly on the generalizability of the environmental and geographic argument.

The argument is macro-historical and path dependent. Macro-historical analysis seeks to explain large, long term trends in political development, rather than offering a

detailed account for the development of a particular set of institutional arrangements. Such accounts necessarily sacrifice some conceptual precision for explanatory breadth. However, recent studies of the developmental impacts of colonialism have gone a long way towards rehabilitating the image of macro-analysis. The fact that current macroeconomic research (Acemoglu, Johnson, and Robinson 2001, Rodrik, Subramanian, and Trebbi 2004) is gravitating toward some of the same explanations prevalent in world systems theory (Wallerstein 1974) suggests that macro-foundational arguments can enrich our understanding of the observed disparities in state capacity between weak and strong states.

Path dependency, in this sense, holds that institutions of states that populate the current international system are in large part a function of the early institutions of those same states: that early moves in a particular developmental direction make subsequent moves in that direction more likely (Levi 1997, Pierson 2000). There are several reasons we might believe conditions during the early stages of state development would persist into the modern era. First, institutions have distributive consequences—especially those institutions that are geared toward turning private wealth into public resources. They create winners and losers, endowing actors with both incentives and asymmetric capabilities to perpetuate the status quo. Second, the costs of implementing institutional reforms are high, even in the presence of relatively widespread agreement about reforms' Pareto-superiority to current institutional arrangements (Fernandez and Rodrik 1991, Acemoglu and Robinson 2006).

1.3.2. Geographic Determinism and Institutional Analysis

Arguments driven by geographically determined resource endowments are almost uniquely suited to attacks from both the left and right flank. Critical theorists levy the charge that geographical arguments in the main tend to reify existing asymmetries of power, developing ex-post justifications and rationalizations for the dominance of Europe during the colonial and post-colonial periods (Sauer 1956, Sluyter 2001). Classical and neoclassical theorists, as well as new institutionalists, on the other hand, contend that human ingenuity and—more importantly—institutions trump the direct influence of biological and geographic realities on political, economic and social outcomes (Simon 1981, Acemoglu, Johnson, and Robinson 2001, Rodrik, Subramanian, and Trebbi 2004).

The former class of criticisms, especially those that assert geographic determinism is merely the old wine of Eurocentric racial superiority poured into in the new bottle of physical geography, is more easily refuted by newer contributions to this literature. Departing from the Eurocentric view of early works, Diamond (1997) addresses this potential threat to the validity of his argument by looking at variation in the complexity of societies that developed in the differing environmental and geographic contexts of Polynesian islands of various sizes and resource endowments. In doing so, Diamond demonstrates the effects of geography within a largely ethnically and culturally homogeneous population, in which factors like culture can be held constant.

Moreover, recent contributions to this literature (especially Acemoglu, Johnson, and Robinson 2001) are quick to point out that the types of institutions imposed during the colonial period varied not according to the ethnic composition and legal institutions

of the colonizing authority, but rather the disease environment of the colonized region itself. Maintaining an emphasis on physical geography as the main explanatory variable, rather than the culture or ideology of the people that inhabit it, helps avoid the pitfalls of assuming that the main differences between societies are a function of their innate attributes rather than the different environments they inhabit.

Addressing the latter class of criticisms, however, necessitates the broaching of two more vexing, fundamental questions: What do we mean when we talk about institutions? And from where do these institutions arise? The second question has been the topic of lengthy debate in the literature on comparative political development. Institutions—especially macro-concepts like the rule of law and property rights enforcement—are endogenous to existing distributions of political and economic power, and arise to formalize and routinize interactions between agents (Demsetz 1967, McCubbins, Noll and Weingast 1987, Knight 1992, Knack and Keefer 1995, Acemoglu and Robinson 2006). Taken from this perspective, the question quickly becomes: What determines existing distributions of political power? Institutions cannot provide the answer to that question because they cannot cause the circumstances that led to their creation.

Looking to physical geography as a determinant of institutions, instead of aspects of human civilization like norms of exchange and patterns of land tenure, solves two problems. First, it avoids the aforementioned problems of Eurocentrism, or the position that European peoples were uniquely suited to the development of the strong institutions associated with the modern state. Second, it helps to avoid the potential endogeneity problems that arise from taking culture as exogenous; i.e., assuming geography exerts no

effect on culture (see Diamond 1997).

The question regarding what we mean when we talk about institutions, however, speaks to an etymological ambiguity that confounds political science research. The term institution applies equally to nebulous, norm-based concepts such as the rule of law and constitutionalism (Weingast 1997) as it does to very specific institutions for aggregating preferences (electoral systems, voting rules) and routinizing relations between branches of government (the veto, bicameralism). I distinguish between institutions and institutional arrangements. Institutions are the basic foundations of political authority, such as the rule of law, the power to tax, and the separation of powers, and institutionalization reflects both 1) the degree to which political authority is exercised in accordance with publicly disclosed laws and adopted and enforced through established procedures, and 2) the degree to which rules and rights are applied impartially to all citizens (Montesquieu 1914, Weingast 1997). Institutional arrangements are those preference-aggregating mechanisms, decision rules, and rules of procedure that exist within an institution or between institutions in order to establish internal "rules of the game" (Shepsle 1979, Ostrom 1990, Boix 1999). Separation of powers is an institution; the veto, and its override, are institutional arrangements.

Whether we speak of institutions or institutional arrangements may explain the degree to which "institutions" writ large exert an independent effect on behavior, and whether they can be understood as plausibly exogenous to geography. When we speak of whether a polity is institutionalized or not, we rarely refer to the formula by which votes are translated into seat allocations in the national legislature. Rather, we usually mean whether or not there is wide acceptance and acknowledgment that the means by which

national offices are filled (be it the vote or not), are viewed as legitimate and, in the words of Guillermo O'Donnell, can plausibly claim to be the "the only game in town": the only proper means by which office can be gained (1996, 37). The argument I make in the dissertation is about institutions, rather than institutional arrangements.

An illustrative comparison may clarify the scope of my dissertation. It is not designed to explain how differences in the types of representative assemblies that arose in England and France in the 17th century led to representative government with checks and balances in one and despotism and diminished economic growth in the other, nor can it account for present differences in cabinet stability between the two. What it does, however, is explain why both countries, despite their institutional differences, are more similar to each other than to Jamaica and Haiti, two countries that share many of the formal institutions of their respective colonizers, but not their wealth, state capacity, and political stability.

1.4. The Independent Variable: Geography

My approach uses geographic factors to explain variation in the fiscal contract between states and society. Geography, as a foundation for causal arguments regarding variation in levels of economic development and institutions, is back, and in a big way. The causal arguments fall into one of two camps: those that argue for direct effects (in particular, Jeffrey Sachs and his associates), and those that argue the effect of geography is mediated by its effect on institutions (in particular, the rule of law). This debate has stimulated considerable research: between Sachs's work on geography and development

and the "institutions rule" camp presented in Table 1.2, this body of work has been cited 990 times, a staggering number for a literature that is less than ten years removed from its foundational works. Even more than the numbers indicate, the return of geography as a deep determinant calls into question the widespread belief that fundamental institutional change is a possible, laudable goal of development efforts (Knack and Keefer 1995, Tsebelis 2000, Henisz 2000, Freedom in the World 2005): if institutions are largely determined by exogenous, largely unchanging forces, what hope is there for meaningful reform?

Table 1.2. Competing Operationalizations of Geography in the
Long-Run Growth Literature[1]

Study	Institutions Variable	Geography Variable
Gallup, Sachs, and Mellinger (1999)	None	Temperate climate, access to navigable waterways
Sachs and Malaney (2002)	None	Malaria prevalence
Hall and Jones (1999)	Social infrastructure	Distance from equator
Acemoglu, Johnson, and Robinson (2001)	Expropriation Risk	Settler mortality
Acemoglu, Johnson, and Robinson (2005)	Const. on executive	Access to Atlantic
Easterly and Levine (2003)	KKZ indicator	Distance from equator, settler mortality
Rodrik, Subramanian, and Trebbi (2004)	KKZ indicator	Distance from equator, settler mortality
Olsson and Hibbs (2004)	PRSG risk measure	Biological and geological conditions

The main challenges of capturing the role of geography are two-fold. The first involves wading into a fairly tangled web of operationalizations and choices of instruments in order to make sense of the literature and identify causal mechanisms.

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1 KKZ is an abbreviation for Kaufmann, Kraay and Zoido-Lobaton, who issued the first versions of what would come to be known as the World Bank Governance Indicators.

Table 1.2 summarizes the geographic variables, which broadly speaking can be grouped into explanations hinging on the disease environment, the distance from the equator, and various measures of biological resource endowments. Competing causal mechanisms are present within each of these groupings, adding an additional layer of complexity that will be addressed at length in the following chapter.

The second challenge is that, because geography is essentially exogenous to human activity, it is a particularly enticing candidate for instrumental variables analysis. Table 1.2 summarizes also the choice of institutional variables for those who contend the effect of geography is mediated by its effect on institutions. In addition to a host of competing causal mechanisms, this branch of the literature raises substantive methodological issues emanating from the requirement that geographic effects be entirely captured by institutional effects; i.e., geography can exert no direct effect.

I focus on two primary operationalizations of geography. The first, climate scale, was developed by Hibbs and Olsson (2004) and measures the degree to which climatic conditions are favorable to annual, cold-cereal heavy grasses such as wheat, maize, oats, and millet. The variable is measured on a four point scale, ordered in ascending value: 1 for dry tropical (desert), 2 for wet tropical (rainforest), 3 for temperate humid subtropical and temperate continental, and 4 for dry, hot summers and wet winters.[2] This scale is based on the Köppen-Geiger climate system, which classifies climate according to average annual precipitation and temperature, and is calculated by summing these values weighted by the proportion of national territory falling within these categories. This is my primary operationalization of preindustrial resource diffuseness.

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2   The treatment of highland climate (Köppen-Geiger zone h) is somewhat problematic. Most analyses ascribe to highland climate the climatic conditions of surrounding, non-highland territory. This study follows that convention.

As noted in Table 1.3, the mean value in the full sample is 2.33 with a standard deviation of 0.99, bounded on the lower end by a host of desert countries such as Saudi Arabia and on the upper end by Ireland, Belgium, Greece, Portugal, Uruguay, and the Netherlands (4.0). In practice, this measure is similar to the temperate climate "ecozone" variable used by Gallup, Sachs, and Mellinger (1999), though its distribution is more normal and it provides a more nuanced operationalization of the core concept. The measure is highly correlated with the Food and Agriculture Organization's land suitability for rain-fed wheat agriculture variable ($r^2 = 0.67$), though the climate scale measure is preferred because several variables used in calculating the FAO measure are clearly endogenous to human activity.[3] It is virtually uncorrelated with land suitability for rain-fed maize and rice agriculture ($r^2 = -0.02$, $r^2 = -0.11$).[4] Higher values should be positively associated with state capacity.

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3   For instance, the FAO takes account of population, land degradation, land use and land cover
    (http://www.fao.org/ag/agl/agll/aez.stm).
4   This fact is attributable to the additive construction of the variable, which does not perfectly measure
    climate suitability for cold-season cereal, and maize and rice agriculture, as two ends of a continuum.
    Dropping climate scale values lower than 2.0 (i.e., values associated with desert climate) strengthens
    the negative correlation between climate scale and suitability for rice agriculture to $r^2 = -0.5$, suggesting
    that the confounding effect is due to the lower end of the distribution being dominated by countries that
    are largely unsuitable for rain-fed agriculture in general.

Table 1.3. Climate Scale by World Region
Climate scale variable based on data from, Hibbs, Jr., Douglas A., and
Ola Olsson, 2004. "Geography, biogeography, and why some countries
are rich and others are poor." *Proceedings of the National Academy of
Sciences* 101: 3715-3720.

	Countries	Mean	Std. Dev.	Min	Max
North Africa & Middle East	21	1.62	0.99	1	4
Sub-Saharan Africa	47	1.82	0.65	1	3.99
Asia	28	2.05	0.76	1	3.57
Latin America & Caribbean	33	2.09	0.4	1.41	4
Oceania	14	2.11	0.56	1.54	4
North America	3	2.26	0.76	1.41	2.87
Eastern Europe	22	3.22	0.93	1	4
Western Europe	24	3.87	0.32	2.87	4
TOTALS	192	2.33	0.99	1	4

Of the 34 countries that score 3.0 or above on the Climate Scale variable, 25 (26, counting Cyprus) are located in Europe. Of the remaining nine, four more (North and South Korea, Japan, and Taiwan) lay along the massive east-west Eurasian axis identified by Diamond (1997) as unique in its ability to facilitate economic and cultural development because of agglomeration effects and technological diffusion. Only Lesotho, Swaziland, New Zealand, and Uruguay, four countries comprised of roughly 10 million people, lay outside this axis. These represent a tiny minority of the territory and population of the non-Eurasian world. That said, it is interesting that countries like Australia, the United States, Canada, and South Africa, though not characterized by "fertile" climates according to this measure, were first colonized and inhabited by large numbers of Europeans in precisely the regions that most closely approximate the prevailing European climate: New South Wales and Victoria (Australia), the Eastern Seaboard (United States), the Great Lakes region (United States and Canada), and Cape Town and Johannesburg (South Africa).

As Table 1.3 makes clear, North Africa and the Middle East, a region dominated by the massive Sahara Desert, scores the lowest of all world regions: only Lebanon and Turkey score higher than 3.0 (4.0 and 3.27). The region is followed closely by Sub-Saharan Africa, which features large swaths of desert in its southern latitudes and tropical rainforests surrounding the Niger River and Delta and the Congo river basin. Asia, Latin America and the Caribbean, Oceania, and North America all cluster between 2.05 and 2.26. Given that the variable is constructed to capture the degree of agroclimatic similarity to that which prevails on the European peninsula, it should come as no surprise that Western and Eastern Europe score highly, with Western Europe's score somewhat diminished by the large arid regions that ring the Mediterranean Sea.

The second operationalization of geography I use is mountainous terrain. Unlike various direct and indirect measures of climate, discussions of mountainous terrain have been largely absent from the debate on state capacity and comparative institutional development. Olsson's (2004) excellent survey of the empirical literature linking geography and institutions unearthed only one study, Braudel's (1972) *The Mediterranean and the Mediterranean World in the Age of Philip II*, that discusses the role of mountains in state formation. This oversight is at odds with the literatures that emphasizes mountainous terrain as a significant covariate of intrastate conflict (Fearon and Laitin 2003, Hegre and Sambanis 2006) and its role in facilitating and sustaining peripheral nationalism (Cederman 2004), two subjects that will be addressed in chapter five.

Table 1.4. (Log) Mountainous Terrain by World Region
Data are from, Fearon, James D., and David D. Laitin, 2003. "Ethnicity, Insurgency, and Civil War." *American Political Science Review* 97 (1): 75-90.

	Obs.	Mean	Std. Dev.	Min	Max
Sub-Saharan Africa	30	1.57	1.47	0	4.42
Eastern Europe	22	1.8	1.39	0	4.12
Western Europe	15	1.83	1.62	0	4.28
Oceania	5	2.18	1.42	0.34	3.6
North Africa & Middle East	15	2.32	1.46	0	4.28
Asia	19	2.54	1.41	0	4.56
Latin America & Caribbean	20	2.81	1.14	0	4.07
North America	3	3.16	0.34	2.8	3.47
TOTALS	130	2.14	1.44	0	4.56

The primary operationalization of this concept is the log-transformed percentage of mountainous terrain (Table 1.4), which is taken from the Fearon and Laitin (2003) dataset on insurgency. The data were coded by A.J. Gerrard and filled in by Fearon and Laitin for a small subset of cases. The mean value is 2.14 with a standard deviation of 1.44, bounded on the lower end by a host of flat countries and on the upper end by Bhutan (4.56) and the mountain kingdom of Lesotho (4.42). From a regional perspective, Sub-Saharan Africa is the least mountainous, followed relatively closely by Eastern and Western Europe. The Americas straddle the massive American cordillera, a series of mountain ranges that stretch from the Brooks Range in Alaska through the Rockies to the Andes and Tierra del Fuego in Argentina, and are the most mountainous of world regions. If Asia is disaggregated, Central Asia (Pakistan, Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan) scores an impressive 3.74. This is my primary operationalization of terrain openness, which I argue should be negatively associated with state capacity

To be sure, boiling geography down to these components will invite criticism from proponents of competing operationalizations. In chapters two and three, it will

become clear how these two measures of the physical environment capture a great deal of what made Europe the specific bargaining context (temperate and somewhat flat) in which state-like institutions first took hold.

1.5. Outline of the Dissertation

The remainder of the dissertation proceeds as follows. Chapter two provides an introduction to the literatures on state capacity, the fiscal contract theory of the state, and the impact of geography on the developmental trajectories of states. Chapter three builds on this foundation, arguing that current differences in the capacity of states were determined historically by 1) the factor endowments facing states and societies during the period of state formation, and 2) the problems of bargaining over services and revenue in areas where traditional military forces have difficulty projecting power. The perspective of this chapter is both macro-historical and institutional. Institutions are not devised in a Rawlsian black box as Pareto-efficient means for assigning roles and rights within a political system. They are designed to reflect existing distributions of political and economic power—to mirror the constellation of forces present in the decision making environment in which they were created (McCubbins, Noll and Weingast 1987). Though institutions may be changed over time, their persistence can be explained by their creation of winners and losers, which endow winners with specific interests in maintaining the status quo (Acemoglu and Robinson 2006). This insight helps to explain institutional persistence despite the existence of seemingly Pareto-superior alternate institutional frameworks.

The remaining chapters set about testing the broad implications of this theory for three empirical questions. In chapter four (Taxation in the Tropics: A Fiscal Perspective on Geography and State Capacity), I address the massive cross-country disparities in the degree to which the state is able to access the economic resources of society via taxation. Using data on 157 countries over the time period 1980-2002, I estimate the impacts of geography and climate on the tax/GDP ratio. As predicted, climate scale is positively and strongly associated with the tax/GDP ratio, while mountainous terrain is negatively and strongly associated. Moreover, the relationship is quite robust and model independent, even in the presence of endogenous indicators typical of the taxation literature and dummy variables for geographic regions. Most striking, however, is that a simple model of total tax share as a function of climate and geography outperforms several more nuanced models in the extant literature.

In chapter five ("Head for the Hills!" or This Hard Land?) I challenge the conventional discourse relating the environment and geography to civil conflict. In the extant literature, the environment and geography are argued to affect conflict from a strategic and tactical perspective, in which rough terrain mitigates the numeric and resource advantages of state forces, thereby facilitating insurgency. I argue that, in emphasizing only direct, strategic and tactical effects, we are not casting our nets sufficiently widely. I argue that states, as fiscal-military institutions, are also products of their environment. In accordance with my theoretical model, I argue that the primary effect of geography on conflict may be indirect, mediated by its effect on the capacity of states against which insurgents rebel, rather than a direct, tactical and strategic effect. I then use two-stage probit models to estimate the indirect effect of geography on conflict

as mediated by the tax/GDP ratio. In the first stage, I use three instruments for the tax/GDP ratio: climate scale, which proxies resource diffuseness, the percentage of mountainous terrain, which proxies terrain penetrability, and finally the percent of land area in malarious zones (Gallup, Sachs, and Mellinger 1999), which controls for the potential confounding effect of disease environment. In the second stage, I estimate the effect of the instrumented taxation variable on the incidence of civil conflict from 1970-2002. Congruent with the findings of chapter four, I find a strong, robust first-order relationship between climate scale and mountainous terrain and the tax/GDP ratio, with the two instruments explaining 62.5 percent of the variance in the tax/GDP ratio.

More importantly, I find that, once properly instrumented, the tax/GDP ratio is strongly and negatively associated with the incidence of conflict: as taxation increases as a share of national economic output, conflict becomes less likely. This relationship holds even in the presence of the three most robust explanatory variables in the conflict literature: GDP per capita, the coherence of political institutions (Polity 2 squared), and reliance on oil exports. Moreover, once the climatic and geographic effects on state capacity are accounted for, the widely accepted explanatory variables do not affect the incidence of conflict, apart from their indirect effects on the tax/GDP ratio. In a like manner, the direct effect of geography on conflict disappears. Thus, I conclude that, at the state level of analysis, the environment and geography affect conflict incidence more by determining the capabilities of states that populate the international system than by affecting the physical, tactical environment in which potential insurgents operate.

In chapter six[5] (Trends and Triggers: Climate, Climate Change and Civil Conflict

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5 Chapter six is co-authored with Sarah M. Glaser. An abridged version appears in *Political Geography* (2007), 26 (6): 695-715.

in Sub-Saharan Africa), my co-author and I address the conventional wisdom relating climate change to conflict, which focuses on long term trends in temperature and precipitation that define climates and their subsequent impacts on access to renewable resources, from two complementary perspectives. First, the effects of climate change on the onset of conflict can be conceived of as 1) long term trends that may lead to a higher baseline probability of conflict, and 2) short term triggers that affect the interannual variability in that probability. We estimate the impacts of both long term trends (operationalized as climate suitability for cold-cereal grain-producing agriculture, land degradation, and freshwater availability per capita) and short term triggers (operationalized as the lagged percent change in annual rainfall) on the onset of civil conflict in Sub-Saharan Africa. We find that both operationalizations have a significant impact on the likelihood of conflict onset, even in the presence of controls typical of the conflict literature. An analysis of marginal effects leads us to conclude that interannual variability matters more than the specter of changes in overall climate that take place over long time periods.

Second, we assess the outlook for the future based on an analysis of simulated changes in precipitation means and variability by a general circulation model (GCM). Using forecast values for precipitation over the period 2000-2099, we find that total annual precipitation flux is expected to increase in western Africa and the Sahel while decreasing in southern Africa. Moreover, few significant trends are found in our measure of interannual variability throughout the region. These findings point to two conclusions. The first is that the future for Africa is not necessarily one defined by increasing interannual variability in rainfall, the most significant climatic variable in our analysis of

conflict onset. The second regards policy. Our findings suggest that reducing dependence on rainwater for agriculture may mitigate conflict, even as rainfall variability is not predicted to increase over time.

Chapter seven offers some concluding remarks about the relationship between the environment, geography, and state capacity. In addition to identifying and recapping the major findings of the project, the chapter offers some informed conjectures regarding the prospects for environmental factors affecting the composition of the state system in the future. I argue that conceptualizing short term environmental stresses as trigger mechanisms, rather than deep causes of conflict, will help political scientists identify the climatic factors that are most likely to tip precarious situations into open conflict.

These findings will no doubt be a source of consternation for many students of state development and political economy. Despite increasing evidence linking the future of human wellbeing to careful stewardship of our environment, many will be loathe to accept that the organization of human societies, and specifically their relationship with the state, could be so contingent on our physical environment. This is especially the case for those of us that populate the most economically developed societies, for whom the economic connections to the environment are not nearly as immediate as those of many of the inhabitants of the developing world. That geographic arguments augment and (in some cases) outperform more politically nuanced ones should stimulate renewed debate over the linkage between basic resource endowments and the developmental trajectory of the modern state.

Chapter Two
State Capacity, Fiscal Contracts, and Geography

2.1. Introduction

This dissertation lies at the intersection of three separate literatures. The first is the literature on the theory and measurement of the concept of state capacity. The second is the literature on the fiscal contract theory of the state. Finally, this project draws on the insights generated by the economics literature on the deep determinants of long-run economic and institutional development. The following three sections address each in detail. To preview, I argue that state capacity is most fruitfully understood as the ability to access and mobilize the resources of the society it governs—specifically, in the form of taxation. Moreover, this relationship is contractual and based on mutual benefits from trade, rather than some form of routinized theft or confiscation. Finally, I address the various causal arguments relating geographic factors, specifically climatic and topographic factors, to variation in the state-society relationship.

2.2. State Capacity

The first subsection addresses four prevailing conceptualizations of state capacity: state capacity as force, state capacity as bureaucratization, state capacity as institutional coherence, state capacity as institutional quality, and finally state capacity as extraction. Decisions about how to best operationalize the broad concept of state capacity are to a certain extent driven by the topics that different researchers are addressing, in addition to competing notions about what constitutes a strong state. I demonstrate that many of these

operationalizations are highly collinear, though several—particularly measures of extractive capacity and military size and expenditure—appear to be capturing different vectors of variance. To preview, I conclude that state capacity is best understood in terms of 1) a local monopoly of coercive force, rather than measures of military power, and 2) the capacity to secure payment for the provision of local public goods in the form of taxation, as these two capabilities are the *sine qua non* of statehood.

2.2.1. Ability to Wield Coercive Force

The first approach is to define state capacity according to the state's ability to deter or repel challenges to its authority with force, both domestically and abroad. This definition is consistent with the widely-accepted Weberian definition of the state: "The state is a human community that (successfully) claims the monopoly of the legitimate use of force within a given territory" (Weber 1919, 212), and is that which is typically utilized by students of interstate and intrastate conflict, as well as theorists of social revolutions and the nature of political order.

With respect to potential domestic challengers, Huntington (1968) contends that the defining characteristic of post-WWII states is the ability to secure domestic order while incorporating the newly enfranchised political actors created by the urbanization, increased literacy, and new interest groups empowered by economic modernization and development. Skocpol (1979) argues that domestic and international power are connected, and that an inability to successfully project military power in foreign wars can lead to breakdown in domestic state capacity, via their effect on the finances of the state,

elite divisions, and power vacuums.

Thomson (1995, 1996) contends that the defining element of sovereignty is the authority of the state to make rules and enforce them within its own territory, what she terms "policing" (1995, 214-216). This view contrasts with Weberian notions, which require the state to be unchallenged in the domestic use of force. Instead, Thomson argues that the state's authority entails the ability to define other forms of domestic coercive capacity as a-political, and the ability to delegate its coercive power to non-state actors. In a similar vein, O'Donnell (1996) defines state capacity according to the ability of state institutions to direct political office-seeking through accepted institutional channels. These channels may be democratic or autocratic, but the state's capacity is determined by whether these channels are the only legitimate mechanism for gaining office and wielding political power.

Finally, Holsti (1996) argues that the post-WWII environment is characterized not by wars between states but wars within states, and that this is the most significant threat to state capacity and sovereignty. Holsti argues that these wars are caused by endemic state weakness in the recently decolonized world, which itself was an outgrowth of the self-serving, extractive institutions European powers bequeathed on their former colonial possessions as the time of independence. Holsti's solution to this problem is to develop state capacity by increasing the state's legitimacy among fractured societal actors, though it is not immediately clear how this approach would be implemented.

Definitions of state capacity focus also on the ability of the state to wage war against external challengers. Waltz (1979) defines the international system as one organized along the principle of anarchy. In an anarchical system, the actors operate

armed with the knowledge that no controlling authority exists to guarantee their safety. Each actor is therefore responsible for pursuing its own interests and providing for its own security. While this need not be the only goal of the state, it is necessarily a precondition for the formulation and pursuit of any and all secondary goals.

Singer and Small (1972) and Singer, Bremer, and Stuckey (1972) were the first to quantify the various factors that affect the ability of states to wage external war, including population size and degree of urbanization, level of economic development, steel production and energy consumption, and finally the resources, both material and human, devoted to the military. Other than direct measures of military spending and personnel, however, the project does not address variation in the ability of states to access the material and economic resources. The Correlates of War (COW) project has been expanded and updated since (Wayman, Singer, and Goertz 1983, Diehl 1983, Jones, Bremer, and Singer 1996), and this definition of state capacity has been utilized with respect to domestic armed challengers by Walter (2006), who utilizes COW data on military personnel per capita and military spending as a percentage of GDP, with the logic being that states that have larger militaries and spend more on their militaries will be more effective at deterring violent challenge. However, both measures are highly likely to be endogenous to conflict or the anticipation thereof. Addressing internal conflict, Fearon and Laitin (2003) argue that state capacity is best captured by GDP per capita, which they argue is associated with stronger bureaucracies and a more capable law enforcement apparatus. This operationalization begs the question of whether these concepts, for which GDP per capita is merely a proxy, could be more precisely identified and measured.

While these studies have undoubtedly advanced the study of war and peace, they beg more fundamental questions about the underlying reasons why power, as measured by the above proxies, is unevenly distributed across members of the international system. Moreover, it is possible that military spending and personnel may be positively associated with conflict. If less capable states are unsuccessful at deterring challenges, they may expect to fight more domestic and international wars, and therefore have to spend more on military capability and employ larger armies. Thus, the relationship between state capacity and military expenditures could be the opposite of that generally posited in the literature.

2.2.2. Bureaucratization and Administrative Capacity

The second approach emanates from the political development literature, which holds that state capacity is best operationalized by professionalization of the bureaucracy. The canonical expression of bureaucratic professionalism as tantamount to state capacity draws also on Weber's (1919) "Politics as a Vocation," in which he argues that the defining feature of the state is not just its monopoly on the legitimate use of force, but also that this monopoly is vested in a rational-legal structure of authority that is organized in bureaucratic fashion and shielded from parochial, political influence.

This definition of state capacity is especially popular in the literature on the policy determinants of economic development. Haggard (1990), Wade (1992), and Evans (1994) all argue to a certain extent that bureaucratic professionalism and autonomy are necessary in order to 1) inform development policy, and 2) shield policy makers from

public response to politically unpopular yet collectively rational policy decisions. In this vein, Evans and Rauch (1999) and Rauch and Evans (2000) develop a scale based on expert assessments of meritocratic recruitment and advancement in state development agencies as a measure of state capacity. They contend that more meritocratic recruitment practices and better wages are indicative of stronger, more capable bureaucracies. Their meritocratic recruitment variable, however, provides only a static measure for 35 developing countries, and relates only to the bureaucracies directly involved in generating economic policy. The International Country Risk Guide offers a similar measure, quality of bureaucracy, that is based on expert assessments—a topic I will return to in section 2.1.4. Though admittedly not the question of interest in their students, these accounts do not address the fundamental causes of bureaucratic professionalization or autonomy, which may or may not be related to other concepts of state capacity.

2.2.3. Political Institutional Coherence

A third branch of the literature defines state capacity as the degree to which democratic and non-democratic features are intermingled in the political system. The most common measure used to capture institutional coherence is the POLITY index (Gurr 1974, Hegre et al. 2001, Marshall and Jaggers 2003). Hegre et al. (2001) argue that mixed regimes, or "anocracies", which are not fully-democratic but also not extremely repressive that are most likely to experience internal conflicts. The finding is that there is a parabolic, inverted-U shaped, relationship between continuous measures of democratic institutions and conflict.[6]

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6 The inverted-U shaped relationship was first demonstrated by Hibbs (1973), who found an inverted-U

This finding, with respect to operationalizations based on the Polity II data, may conflate the concepts of regime type and political consolidation. Gurr (1974) introduced the concept of anocracy, which encompasses values around 0 on the -10 (fully autocratic) to 10 (fully democratic) POLITY scale. Median values on a linear scale of authoritarianism and democracy should be those cases in which democratic and authoritarian political institutions are mixed. However, the definition of anocracy developed by Gurr says no such thing: the essential, defining characteristic of anocracy is the lack of centralized political power and institutionalization (1974, 1487), which captures a different vector of variance: level of political consolidation. Moreover, some variants of the Polity data (in particular, Polity2), impute 0 values for regime transitional periods. Because this coding imputes 0 values during periods of regime change, findings regarding institutional coherence based on this operationalization may receive support based purely on the strength of this coding decision.

Other operationalizations of institutional coherence include Fearon and Laitin's (2003) use of a dummy variable, anocracy, which takes of a value of 1 if the country-year POLITY score is between -5 and 5, and zero otherwise. Their findings confirm those of Hegre et al.: where instability and intermingling are high, violent challenge is more likely and state capacity is lowest; where intermingling is low and stability is high (i.e. strong democracies or non-democracies, stable political systems), violent challenge is less likely and state capacity is high.

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shaped relationship between industrialization and collective political protest, but not internal war. Later, Muller and Weede (1990) found an inverted-U relationship between government repression and political violence: political violence is most likely when states are neither powerful enough to engage in high levels of repression or accommodating enough to engage in low levels of repression. While these findings lend support to the inverted-U hypothesis, they do so with respect to industrialization and political repression, rather than institutions.

2.2.4. Legal Institutional Quality

A fourth branch of the literature defines state capacity according to the quality of institutions that govern economic exchange—in particular, the rule of law and property rights enforcement. This definition is a response to renewed interest in the institutional determinants of long-run economic growth. Haggard, McIntyre, and Tiede (2008) argue that legal institutions affect long-run growth through two distinct theoretical channels: 1) the effects of property rights on investment, and 2) the effects of contract enforcement on trade. The standard economic logic is that secure property rights are important because they give private actors incentives to invest in making their assets more productive, while contract enforcement is important because of the various time-inconsistency problems and potential for opportunism that attend trade, especially as that trade takes place over longer distances.

North and Thomas (1973) and North (1981) was the first to apply the logic of property rights enforcement to the question of state strength in early modern Europe, and revolves around constraining the ability of the state to act opportunistically, depriving its subjects of their property and thereby giving them a disincentive to invest productively. North and Weingast (1989) later explained the success of the British Empire over its continental competitors as a function of the British sovereign's institutional checks against expropriating subject wealth, which had the effect of massively increasing the amount of debt, and therefore capital, the sovereign could raise. Thus, the state capacity of England was a function of its superior property rights environment.

Building off these initial contributions, the economic growth literature offers

several competing measures designed to capture the quality of institutions governing property rights and trade. These measures typically require two conditions: first, that the laws of the country protect private property, and second, that the legal system of that country is effect in enforcing these rights. Virtually all of these measures are based on country expert evaluations or international investor perceptions of the rule of law. Thus, a state is capable to the extent that its legal institutions and mechanisms for enforcing legal rulings are perceived as efficacious by international observers.

The first is the Political Risk Services Group's International Country Risk Guide rule of law/law and order tradition indicator, which measures the strength and impartiality of legal system, and the degree of popular observance of the law. This measure is based on expert assessments of the preceding concepts, and is marketed to firms as a tool for assessing the risk of foreign direct investment. It has been used in the long-run growth literature by La Porta et al. (1999) and Djankov et al. (2003), who find that higher levels of rule of law are associated with greater economic development. A similar measure, the Heritage Foundation/Wall Street Journal security of property variable, measures the degree to which a country's laws protect private property rights and the degree to which the government enforces those laws, is used also by La Porta et al. and Djankov et al.

The state of the art in rule of law data is the recently released World Bank Governance Indicators[7] rule of law variable (Kaufmann, Kraay, and Mastruzzi 2007). The Governance Indicators are composite measures that draw on 311 constituent variables from 33 different sources and 30 different data-reporting organizations. Kaufmann, Kray, and Mastruzzi use an unobserved component model to aggregate the various measures (of which the ICRG and Heritage Foundation are two), weighted by the

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7   Data can be accessed at http://info.worldbank.org/governance/wgi2007/.

perceived reliability of each source (2007, 11). This measure is used by Easterly and Levine (2003).

Though these measures are all widely accepted and the subjects of voluminous literatures, their utility is limited by their coverage: data are available for a broad cross-section of countries (212 in the World Governance Indicators), but for relatively brief window of time. The time series with the longest coverage, the International Country Risk Guide, only offers coverage dating back to the 1980s; the Heritage Foundation and World Governance Indicators date only to 1996. In order to avoid the problems that attend a small time window of observation, Acemoglu, Johnson, and Robinson (2001), Glaeser et al. (2004), and Acemoglu and Johnson (2005) offer an alternate conceptualization of rule of law: constraints on the executive. In focusing on the institutional constraints on the exercise of executive authority, they offer a perspective that is potentially a more direct operationalization of the original concept addressed by North and Thomas (1973) and North and Weingast (1989). The measure, executive constraints, is present in various iterations of the Polity data, and measures the extent to which executives are constrained by checks and balances, be they institutional or societal.

2.2.5. Extractive Capacity

Finally, a fifth branch of the literature addresses the impact of economic factors on state capacity, particularly the capacity of states to capture the economic resources of the societies they govern (Organski and Kugler 1981, Arbetman and Kugler 1995, Organski 1997, Feng, Kugler, and Zak 2000, Thies 2004, 2005, 2007) and the effects of military

competition on the development of extractive institutions in the early modern period (Tilly 1975, Downing 1992). Organski and Kugler begin by offering a corrective to the Correlates of War perspective on state capacity: state capacity is not best conceptualized as national economic output, but the ability of the state to turn that output into state revenue.

Arbetman and Kugler (1995) and Feng, Kugler, and Zack (2000) estimate this extractive capacity, called relative political capacity, as the ratio of expected tax revenue to the expected tax revenue, which is estimated as a function of the structure, size, and social spending in the national economy.[8] As will be discussed in the context of operationalizing the concept of the fiscal contract, this measure assumes that revenue extraction from the mining and agriculture sector takes the form of taxation, and therefore is an imperfect measure of revenue extraction, though it may more accurately capture the extent to which the state can generate revenue in the form of taxation by making use of convenient tax handles (Musgrave 1959).

Bellicist theories of state development cast state capacity in similar terms. Bellicists contend that revenue demands generated by these increasing costs of warfare shaped the demand for political institutions capable of extracting the resources necessary to remain competitive in a context of virtually constant warfare. These arguments draw on a mixture of structural-functionalist and evolutionary (Krasner 1984, Alchian 1950) theoretical analogies, in which warfare necessitates the extraction of resources and provides the disciplining mechanism necessary to select out forms of resource extraction and mobilization that are not competitive (Tilly 1975, 1992). More recently, Thies (2004,

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8   Tax/GDP = $\beta 0 + \beta 1$ (time) + $\beta 2$ (Real GDP in constant 2000 dollars) + $\beta 3$ (GDP from Mining /GDP) + $\beta 4$ (GDP from Exports/GDP) + (Health Expenditures/GDP) + ϵ (Feng, Kugler, and Zack 2000).

2005, 2007) has extended the bellicist argument to describing the process of state-building, viewed through the lens of extractive capacity, in the post-colonial developing world and Latin America. Looking variously at Latin America, Central America, and Sub-Saharan Africa, he finds that both inter- and intra-state rivalry and military challenges cause developing states to increase their extraction of revenue, measured as the total tax/GDP ratio.

2.2.6. Different Measures, Same Difference?

This literature review identifies thirteen operationalizations of the concept of state capacity. However, it is an open question whether these various measures are measuring different concepts. Table 2.1 reports the results of factor analysis on the nine competing operationalizations of state capacity addressed in the literature review, with three (Evans and Rauch's meritocratic recruiting variable, plus two other rule of law variables which are the principal components of the WGI *Rule of Law* variable) operationalizations being excluded from analysis. Factor analysis explains variability among the observed variables in terms of fewer unobserved factors, and subsequently reports the observed variables as linear functions of the unobserved factors and error terms. As such, it is well suited to assessing whether the various measures of state capacity are indeed capturing a single vector of variance.

The analysis indicates that variance in the nine remaining operationalizations is adequately captured by three underlying factors. Factor analysis also returns uniqueness values for each variable, which is the proportion of the variance of the variable not

associated with the estimated underlying factors. Higher uniqueness values, therefore, indicate that the variable is capturing a more distinct vector of variance relative to other variables in the model. The most unique operationalization among the nine is the Polity IV *Executive Constraints* variable, with the measures of military capacity being the second-most unique. Relative Political Capacity emerges as a unique source of variation as well, though this likely due to the fact that two of its principal components, GDP per capita and taxes/GDP, are included in its construction; thereby netting out their effects.

Table 2.1. Cross-Sectional Factor Analysis, Operationalizations of State Capacity

The literature review identifies thirteen competing operationalizations of state capacity, four of which were dropped due to the fact that they were constituent measures of another, broader measure. Factor analysis indicates that most of the variance in these twelve variables can be explained by three factors, and that the most unique operationalizations are those revolving around wealth, military capacity, and tax capacity.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	4.12	3.01	0.75	0.79
Factor 2	1.12	0.62	0.2	0.95
Factor 3	0.5	0.33	0.09	1.04

LR test: independent vs. saturated: chi2(78) = 374.46 Prob>chi2 = 0.0000

N	85

Factor Loadings and Unique Variances

Variable	Factor 1	Factor 2	Factor 3	Uniqueness
GDP per capita	0.92	0.12	-0.04	0.09
Military personnel per capita	0.29	0.59	0.29	0.48
Military expenditure per capita	0.1	0.56	0.31	0.57
Quality of governance (ICRG)	0.95	0.04	-0.11	0.06
Polity 2 squared	0.78	0.07	-0.18	0.32
Rule of law (WGI)	0.96	0.03	-0.1	0.05
Executive constraints (Polity III)	0.3	0.01	-0.14	0.79
Relative political capacity	0.3	-0.51	0.44	0.45
Taxes/GDP	0.76	-0.42	0.22	0.2

Interestingly, even after the competing operationalizations of rule of law are dropped from the analysis, rule of law does not appear distinct from the vector of variance

associated with GDP per capita. This affirms the position of the new literature on institutional determinants of economic growth, which identifies a significant problem of endogeneity between the two.

In light of this analysis, I broach two generalizations that will guide the subsequent discussion. First, state capacity is best conceived of as the ability of the state to defend itself against internal and external challengers—but not necessarily as evidenced by the size or technological sophistication of the military. Because of the potential endogeneity of higher military capacity to inter- and intrastate conflict, I choose to focus instead on the incidence of actual conflict. Though states may pursue other aims, maintaining coercive power is the aim that must be satisfied over and over if other ends are to be entertained. While this is a minimal definition, is it attractive for its universality and, therefore, because it facilitates comparison across cases and within cases over time.

Second, in order to maintain coercive power, the state must be able to access the economic resources of the society it governs. As will be developed in the next section, states are generally assumed to be incapable of generating revenue internally. Without resources, the state cannot invest in the coercive power necessary to defend itself from internal and external challenges. This is because state agents that specialize in violence consume resources but do not otherwise engage in economically-productive activity.[9]

A state is capable, therefore, to the degree that it can provide the basic service of domestic order (via its effective monopoly on organized political violence) and secure payment from society, in the form of taxation, for the provision of said service. The next section builds a clear link between the state's specialization in coercion, its fiscal

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9   The microeconomic theory of the state, in which specialization in violence is a service that the state
    trades for revenue, contains an obvious theoretical challenge to this position.

incentives to provide services to society, and sets up a challenge to the conventional political economy of the state-society relationship.

2.3. The Fiscal Contract, and Deviations Therefrom

The fiscal contract theory of the state holds that if states are beholden to their citizens for revenue, they face economic incentives to defer to those citizen's policy preferences. Variously formulated, it is a contingent exchange relationship between state and society that arises because of an asymmetry of resources and coercive power between society, which has a comparative advantage in economic activity, and the state, which has a comparative advantage in coercion (Lane 1979, Bates and Lien 1985, Levi 1988, 1997, Lake 1992, Timmons 2005).

According to the fiscal contract theory, states essentially have two options for generating tax compliance: they can rely on and invest in monitoring systems and coercive means to punish non-payers, or they can defer to citizen preferences and provide public goods in order to generate quasi-voluntary compliance. In practice, all states do some mixture of the two; no state exists without a coercive apparatus for extracting revenue and no state, even the most poor, exists without providing some basic public goods. The fiscal theory of the state helps us answer the question of what determines the relative weights assigned to punishments and inducements as a revenue-generating strategy.

In his seminal analysis of the political economy of protection and violence, Lane (1979) makes the distinction between a business, the state, which uses its comparative

advantage in the production of violence to regulate violence and produce protection, and other businesses that produce other goods and services, and pay the state for protection. Because the provision of protection requires the elimination of competing specialists in violence, the state becomes a monopoly local provider of protection, though because of protection's local non-excludability and non-rivalry, it does not act as a discriminating monopolist. For Lane, this situation is mutually beneficial, allowing states to generate monopoly rents—revenue greater than the cost of providing protection—and spurring private economic development in two ways. First, protection is a necessary condition for other businesses to invest in upgrading their productive capacity. Second, monopoly rents produce greater consumption within the economy by state actors, whom he conceives of as a military elite. In this version of the fiscal state theory, there is no perceived need for states to use coercion to exact payment: the mutual benefits of the trade are self-evident and there is no incentive incompatibility.

Subsequent contributions to the fiscal contract literature address the problem of compliance that results from the main output of the state—protection—being a public good. Because the primary output of the state is a public good, private economic actors have significant incentives to free ride, enjoying the services without paying for their provision.

Bates and Lien (1985) focus on asset mobility as the key determinant of society's bargaining leverage. The 14th-century introduction of taxes on trade and movables—oxen, grain, household goods, and other possessions that could be moved and therefore hidden—by Edward I in England was the key moment. Because these taxes could integrate many more actors into the fiscal life of the kingdom, they were potentially

highly lucrative. Because the assets were mobile and therefore concealable, however, taxation could be relatively easily avoided. Precisely because the costs of monitoring and enforcing compliance with taxation increased dramatically, monarchs could no longer expect to exact compliance merely through threats of coercion. This development led both to representative institutions, to facilitate bargaining over revenue, and increased incentives for the sovereign to defer to the policy preferences of the citizenry.

McGuire and Olson (1996) arrive at a similar conclusion, though the theoretical mechanism is different. They model the ruler as a stationary bandit facing no threat of removal from office and, consequently, an infinite time horizon and a populace with no asset mobility. As assets are not mobile, tax compliance is in no sense voluntary; therefore, the ruler has no incentive to deviate from a coercive equilibrium. Considering the provision of public goods as a collective action problem, it is the ruler's position as residual claimant to overall wealth (in the form of taxes) the ruler will have an encompassing interest in maximizing the wealth of their population through the provision of market-reinforcing public goods.

Similarly, Levi (1988) regards the taxation and public goods provision as essentially a fiscal contract between the state, which enjoys economies of scale in the production of public goods, and a population. However, Levi's analysis differs in two important ways. The first regards the problem of agency losses, or the possibility that citizens pay taxes but the state does not provide the expected outputs. However, this potential is symmetric, as the collective provision of public benefits through taxation is subject to free riding in the form of tax evasion and underpayment. The second regards the fact that Levi views the coercive collection of taxes as economically untenable; as the

size of the population grows, directly monitoring tax compliance and punishing evasive behavior becomes prohibitively expensive. As such, the state will invest resources in establishing norms of quasi-voluntary compliance by providing desired policy outputs in the form of public goods and investing in a coercive apparatus to deter those individuals that do not comply voluntarily. In practice, Levi finds that most individuals comply when they believe their taxes are funding positive policy outcomes.

Timmons (2005) uses the iterated prisoner's dilemma (IPD) framework to explain the existence of—and convergence to—a cooperative equilibrium using nothing more than simple assumptions about the costs associated with states trying to confiscate revenue by force. Because coercion is costly and those costs rise exponentially with increasing population size, states have incentives to supply public services in exchange for revenue. Timmons draws on the tax morale literature (Alm, McClelland and Schulze, 1992, 1999; Alm, Sanchez and DeJuan, 1995, Andreoni, Erard and Feinstein, 1998, Posner, 2000, Torgler, 2002) in order to solve the apparent free-rider problem, which indicates that individuals within society comply because they value the goods and services their taxes finance. Thus, states operate as fiscal contracts, using different tax instruments to tax different groups within society at different rates and providing them with different public services. To wit, he finds that levels of regressive taxation (targeted at the poor) are associated with better basic social outcomes—among them, infant mortality—while levels of progressive taxation (targeted at the rich) are associated with property rights protections, as measured by the sanctity of contracts, private property, and the transparency and impartiality of judicial proceedings.

There are two main problems with the extant fiscal contract literature. The first is

that despite the use of the bargaining framework for understanding the fiscal theory of the state, this literature is largely silent on the role of transaction costs in affecting the bargained outcome. Transaction costs are those costs associated with 1) information gathering, 2) bargaining, and 3) policing and enforcement costs when two parties attempt to contract with one another. The central insight of the transaction costs literature is that mounting transaction costs can prevent otherwise Pareto-improving bargains from being struck, diminish the extent of contracting and reducing potential gains from trade (Coase 1960, Williamson 1979). Thus, mutual perception of gains from trade is a necessary, but not sufficient, condition for the emergence of the fiscal contract. Any theory of the fiscal relationship between state and society must take into account the nature of transaction costs and their effect on the bargaining environment.

The second is that while the preceding discussion focuses attention on the state's demand for revenue, it does not in the main concern itself with the reasons why states would need to extract resources from the societies they govern. The bellicist theory of state development offers a clear answer: "war made the state, and the state made war" (Tilly 1975, 47). This perspective presumes, however, that states have no other means of financing their growing bureaucratic and security apparatuses. The literature on rentier states (Chaudhry 1989, Shafer 1994, Karl 1997, Ross 1999) addresses the political and institutional effects of state dependence on the extractive exploitation of mined commodities. Oil producing countries, for instance, tend to have weaker state apparatuses than their income levels would predict because rulers have less need to access the resources of society in order to generate revenue (Chaudhry 1989, Karl 1997). Ross (1999) demonstrates that oil hinders the development of democracy via this mechanism:

because representative institutions arise in order to routinize bargaining between the state and society (Tilly 1975, Bates and Lien 1985) over services and revenue, states that do not need to bargain with society over revenue because of mineral wealth are less democratic.

This fiscal contract literature is informed by the historical processes of state formation in early modern Europe (Tilly 1975, Bates and Lien 1985, Downing 1992, Root 1994, Ertman 1997). While there was significant variation in the institutional form that these states adopted--absolutist, patrimonial monarchies in some cases, (France, Spain) bureaucratic, constitutional monarchies (Britain, Sweden) in others—the form of these early modern states all followed the function of extracting resources from a preindustrial, overwhelmingly agrarian society whose main products were wheat, millet, barley, rye, and oats: the cold-season heavy grasses of the tribe *Triticeae*, which are particularly well-suited to North-West Europe's temperate climate. The economic context was not one of comparative wealth—North-West Europe at the time was roughly equal to the rest of the world in per capita economic output (Maddison 2001)—but rather one of comparatively low yet consistent population density. Moreover, populations were once again increasing, following the massive die-offs of the Black Plague. Population growth increased the value of agricultural commodities, particularly staple grains, and increased the value of agricultural land (Goldstone 1991, Albala 2003).

The main implications of such an economic context were two. First, it provided an incentive for early modern monarchs to extend their rule beyond centers of dense population to incorporate vast areas of increasingly valuable cultivated—and therefore taxable—land in the more sparsely populated countryside. As taxation was expanded to

include ever smaller and more numerous economic actors, sovereigns allowed democratic institutions to arise that would give the citizenry increased control over how its resources were spent. Second, the grassy, relatively flat countryside of North-West Europe provided relatively open terrain that was ideally suited for the projection of coercive power by conventional military forces. Thus, taxation and military power came to be viewed as synonymous with the state. However, this theoretical literature linking states and societies via reciprocal economic exchange is derived from a small subset of cases restricted to a very specific geographic context. The next section, on geography and long-run development, raises questions about the applicability of this theoretical model in areas characterized by different geography.

2.4. Geography and Development

The literature linking geography to development is divisible into two competing camps of causality: those that argue for direct effects, primarily via the effect of geography on agricultural productivity, the disease environment, and trade, and those that that argue the effect of geography is indirect, mediated by its effect on political and economic institutions—in particular, the rule of law and property rights delineation and enforcement. As an explanatory variable, geography is most laudable for being as plausibly exogenous a factor to human activity as a social scientist can hope to encounter. For this reason, it is particularly amenable to instrumental variables analysis. Its chief difficulties lay not in its plausibility as a factor conditioning human development, but rather in identifying 1) what the important geographic factors are, and 2) the pathways via

which it exerts its primary influence.

The arguments for the direct effect of geography revolve around initial biological endowments, the disease environment, and transportation costs. Diamond (1997) has argued that the timing of the transition from hunter-gatherer societies to sedentary, agricultural societies has had an immense impact on present-day levels of economic development. He argues that the human populations of Eurasia benefited from a large expanse of territory lying along the east-west axis, thereby positioning Eurasian peoples to benefit from agglomeration effects and technological diffusion. Olsson and Hibbs (2004) use data on prehistoric, initial biological endowments and the timing of transition to agriculture to estimate present day levels of wealth, finding that areas with appropriate endowments of domesticable plant and animal life are indeed more wealthy than those with less accommodating biological endowments, even in the presence of controls for institutional quality. The argument is that these societies transitioned to sedentary agriculture at an earlier time, and thus had a "head start" on the accumulation of technology and capital.

In addition to these initial endowments arguments, others focus on the present-day limitations that geography places on development. Gallup, Sachs and Mellinger (1999) have demonstrated that geography affects long- run economic growth by influencing agricultural productivity, access to markets and human capital formation. They estimate that tropical agriculture suffered from a productivity gap of up to 50 percent compared with agriculture in more temperate zones. The mechanisms linking tropical climates to lower agricultural productivity are nutrient-deficient soil, which is unsuitable for large-scale, heavy grass agriculture. Secondarily, they argue that geography, specifically lack

of access to navigable waterways, reduces economic productivity by increasing the costs of transshipment of goods. Finally, they argue that the disease burden faced in tropical climates discourages investment in human capital formation, leading to lower worker productivity.

Sachs and Malaney (2002) explore the economic effects of the increased tropical disease burden in great detail. They outline five main causal channels by which malaria, one of the most burdensome of tropical diseases, effects economic growth: 1) increased fertility, due to expectations of increased infant and child mortality, 2) reduced investment per capita in education and human capital formation, 3) decreased rates of saving and investment due to increased expenditure on health care, 4) lower worker productivity due to decreased physical capacity and lost time, 5) premature mortality (2002, 682-684).

The literature on present, direct effects of geography on economic development are juxtaposed against a literature linking geography to ecoomic development via its impact on institutions. Theories linking geography and climate to political institutions date back to Aristotle and Montesquieu's *Spirit of Laws*. Olsson (2005) presents an excellent review of the theoretical and empirical literature linking geography to institutions. What follows in a brief review of the most influential works in the field.

Engerman and Sokoloff (1997, 2002) emphasize the negative consequences for institutional development of certain geographically determined factor endowments that engender extremely unequal resource distribution. Specifically, they argue that the suitability of the Caribbean climate and soil to plantation-based cultivation of valuable luxury crops such as sugar and coffee led to the massive importation of slaves and the development of institutions that facilitated the concentration of wealth and political

influence. In contrast, the climate of the North American colonies (or rather, the Northern North American colonies—the American South was characterized by large slave populations and significant plantation agriculture) did not facilitate plantation-style agriculture, and therefore led to more equitable distribution of land and legal institutions that would come to help spur economic development.

This argument parallels the literature linking the development of state institutions (and subsequently state weakness or stability) to the economic interests and institutional development created by certain factor endowments and modes of economic production (Moore 1966, Skocpol 1979, Shafer 1994, Karl 1997). In these accounts, state institutions and policy are treated as endogenous to a specific set of demands dictated by prevailing modes of production. Shafer argues the nature of the resource, and its implications for patterns of ownership and political influence, affect the ability of state institutions to enact structural adjustment policies. In the cases of Zambia (copper) and Sri Lanka (tea, a plantation crop), the capital intensity and economies of scale of the leading sectors led to their economies being dominated by a small number of politically and economically influential producers (and, in the Zambian case, influential labor unions), who were able to stop efforts at economic reform. In contrast, Costa Rica (family-farmed coffee) and Korea (light manufacturing), low capital intensity and minor economies of scale produced an economy with a large number of small producers who were less able to block structural adjustment and subsequent economic growth.

Hall and Jones (1999) were among the first to use geography as an instrument for institutional quality. They observe that absolute distance of a country centroid from the equator in latitude degrees is positively and strongly associated with institutional quality,

and affects economic output per worker via this mechanism. Their explanation for this finding hinges on the suitability of environments at higher latitudes for Western settlement, and via that mechanism, the diffusion of Western values such as checks and balances, property rights protection, and the economic philosophy of Adam Smith (Hall and Jones 1999, 100). Their approach is agnostic as to the factors that made countries at higher latitudes more suited to European settlement. Moreover, their argument fails to account for why these institutions failed to take root in more tropical areas that fell under Western European control.

Choices about the way that geography is operationalized reflect theoretical arguments about how geography affects economic development. Acemoglu, Johnson and Robinson (2001) and Rodrik, Subramanian and Trebbi (2004) affirm the position of Hall and Jones, arguing that geography has a strong indirect effect on economic growth by influencing the quality of political institutions. However, they provide a more nuanced explanation for the relationship between patterns of European colonization and institutional quality. Their argument hinges on the effects of settler[10] mortality rates on the types of political and legal institutions that developed. Where geographic conditions approximated those in continental Europe, European settlers were more likely to arrive in large numbers and demand European-like institutions, with protections on private property and checks and balances against government expropriation. Where geographic conditions did not sustain large settler populations, extractive (and therefore non-capital forming) institutions were likely to be put in place, and help explain current levels of economic development. Easterly and Levine (2003) confirm the findings of the

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10 Though the term "settler mortality" is used by the various researchers, the data are derived in large part from mortality rates of soldiers and priests in newly colonized territories, rather than settlers, who would presumably arrive later.

"institutions rule" literature, demonstrating that three different operationalizations of geography: the disease environment, tropical environment, and certain types of crops and minerals (the exploitation of which is in part geographically determined) are all significant determinants of current levels of economic development.

Acemoglu, Johnson, and Robinson (2005) add a second stage of institutional development to their colonial story, arguing that the economic rise of Europe was fueled not just by colonialism, but by the effect of Atlantic trade on property rights institutions in countries with preexisting checks on the power of monarchs. These checks limited the ability of monarchs to monopolize Atlantic trade, thereby spurring private economic development. Their argument suggests that certain initial institutions may spur further institutional development, suggesting a degree of institutional path dependency (Levi 1997, Pierson 2000).

Within the "institutions rule" camp, there are significant differences regarding the specific mechanism by which geography exerts an effect on institutions. For Acemoglu, Johnson and Robinson, the link is the disease environment. Their argument is agnostic about the types of resources colonizers encountered. What is key is that the disease environment made the exploitation of these economic resources by large populations of European settlers infeasible. In contrast, Engerman and Sokoloff argue that geography determined colonial institutions via its impact on factor endowments. Their position is strengthened by the literature on the development of property rights (Demsetz 1968, Libecap 1989, Ostrom 1990), which suggests that factors relating to a resource's production function determine the types of property rights that develop around it.

This chapter discusses the theoretical and empirical literatures on state capacity, the fiscal contract theory of the state, and the impact of geography on long-run economic development. It argues that state capacity is best understood as the ability to 1) deter violent internal challenges to its authority, and 2) access and mobilize the resources of the society it governs—specifically, in the form of taxation. Moreover, this relationship is contractual and based on mutual benefits from trade, rather than some form of routinized theft or confiscation, though certain factor endowments may allow states to depart from this cooperative equilibrium. Finally, it demonstrates that geographic factors, specifically climatic factors, have emerged as a significant potential source of variation the developmental trajectory of the state-society relationship.

These arguments beg two fundamental questions. First, if the strength of the fiscal relationship between state and society is contingent on the distribution of economic resources within society, what determines that distribution? Second, contingent on the distribution of resources establishing the possibility for a Pareto-improving exchange relationship, what factors might determine the costs of reaching such a bargain? The following chapter develops a theoretical argument, rooted in the delegation and bargaining literatures, that answers these questions and develops testable hypotheses.

Chapter Three
Geography and the Fiscal Contract

Taxes are the source of life for the bureaucracy, the army and the court, in short, for the whole apparatus of the executive power. Strong government and heavy taxes are identical. By its very nature, small-holding property forms a suitable basis for an all-powerful and innumerable bureaucracy. It creates a uniform level of relationships and persons over the surface of the land. Hence it also permits the uniform action from a supreme center on all points of this uniform mass. It annihilates the aristocratic intermediate grades between the mass of the people and the state power.

Karl Marx*, The Eighteenth Brumaire of Louis Bonaparte*

The theory presented in this chapter links climatic and geographic factors to 1) the distribution of economic resources and incentives for states and societies to engage in bargaining over revenue and public goods during the preindustrial period of state formation, and 2) the transaction costs of reaching and enforcing said bargain. Once these factors have been identified and their incentive effects have been discussed, the chapter will turn to a defense of the contention that preindustrial patterns of resource diffusion should exert a persistent effect on the modern relationship between state and society.

3.1. Resource Diffusion, Transaction Costs, and the Fiscal Contract

The central insight of the fiscal theory of the state is that asymmetries of capabilities between states and societies give both parties incentives to contract with the other. The state is a unitary actor that enjoys a comparative advantage in the provision of public goods, including the use of violence. Society is a collection of many individuals

that collectively has a comparative advantage in the creation of wealth (Hayek 1980) but that requires the provision of public goods, most notably protection, in order to do so (Lane 1979, Lake 1992, McGuire and Olson 1996, Bates 2001). States can choose to either access this revenue through coercion, what I call coercive capture, or by trading services, as per the fiscal contract. In practice, all states do some mixture of the two; no state exists without a coercive apparatus for extracting revenue and no state, even the most poor, exists without providing some basic public goods. However, the costs of coercion and the economic disincentives engendered by state predation slant the balance in favor of service provision, making the cooperative, tax-and-provide-services equilibrium the most stable, and allow both parties to enjoy gains from trade (Bates and Lien 1985, Levi 1988, 1997, Timmons 2005).

In these various treatments, the asymmetry of capabilities and prohibitive costs of coercion are assumed. The state is a "stationary bandit," incapable of generating internal revenue. Society is a corporate yet atomized economic actor that cannot provide the public goods necessary to sustain its economic activities. Yet examples abound of states that generate revenue without tugging at the purse strings of the societies they govern (Saudi Arabia, Botswana, Zambia), and societies in which non-state actors, such as ethnic groups, economic oligarchs, and religious organizations provide public goods in quasi-governmental fashion. Much of West Africa (for an in depth discussion, see Yorke (2008), Central America, and Central Asia, respectively, would fit this description.

The possibilities that 1) the state can generate revenue coercively, and 2) that society may provide its own public goods, are not addressed. If the assumed asymmetry of capabilities, and thus demand, is necessary to motivate the bargaining relationship,

deviation from this assumption must diminish the likelihood of convergence on a strong fiscal contract.

Emanating from the bargaining analogy, I cast the emergence of the fiscal contract as a problem of delegation (Kiewiet and McCubbins 1991, Miller 1992, Weingast 1997, Lake and McCubbins 2006). A corporate principal, society, can choose to contract with an agent, the state, for the provision of public goods, in return for revenue, provided in the form of taxation. This revenue is payment above and beyond what the state, a specialist in coercion, can extract through coercive capture. I assume that both states and societies value autonomy. In the case of the state, this means simply that states will not bargain with society unless compelled to by economic necessity. The contractual relationship curtails its autonomy as an actor; being reliant on society for revenue gives it pecuniary incentives to defer to their preferences in order to generate quasi-voluntary compliance, which occurs when individuals choose to comply with requests for revenue even when the probability of being punished for non-compliance is extremely low (Levi 1988). Quasi-voluntary compliance is more important the less feasible coercive capture is as a strategy for generating revenue.

In the case of the society, this means that society will prefer self-provision of public goods over contracting with the state, a specialist in coercion. The potential for agency loss is inherent in any contractual relationship, but its negative ramifications are especially high when the agent is a coercive actor. The logic of this assumption is embodied in Madison's dilemma: after giving the state enough power to control society, the state must somehow be obliged not to use that power against society for predatory purposes (Madison 1787).

From the state's perspective, incentives to enter a fiscal contract with society emanate from its demand for revenue, but more importantly from limitations on internal or coercive revenue generation. The demand for revenue can be assumed; for the state to exist, it must be able to generate resources to fund its bureaucratic and military apparatus (Tilly 1975, Waltz 1979, Campbell 1993, Thies 2004, 2005, 2007). Less well understood are the factors that affect the ability of the state to monopolize economic resources or extract revenue from private actors in a coercive manner.

From society's perspective, incentives to enter into a fiscal contract with the state are a function of its demand for public goods, but also of coordination problems in self-provision. The provision of public goods is the canonical collective action problem: precisely because the goods are non-excludable, individuals have considerable incentives to free ride, leading to chronic underprovision (Olson 1965, Ostrom 1990). What must be identified are the circumstances under which society can be expected to overcome collective action problems without contracting to an outside agent.

The fundamental factor that affects both 1) limitations on the coercive power of the state, and 2) the coordination problems faced by society in the production of public goods is the diffuseness of the economic resource base. Auty (2001) distinguishes between point-source and diffuse resources. Point-source resources are resources that are geographically concentrated and typically exploited by capital- and labor-intense enterprises. Classic examples of point-source resources include mined commodities, such as petroleum, natural gas, deep-shaft diamonds, and copper, but also plantation-cultivated agricultural products, such as sugar, tobacco, cotton, and cacao. Due to their capital- and labor-intensity, point-source resources enjoy significant economies of scale

and higher barriers to entry, and thus are biased toward a comparatively small number of individual producers and oligarchic market structures.

Diffuse resources are those the cultivation/exploitation of which takes place over comparatively large tracts of territory and that require low capital and labor inputs. Examples of diffuse resources are timber, alluvial diamonds, staple grains of the *Triticeae* tribe like wheat, oats, and millet. Because they enjoy few economies of scale, they tend to be characterized by low barriers to entry and thus relatively numerous producers. The larger number of producers of diffuse resources means that market conditions approximate perfect competition, in which no individual producer has the market power to affect prices.

Resource diffusion affects the nature of state-society bargain in two ways. For the state, resource diffusion is negatively related to the feasibility of coercion as a means of generating compliance with its revenue demands. For society, resource diffusion should affect demand for public goods, via its effect on the incentives for private actors to provide those goods without contracting with the state.

For the state, point-source resources are more easily monopolized or extracted coercively because of several factors relating to their geographic concentration. First, producers can be identified, monitored and coerced, if need be, relatively easily (Prest 1985, Tanzi 1991). Second, the territorial concentration of production and labor constitutes a natural tax handle, or bottleneck in the production of a good, which makes evasion inherently more difficult (Musgrave 1969). When revenues can easily be extracted from a few sources that are also easily controlled, they are more subject to direct capture by the state through a variety of mechanisms: marketing boards, control of

line ministries, or direct procurement (Isham et al. 2005). The implication is that highly concentrated resources can be exploited for state revenue by with minimal bargaining with societal actors. The comparative advantage of the state in the use of coercion and the concentration of resources renders bargaining unnecessary.[11] In contrast, diffuse resources are more costly for states to capture coercively. Production takes place over large tracts of territory, and thus provides fewer natural bottlenecks of production at which to tax. Diffuse resources also involve a larger number of individual producers, which implies that the costs of monitoring and coercion will be higher.

The diffusion of resources affects society's incentives to contract with the state. These incentives are greatest when the distribution of economic resources make society unlikely to provide effectively public goods on its own. Point-source resources help societal actors resolve their collective action problems. Because their production is highly geographically concentrated and enjoys significant economies of scale, these resources tend to be exploited by a small number of relatively large producers. Such concentrated production allows the possibility of excludability, for private actors to act as discriminating monopolists in capturing the excess welfare their goods generate, and thus have specific incentives to privately provide these goods. Furthermore, a small number of private actors faces fewer collective action problems in jointly producing public goods. Under these circumstances, private actors may have little to gain from contracting with the state for the extensive provision of public services.

In contrast, diffuse resources exacerbate collective action problems in the self-

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11 However, others have noted that certain types of concentrated resources may not result in a lack of exchange and weak state-society relationship, but rather state capture by economic oligarchs (Engerman and Sokoloff 1997, 2002, Bates 1998, Isham et al. 2005). As is developed thoroughly in the next section, society faces a variety of collective action problems in contracting with the state. Oligopolistic economies endow a relatively small number of actors with significant private incentives and resources to affect political outcomes (Frieden 1999).

provision of local public goods. Production takes place over large tracts of territory and involves numerous producers, increasing the coordination costs of collective action. Moreover, the small market shares enjoyed by individual producers do not give any of them incentives to unilaterally provide public goods; they are not "privileged groups" (Olson 1965, 53). As such, the possibility for self-provision is negatively associated with resource diffusion.

The previous discussion address the effect of resource diffusion on the incentives for states and societies to engage in a fiscal contract. Facing a diffuse resource base, the state can not expect to generate revenue efficiently by relying on coercion, while society cannot expect to provide the public goods necessary for economic activity on its own. Thus, a tax-and-provide-services equilibrium is Pareto-improving for both actors, and resource diffuseness will be associated with a higher equilibrium fiscal contract. Facing a point-source resource base, however, the state can extract revenue efficiently through coercion, or in fact directly monopolization of the resource, while societal actors have individual incentives to provide public goods themselves. These conditions are not conducive to the formation of a strong fiscal contract. Resource diffuseness will be associated with a higher equilibrium fiscal contract.
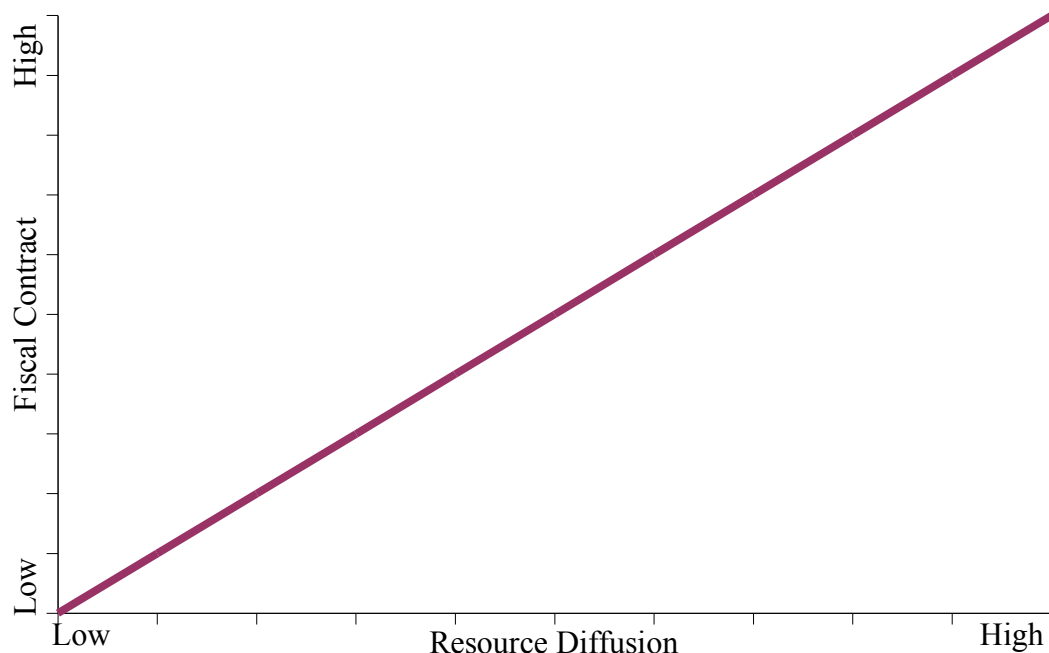
Figure 3.1. Resource Diffusion and the Fiscal Contract
Resource diffusion affects the strength of the fiscal contract by
determining the incentives for states and societies to bargain over
revenue and public goods. When resources are diffuse, the state cannot
rely on its comparative advantage in coercion to generate compliance,
and society will face large collective action problems in the self-
provision of public goods.

Having incentives to enter into a Pareto-improving bargain is not a sufficient
condition for the emergence of strong delegation. For any given distribution of
bargaining strength and preferences, transaction costs affect the outcome. Transaction
costs are those costs that arise from 1) information gathering, 2) bargaining, and 3)
policing and enforcement costs. As these costs increase, the fiscal contract will become
weaker.

The central insight of the transaction costs literature is that mounting transaction
costs can prevent otherwise Pareto-improving bargains from being struck, or diminish the
extent of delegation (Coase 1960, Williamson 1979). With respect to principal-agent

relationships, the third category of costs (policing and enforcement) are especially important because of the potential for agency losses. Agency losses occur whenever the agent (the state) acts in a way that deviates from the principal's (society) preferences (Lupia 2001). In this case, agency losses would be significant if the state, once provided with revenue, were to either use its power against society or line its own pockets, rather than providing services. States and societies may have common interests in sustaining the fiscal contract over the long run (Niskanen 1971, Timmons 2005), but both states and societies have individual incentives to deviate from the equilibrium behavior, especially if this deviation is expected to go unnoticed and unpunished. Moreover, the anticipation of these costs can cause actors to diminish the extent of delegation—in this case, for a given distribution of preferences over revenue and public goods, transaction costs can diminish the strength of the fiscal contract. For this reason, factors that affect the ability of states and societies to monitor and punish defection are important. As these transaction costs increase, the fiscal contract will be weaker.

The fiscal contract between state and society is a bargain over services and revenue. This bargain will be affected by the diffusion of the resource base and the transaction costs, both for state and society, associated with the identifying, reaching, and enforcing the bargain. The next two sections address the relationship between 1) climate, agriculture, and resource diffusion, and 2) mountainous terrain and transaction costs.

3.1.1. Climate, Agriculture, and Resource Diffusion

In order to link climate to the strength of the fiscal contract, we must look back in time to identify the context in which the modern state developed: the constant territorial wars of 14th, 15th, and 16th century Europe. The major conflicts of the era included the Hundred Years' War (1337-1453), the Anglo-Spanish War (1585-1604), and the Eighty Years' War (1568–1648), which ended in the Peace of Westphalia and the rise of the modern international system populated by territorially sovereign states.

Although scholars differ regarding the mechanisms through which warfare affected the state-building process, there is wide agreement that the technology and costs of warfare in Europe changed fundamentally in the 15th,16th, and later 19th centuries. The introduction of the crossbow and the development of mobile canonry diminished the utility of cavalry, precipitating a shift toward large, infantry-based armies (Downing 1992). Several centuries later, a revolution in transport technology centered on steamships and railroads increased the mobility of large armies and more advanced field artillery; a concurrent advance in communications (the telegraph) facilitated the central coordination of these large forces. While these advances increased the war making capacity of European monarchs, they carried extremely high costs, both purely economic (supplies, salaries) and in personnel (the move to standing, conscription- and volunteer-based armies).

Coercive models of state development address the demand for revenue, arguing that increasing costs of warfare shaped the incentives of monarchs to develop institutions capable of extracting economic and human resources in order to remain competitive in a

context of virtually constant warfare. Comparatively little attention has been paid to answer the question of how systematic variation in the resource bases from which this revenue would be extracted would affect incentives of monarchs and other early state-builders to bargain with society for revenue.

The institutions of the modern state arose in preindustrial, early modern Europe. During the following two centuries, colonialism, warfare and the diffusion of international markets brought state-like institutions to the rest of the world. These institutions preceded the onset of industrialization in most, if not all cases. In preindustrial era, the vast majority of humanity was involved in agriculture, with a small percentage involved in mining, craftsmanship, and trade, a trend that continues in many parts of the developing world to the present day.

Mining is the quintessential point-source, concentrated resource, which facilitates coercive capture by states and implies a weak fiscal contract (Karl 1997, Ross 1999, Sachs and Warner 2001). The link between climate and resource diffusion, however, is via the impact of climate on agricultural production. Climate is the most significant determinant of the type of agriculture that is feasible. Temperate agriculture is that which takes place between the tropics and the polar circles, as depicted in figure 3.2. The north temperate zone extends from the Tropic of Cancer to the Arctic Circle, encompassing the majority of the Eurasian land mass, Canada, the United States, and northern Mexico. The south temperate zone extends from the Tropic of Capricorn to the Antarctic Circle, and encompasses the Latin American nations of the Southern Cone (Chile, Argentina, Uruguay, and southern Brazil), South Africa, Lesotho and Swaziland, Australia, and New Zealand. Tropical agriculture is that which takes place in the tropical zone is centered on

the equator bounded to the north by the Tropic of Cancer and the Tropic of Capricorn to the south. The tropics are dominated by a humid belt, centered around the equator and encompassing the world's tropical rainforests, and the large arid belts that encompass the Saharan, Arabian, and Kalahari deserts (Strahler and Strahler 1998).
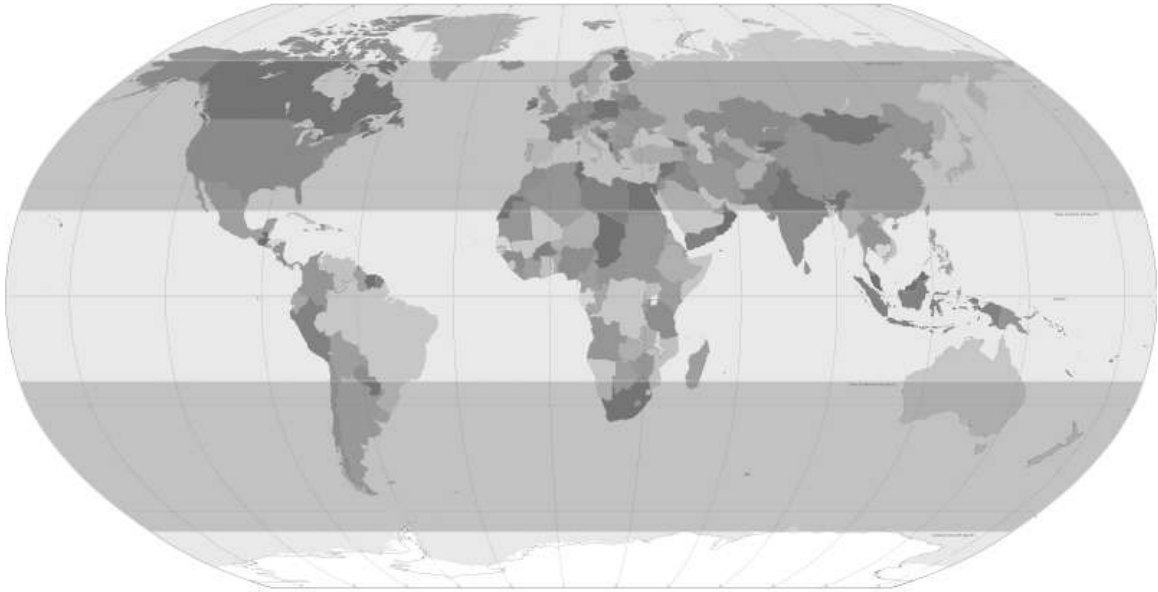
Figure 3.2. Temperate and Tropical Zones
The red shaded zones indicate temperate zones, which are characterized by four-season weather patterns with either ocean-regulated, stable temperatures (maritime) or dry hot summers and wet winters (continental). The unshaded zone between the two is the tropical and subtropical zone (map courtesy of Wikimedia Commons, http://en.wikipedia.org/wiki/Image:World_map_temperate.svg).

Temperate staple cereals, such as wheat, millet, and oats, are diffuse resources. Their production neither exhibits significant scale economies nor requires large initial investments in capital, leading to a market structure composed of numerous small producers. Moreover, the yield per acre of cold-season cereals lags behind that of tropical cereals, and sustains comparatively lower population densities, meaning that a large number of individual producers is spread out over a larger area. Though the introduction

and widespread adoption of the thresher in the late 18th and early 19th centuries increased the capital intensity, had the effect of further decreasing labor intensity and allowing single producers to cultivate even larger tracts of territory, thereby increasing resource diffusion.

In contrast, tropical and sub-tropical staple cereals, like maize, rice, and sorghum are more concentrated resources. Their cultivation is characterized by low barriers to entry, but comparatively high labor intensity, especially in the case of rice, which requires significant inputs of manual labor that must be well-coordinated but that defy mechanization. Moreover, and have much higher yields per acre under cultivation and therefore can sustain much higher population densities (Pomeranz 2000). All of these factors make tropical staple production less diffuse than temperate staple agriculture.

Tropical and sub-tropical non-cereal plantation staples, such as cotton, sugar, and banana are the agricultural products that most closely approximate a point-source resource. They are characterized by both significant initial capital investments and labor intensity. Both of these factors bias their production toward a small number of large, corporate producers and concentrated distributions of capital.

Isham et al. (2005) identify a third type of tropical staple agriculture that does not fit precisely into either category: "coffee and cocoa" economies. This type of tropical agriculture defies the easy categorization of either diffuse or point-source because these crops can be cultivated by large plantations, but also by small family farms—meaning it can be either a point-source or diffuse resource. However, both crops are tree crops, the cultivation of which is only economically feasible over long time scales (as opposed to the annual cycles of staple grasses) and require comparatively large initial investments of

capital that are immobile. For these reasons, this third class of tropical agriculture approximates a more concentrated resource with respect to its incentive effects for states and societal actors.

This section links climate to the distribution of economic resources facing both states and societies in preindustrial economies, the conditions that were present during the development of state institutions. It associates temperate climates with comparatively diffuse agricultural production, and tropical and sub-tropical climates with comparatively concentrated agricultural production. In line with the theoretical argument developed in this chapter, diffuse resources affect the incentives of both states and societies to strike a Pareto-improving bargain over revenue and public goods, by 1) diminishing the utility of coercion as a means of generating compliance for the state, and 2) increasing the problems of collective action for self-provision by society. In contrast, point-source resources 1) increase the ability of the state to generate resources via coercive capture, and 2) give a smaller number of producers specific incentives to self-provide public goods. The preceding discussion yields two simple propositions: *climate suitability for temperate agriculture is positively associated with the fiscal contract, while climate suitability for tropical agriculture is negatively associated with the fiscal contract.*

3.1.2. Mountainous Terrain and Transaction Costs

The previous section develops an argument linking climate to the natural resource endowments facing states and societies during the preindustrial period of state formation. These resource endowments, it argues, were a significant determinant of the bargaining

environment that led—or did not—to the establishment of a strong fiscal contract. This section develops a theoretical argument relating another geographic factor, mountainous terrain, to the transaction costs associated with bargaining over revenue and public goods, paying particular attention to the problems that mountainous terrain entails for 1) information gathering, 2) bargaining, and 3) post-bargain policing and enforcement costs associated with the fiscal contract.

The effects of mountainous terrain on transaction costs emanate from its effects on the distribution of population, the costs of communication and travel, and its effects on the ability of actors to project coercive force. Mountainous terrain clearly effects the distribution of population and increases costs of communication and travel. Mountainous terrain tends to be characterized by sparse population, a function of steep slopes, high relief, and scarcity of level, arable land (Gerrard 1990). Because arable land is not uniformly distributed, the population that is present tends to be highly concentrated in isolated, small pockets (Price 1981). The fact is evident in the linguistic diversity that characterizes mountainous regions, as communities descended from a common culture developed distinct languages in isolated niches (Diamond 1997, Harrison 2007).

Mountainous terrain is widely recognized by military historians and economists as increasing dramatically the costs of transportation and communication. Rapid changes in elevation, weather, and reduced visibility and mobility make traversing mountains an arduous process. Moreover, routing options are limited, and in most cases local knowledge of safe passages is necessary (O'Sullivan and Miller 1983, Doyle and Bennett 2002). For these reasons, transportation and communications infrastructure is most costly to develop in mountainous areas (Lebo and Schelling 2001).

For these reasons, mountainous terrain affects transaction costs in all three areas. First, mountainous terrain affects both the ability of state agents to monitor the population at large and the ability of the population to observe the behavior of state actors and other groups within the population. States have struggled historically to observe, collect information regarding, and assimilate remote, isolated communities. Braudel (1972) observes of mountain communities:

> Their history is to have none, to remain almost always on the fringe of the great waves of civilization, even the longest and most persistent, which may spread over great distances in the horizontal plane but are powerless to move vertically when faced with an obstacle of a few hundred metres (34).

Though this account certainly discounts the existence of influential, highly developed mountain empires—notably, the Incan—the historical record by and large substantiates Braudel's claim. Low levels of population density and difficulty in travel and navigation make any sort of information collection extremely costly.

Moreover, the isolation of mountain communities affects their ability to monitor the actions of other communities within society. This is important because it affects their ability to monitor whether other societal actors are cooperating with the state. Levi's (1988, 1997) theory of quasi-voluntary compliance revolves around beliefs within society that the contributions that are expected from different groups within society are fair and evenly applied. That is, society can overcome its collective action problem in tax payment, but groups within society must be able to monitor the compliance of other groups. Isolated communities will face larger costs in monitoring not just the compliance of the state, but more importantly the actions of other isolated communities whose compliance is necessary for sustaining cooperation when incentives exist to "cheat"

(Ostrom 1990).

Second, mountainous terrain affects bargaining costs by both increasing the costs of collective action on the part of society and decreasing the credibility of state promises of services. Contractual state-society bargaining requires institutional or cultural mechanisms that lower the costs of societal coordination, helping it to overcome its collective action problem in negotiating with the sovereign (Root 1989, Weingast 1997). When these costs are low, society can act collectively to bargain with the sovereign over revenue and services. When the costs of coordination are prohibitively high, the cost of contracting, both from the perspective of the state and society, increase dramatically. Levi (1997) argues that non-state institutions, particularly religious ones, can help in overcoming the high costs of coordinating between isolated actors. While common religion may help to overcome coordination problems among isolated communities, the same factors that increase linguistic diversity in mountainous terrain can increase also religious fractionalization.

Third, and most important, mountainous terrain affects the costs of enforcing the bargain for societal and state actors. In order for a bargain to be credible, both parties must have means of punishing deviation from the negotiated outcome. For societal actors, the same factors that increase the cost of information and bargaining collectively will also increase the cost of acting collectively to punish state actors (Weingast 1997). The effect of mountainous terrain on the ability of the state to project coercive force, and therefore enforce compliance, is paramount. No less an expert than Field Marshal Bernard Montgomery, commander of Allied ground forces during the invasion of Normandy, attributed victory in battle to "transportation, administration, and geography,"

(quoted in O'Sullivan and Miller 1983, 7) while recognizing that the third factor largely determined the first two.

At the highest level of abstraction, terrain can be grouped into two types: open terrain and close terrain. Open terrain is defined as terrain in which enemy combatants can be detected and observed beyond the effective range of prevailing weapons technology. Typically, open terrain consists of farmland, grassland or desert. Close terrain, on the other hand, is terrain in which detection ranges are (sometimes significantly) shorter than effective weapon ranges: mountains, closed forest (forest with a canopy layer), jungles, and marshes.

In open terrain, military units are subject to non-decreasing, and often increasing returns to scale in terms of manpower and technology.[12] The classic formulation of returns to scale in open terrain is embodied in Lanchester's Laws, a series of mathematical formulas developed by Frederick Lanchester during the First World War to describe the relative strengths of fighting forces under different military technologies. Lanchester's Linear Law of Ancient Combat concerns the interactions of massed troops in the era before mechanized warfare. Because warfare between massed armies armed with hand-held weapons is essentially a large series of one-on-one engagements, the number of men remaining at the end of a battle will simply be mathematic difference between the sizes of the armies, *ceterus paribus*. This implied constant, positive returns to scale, with force proportional to the number of troops, and encouraged commanders to amass as many troops as possible.

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12 Note that the usage here implies nothing about training as a technological input. Rhodesia's Selous Scouts and the US Special Forces were are among the most highly trained and functionally differentiated tactical units in military history, yet their efficacy is due at least in part to the fact that their team size is limited to 12-15 soldiers.

Lanchester's Square Law of Modern Combat, however, holds that in modern warfare, with varying types of artillery firing at each other from a distance, the guns or archers can attack multiple targets and receive fire from multiple sources. Lanchester calculated the power of such a force as proportional to the square of the number of troops, meaning that the returns to scale are exponential. Because open terrain facilitates oversight by commanding officers, the transaction costs associated with hierarchical command and functional differentiation are significant. In both cases, open terrain is an implicit—and extremely significant—assumption, derived from the European style of large-scale warfare.

In contrast, in close terrain, these same inputs are subject to non-increasing (and perhaps decreasing) returns to scale. There are two principal reasons. The first is that despite increasingly sophisticated communications technology, battles in close terrain tend to devolve into "soldiers' battles," (O'Sullivan and Miller 1983, 64) in which partisans engage the enemy at extremely close range. Under these circumstances, the advantages that come with functional differentiation and hierarchical coordination are lost; that is, the transaction costs of coordination among units increase dramatically. The second is that the terrain itself inhibits the movement of both large numbers of foot soldiers and mounted cavalry. Under these circumstances, adding manpower in the form of troops or technology in the form of heavy arms and vehicles may actually inhibit the mobility and effectiveness of the unit.
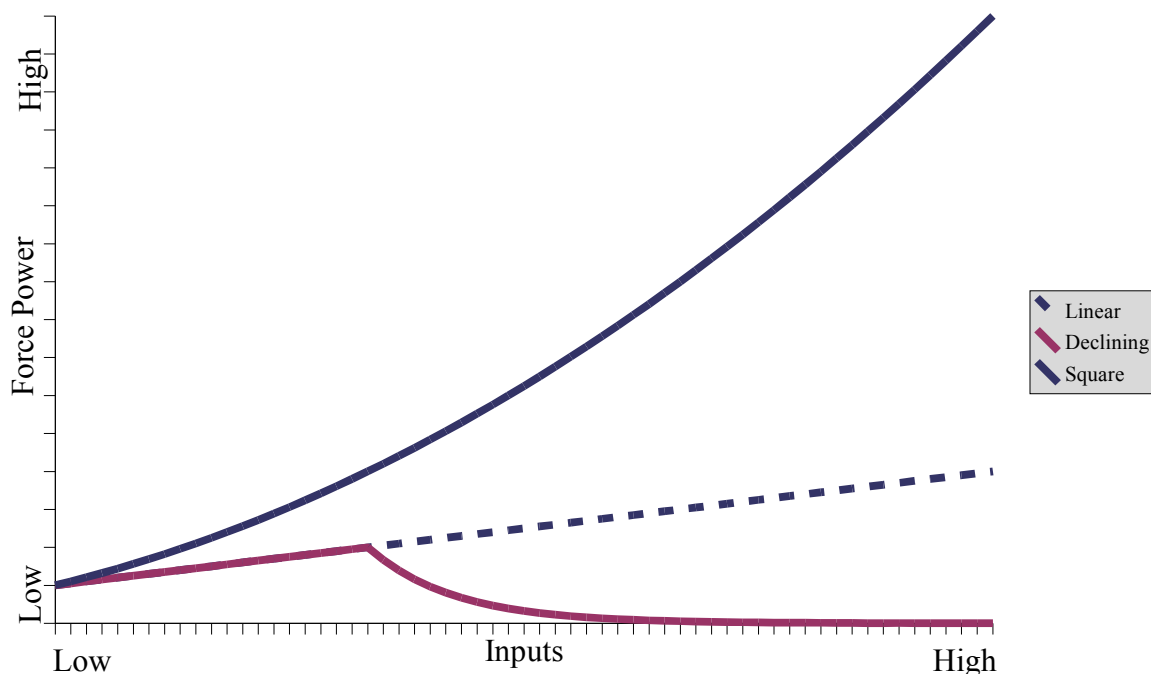
Figure 3.3. Force Power and Returns to Scale
Lanchester's Laws for calculating force power assumed linear or square returns to troop scale, depending on the prevailing level of military technology. In both cases, open terrain is implicitly assumed. An alternate perspective is that in close terrain, force power is subject to declining returns to scale, due to limited ranges of engagement and difficulties in force coordination.

A striking feature of this distinction is that it has remained a reality of warfare throughout the modern era. Just as small numbers of Swiss irregulars were able to repel the attacks of significantly better armed Austrian knights in early modern era, Francis Macon's forces were able to conduct successful hit-and-run attacks on massed British and Loyalist forces in the swamps and marshes of South Carolina during the American Revolution. Later, Che Guevara's out-manned and out-gunned "suicide squad" was able to make significant military gains against Cuban government forces in the Sierra Maestra. Though the helicopter may be changing the logic of technological inputs in close (especially mountainous) terrain, the use of this technology in combat roles is a very

recent phenomenon—with US-Vietnamese and Soviet-Afghani conflicts being the first in which combat helicopters were widely deployed to enhance the mobility and firepower of units—and in neither case did the technology allow a much larger and technologically advanced fighting force to secure victory. Moreover, the use of helicopters in thick jungle and mountainous terrain necessitated their operation at low altitudes, which exposed them to small arms fire and mitigated many of their putative advantages. Even when technology allows military units to take to the sky, the costliness of projecting state power in mountainous areas is still greater than in open terrain.

This argument highlights another impact of mountainous terrain on the bargaining environment: mountainous terrain makes the promise of state-provided goods, especially security, less credible. The fiscal theory of the state typically assumes that states have large comparative advantages in the use of force; so much so that they form natural local monopolies (Lane 1979, Lake 1992). This discussion highlights the limits of this monopoly in mountainous areas, where the state is less capable of projecting force and therefore providing protection. If the state cannot credibly commit to protecting society, the society will be less likely to comply with requests for revenue and more likely to rely on local forms of protection.

Mountainous terrain is significant for the fiscal contract because it increases the transaction costs associated with gathering information, bargaining, and finally monitoring and enforcing cooperation. While there are factors that might affect the degree to which societies can overcome these difficulties—shared religion, culture, economic institutions like regional marketplaces—mountainous terrain has been demonstrated to exert an impact on the strength of these non-state institutions as well.

The preceding discussion yields a simple proposition: *mountainous terrain is negatively associated with the fiscal contract.*

3.2. Institutional Persistence

The preceding argument develops a link between agricultural production and the incentives facing state and societal actors. This linkage is plausible with respect to preindustrial economies, which were dominated at their inception by agricultural production and mining. However, the resources bases facing states and societies in the modern era are far more complex. As economies developed and diversified, with a shift to manufacturing and later to services, over the subsequent centuries, the fiscal incentives facing states and societies have changed dramatically. Moreover, economic development, long isolated to Europe and its "Neo-Europe" offshoots, was achieved in areas outside the traditional arenas of state power. Given the massive changes in the geographic distribution and sources of global wealth (Maddison 2001) and political and legal institutions (La Porta et al. 1999, Acemoglu, Johnson, and Robinson 2001, Gleditsch 2002, Cederman and Gleditsch 2004), is it defensible to argue that these initial agricultural conditions would exert persistent effects in the modern era?

There are two reasons we should expect that these initial distributions of resources to exert persistent effects into the modern era. The first is that the actual conditions of natural resource dependence persist into the modern era. The economies of many developing nations in the world can still accurately be described as preindustrial or natural-resource dependent. Of the 90 developing economies studied by Isham et al.

(2005) over the period 1957-1997, only nine were classified as manufacturing economies, with the remaining 81 dependent on some type of agricultural or mined commodities. Moreover, as the discussion in section 1.2 highlights, the effects of mountainous terrain, especially its effects on the ability of the state to project force and the costs of supplying public goods, have not changed markedly with technological advancements, as noted by Lebo and Schelling (2001). The majority of industrialized, diversified, highly developed economies are located in temperate zones, which were characterized by diffuse resource bases in the preindustrial era.

The second is institutional. Institutions have distributive consequences—especially those institutions that are geared toward turning private wealth into public resources, as these public resources have incentive effects for economic growth (Knight 1992, Auty 1997). Institutions create winners and losers, endowing actors with both incentives and asymmetric capabilities to perpetuate the status quo, even if that status quo is sub-optimal. Point-source resources tend to inhibit economic growth and diversification, through both its effects on the relative competitiveness of non-point-source exports, the "Dutch disease" (Corden and Neary 1982), but also via its negative impact on the quality of the institutions necessary to sustain manufacturing and service-based economies, which require complex networks of information and transactions, along with contract and property rights enforcement (Sachs and Warner 2001). The literature on institutional determinants of long-run growth has demonstrated convincingly that early political and economic institutions have persistent effects in the modern era. These institutions must be endogenous to the distribution of resources that attended their creation (McCubbins, Noll, and Weingast 1987). This chapter develops a theoretical

argument that helps to identify the impact that the distribution of economic resources in preindustrial society had on the incentives of rulers to defer to the policy preferences of the ruled, which helps fill out the conventional story for how institutions like the rule of law came about in the first place.

The proceeding sections develop a fiscal theory of the state in which resource diffusion and transaction costs are the significant factors affecting the strength of the contract between state and society. The first section argues that two factors defining the physical environment, climate suitability for Eurasian agriculture and mountainous terrain, affect this bargain via their effect on resource diffusion and transaction costs, respectively. This argument yields two testable hypotheses. First, resource diffusion, as proxied by climate suitability for temperate agriculture, will be positively associated with the fiscal contract. Second, transaction costs, as proxied by mountainous terrain, will be negatively associated with the fiscal contract. The second section addresses some of the theoretical reasons that these early determinants of the fiscal contract would exert an impact that persists into the modern era.

The hypotheses regarding climate, terrain, and the fiscal contract will be tested in chapter four. Subsequently, chapter five will bring this argument, linking geography and tax capacity, to bear on identifying the fundamental causes of civil conflict.

Chapter Four
Taxation in the Tropics:
Geography and the Tax/GDP Ratio

4.1. Introduction

If, as the preceding chapter suggests, taxes are the state's "source of life," what determines the relative vitality of states? While much has been made of the hundred-fold gap in wealth between the richest and poorest societies, less attention has been focused on the varying degrees to which states are able to extract revenue from the societies they govern. From 1966-2002, the countries of the OECD collected an average of 28.2 percent of GDP in taxes, while non-OECD countries collected an average of around 16.5 percent.

Moreover, disparities exist even at comparable levels of economic and political development. For example, the similarly poor, civil war-torn, anocratic, and poorly performing (in terms of the Human Development Index) African states of Burundi and Sierra Leone nevertheless are quite different with respect to the ability of the government to extract revenue: from 1980-2002, Burundi's average total tax share (expressed as total taxes/GDP) was 14.9 percent, for Sierra Leone, the value was only 8.5. Moreover, the interannual variability of total tax share in Sierra Leone was three times higher (coefficient of variance of .36) than in Burundi (.12). Common sense dictates that for governments to enact policies and provide services, they must be able to turn some portion of private wealth into public resources. Clearly, some governments are more efficacious than others at generating revenue. The question, then, is why?

In explaining cross-national variation in total tax share, three answers stand out.

The first, emanating from the public finance literature, contends that levels of taxation (as well as its overall structure) are determined by administrative issues, including technical barriers to or facilitators of collection, and the size and shape of the national economy. The second, emanating from the political science literature, adds to these administrative and technical concerns a focus on regime type and factors affecting the ruler's expected tenure in office. The third, emanating from the literature on public goods provision, suggests that differences in levels of taxation are a function of preferences over the size of the public sector. The main problem with all of these explanations concerns the potential for endogeneity: regime type and the shape of the economy may affect levels of taxation, but it is possible also that taxation may affect the shape of the economy and regime type —factors that, due to their high degree of stationarity over time, make arguments about causality less compelling. In addition, and perhaps more damning, it is possible that all of these factors are driven by fundamental causes that have not been captured by extant models.

This chapter turns to a plausible, exogenous source of variation: geography and climate. Specifically, it argue that geography and climate affect levels of taxation by affecting the incentives of states and societies to enter into fiscal contracts. Building on the last chapter, it hypothesizes that resource diffusion, as proxied by climate suitability for temperate agriculture, will be positively associated with tax capacity, while mountainous terrain will be negatively associated with tax capacity.

Using data on 157 countries over the time period 1980-2002, I estimate the impact of geography and climate, operationalized alternately as the percentage of total land area in the temperate climate zone and climate suitability for agriculture, as well as the

proportion of mountainous terrain in the country, on total taxes as a percentage of GDP. As predicted, climate suitability for large-scale agriculture is strongly and positively associated with total tax/GDP, while mountainous terrain is negatively and strongly associated. Moreover, the relationship is strong and robust, even in the presence of endogenous indicators typical of the taxation literature and dummy variables for geographic regions, and the relationship is demonstrated not to be model dependent. Most striking, however, is the fact that a simple model of total tax share as a function of climate and geography outperforms models in the extant literature.

To the extent that these findings are credible, they will no doubt be a source of consternation for many students of fiscal systems and political economy. Despite increasing evidence linking the future of human wellbeing to careful stewardship of our environment, many will be loathe to accept that the organization of human societies, and specifically their relationship with the state, could be so contingent on our physical environment. This is especially the case for those of us that populate the most economically developed societies, for whom the economic connections to the environment are not nearly as immediate as those of the many inhabitants of the developing world, for whom their daily existence is a struggle against the vagaries of their ecological surroundings. To be sure, the situation is probably endlessly more complicated than that presented here. The question, however, is to what degree the increase in complexity buys more explanatory power. That simple models outperform much more politically nuanced ones should stimulate renewed debate over this fundamental part of the state-society relationship.

The remainder of this chapter proceeds as follows. Section two presents a review

of attempts (some recent, some not) to link total tax share to economic and political factors, culminating in a critical assessment of the literature's failure to address deeper determinants of the state-society relationship and its reliance on explanatory variables that suffer from problems of endogeneity. Section three summarizes the argument of chapter three and presents testable hypotheses. Section four presents discusses the data, presents the basic model as well as robustness checks, and discusses the findings. Section five concludes with a summary and a discussion of the normative and policy implications of the relationship between geography, climate and the state.

4.2. Literature Review

In explaining the vast cross-national and cross-regional differences in total tax share, three major answers stand out. The first, emanating from the literature on public finance, suggests that overall levels of taxation are determined primarily by the administrative difficulties of collecting taxes and levels of economic development and certain natural resource endowments. The second, emanating from the political science literature, focuses on regime type and factors affecting the ruler's expected tenures in office. Finally, a third branch contends that differing levels of taxation reflect differing preferences for the public provision of services.

The public finance literature essentially views the extraction of revenue from the perspective of efficiently matching tax levels and instruments to demand for public services and technological and/or administrative constraints on the collection of taxes. Musgrave's (1959) classic treatise on public finance argued that taxation as a percentage

of the economy would increase with per capita income. As economies expanded, he argued, both demand for expanded public services and ability to pay would increase, an argument he refined but that owes its first expression to German economist Adolph Wagner (1890). Moreover, as the economy developed, it would become increasingly monetized and formal, easing the administrative task of collecting taxes.

This contention received early empirical support from Chelliah, Baas and Kelly (1975). Musgrave also stressed the importance of international trade and efficient use of "tax handles," or natural bottlenecks in the production or transshipment of goods that facilitates tax collection. As imports and exports travel through a finite number of ports and firms, and typically arrive in bulk, evasion is generally more difficult than with other types of taxation, a position further developed by Prest (1985) and Tanzi (1991). Moreover, the administrative costs of collecting taxes via this instrument are comparatively low, indicating that even countries with low levels of bureaucratic capacity could exploit trade as a source of state income. Conversely, the total tax share is lower when the agricultural sector is large, as agricultural production is marked by fewer easily exploitable handles and may indicate a larger informal economy (Chelliah, Baas and Kelly 1975, Snider 1990). The possibility that agricultural products could vary significantly according to their means of production, and therefore east with which they could be taxed, was not addressed.

In keeping with the emphasis on tax handles, these early studies saw the existence of a large mineral sector as a convenient tax handle (Chelliah 1971). However, as Cheibub (1998) notes, mineral sectors in many developing (and several developed) countries are controlled by the government, and these firms often do not pay taxes.[13]

13 Rather, this source of revenue tends to take the form of nontax revenue, is that revenue derived from the

Sachs and Warner and Karl (1997), while not necessarily nested in the public finance literature, have contended that the existence of a plentiful, valuable natural resource base (particularly oil) exerts a downward pressure on tax levels, as governments are able to finance itself through the monopolization of these industries, obviating the need for high levels of taxation.

Taken as a body of work, the public finance literature on total tax share is concerned with the administrative and technical aspects of tax administration, given exogenously determined resource constraints and demographic patterns. In contrast, others have focused on political factors that might affect the influence of citizens over total tax share. Interest in the effects of political institutions on taxation was piqued by the wave of democratization that occurred in the 1980s and 1990s, and the common fear that newly democratized regimes would lack the capacity to extract necessary revenue from their populations. Looking at taxation in three highly developed, democratic countries (the USA, UK and Sweden), Steinmo (1996) argued that political institutions, particularly levels of party discipline in the legislature and alternation in the executive, shaped the structure and overall level of taxation. However, his argument tends to focus more on the structure taxation (progressive versus regressive, uniform or marked by exceptions and loopholes) than overall levels. Campbell (1993) presented a conceptual model of taxation that held overall levels are determined by the balance of class and interest group pressure, as mediated by party and electoral systems, systems of interest representation and partisan control. While an important contribution to the theoretical development of the tax literature, this analysis does not provide clear causal mechanisms

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levying of fines, collection of fees, recoveries from legal judgments, lotteries, and, most importantly, the income from property or sales.

that could generate testable hypotheses.

Large *N* empirical analyses followed later in the the decade. Looking at advanced industrial democracies, Steinmo and Tolbert (1998) argue that the form of incorporation of organized labor into the political system exerts a powerful impact on overall levels of taxation. Countries in which labor was represented by corporatist institutions, rather than interest group pluralism, were associated with higher levels of taxation. Moreover, patterns of coalition government affected levels of taxation: tax burdens are lowest in in systems with majoritarian governments, slightly higher in those with shifting coalition governments, and highest in dominant coalition systems. These findings suggest that taxation is associated positively with expected security in office, though the relationship may be curvilinear. However, the utility of this study in applying inferences to the entire universe of cases is limited—Steinmo and Tolbert only look at advanced industrial democracies.

Cheibub (1998) was the first to assess rigorously the effect of regime type on the extractive capacity. Cheibub argued that prior to assessing the effect of regime type, one must address the issue of selection effects—that is, the observed and unobserved factors that affect total tax share may also affect regime type, leading to biased estimates. Controlling for these selection effects, Cheibub found that regime type exerted at best a small effect on taxation, averaging less than one percent (372). However, Cheibub found that large differences existed in the impact of other explanatory variables across regime types: while GDP per capita was positive and significant for democracies, it exerted no effect in dictatorships. In dictatorships, the size of public debt, trade, and the size of the mineral sector were the most significant predictors of total tax share, though Cheibub did

not address the question of whether states that extract more revenue did so because they were more credible, and therefore more able attract loans and thereby incur debt. Countering Steinmo and Tolbert, Cheibub found that, in democracies, higher risk of removal from office was associated with much higher rates of taxation.

Analyzing a cross section of developing countries, Fauvelle-Aymar (1999) focused on measures of governmental legitimacy and efficiency (defined as the pursuit of efficient economic policies). She argued that for a government to capture high levels of taxation, it must be perceived as legitimate (as proxied by the number of opposition demonstrations and the POLITY democracy score), efficient (proxied by the number of coups, with higher numbers of coups being assumed to operationalize lower efficiency), and credible (operationalized as the volatility of country-specific inflation rates). Fauvelle-Aymar found that democracies taxed slightly less, while countries with large numbers of coups and greater volatility taxed at much lower rates.

Though principally concerned with the reverse—whether taxation levels affect regime type—Ross (2004) demonstrated that democracies appear to sustain higher levels of taxation—not necessarily because of regime type, but because they provide higher levels of public services. Ross's argument suggests that as the price of providing public services increases, due to either exogenous shocks or expanded need for public services, autocratic governments are forced to become more accountable to their citizens. Thus, Ross argues that the causal arrow between democracy and taxation should be reversed.

The problems with this literature are several. First, it is clear from the data that tax/GDP does not vary within countries much over time, at least in the period 1980-2002. Some of the explanatory variables in the literature move a lot (regime uncertainty, regime

type, discount factor) relative to levels of taxation, which move, in many cases, only slightly. Take, for instance, the example of Pakistan. During the sample period, Pakistan experienced a quick transition to, and then away from, democracy, as well as nearly a decade of ethnic conflict and experiences two coups—all the while maintaining a total tax share of between 12.23 and 13.82 percent (coefficient of variance=.04; the unweighted average for all countries=.15, indicating a standard deviation, on average, 1/7 of the mean panel value). Second, many of the explanatory variables are slowly moving, with little change in relative rankings and differences over time. Most of the countries that were rich in 1980 are still rich today; most of the countries that derived a large portion of their GDP from trade are the same ones that do today, and most countries characterized by volatile political systems that shift frequently from authoritarianism to democracy, or at the very least ruler to ruler, remain so (so much that Acemoglu and Robinson (2006) characterize this situation, where change is nearly constant, as a stable, identifiable equilibrium).

Serious discussions of endogeneity and mediated causality have been absent from this debate. The typical estimation strategy focuses on loading up the right hand side of the equation with variables designed to operationalize the identified causal factors (political institutions and preferences, economic development, and structure of the economy), usually temporally lagged, in order to mitigate problems of endogeneity. The problems with this situation are at least two-fold: first, the presumption of independence on the right-hand side is clearly violated—entire literatures are dedicated to identifying the effects of economic structure on economic growth, the effect of political institutions on growth, and finally the effect of growth and the structure of the economy on political

institutions. Second, there are clear problems of reverse causality. Ross's argument demonstrates as much with respect to regime type. Though none of the other studies mentioned here explicitly model the connection, one of the axiomatic tenets of neo-classical economic theory is that taxation affects economic incentives by distorting market signals.

Setting aside the various and well-documented problems of endogeneity that arise from the interplay of political institutions, patterns of economic development and the structure of the economy, it may be the case that our analyses should focus more on deep determinants that might simultaneously determine levels of development, regime type, and the structure of the economy, especially as total tax share is relatively stable over time within countries.

4.3. Geography, The Fiscal Contract, and Hypotheses

Chapter three presents a theoretical argument linking 1) climate suitability for temperate agriculture to resource diffusion and the incentives for states and societies to enter into a fiscal contract, and 2) mountainous terrain and the transaction costs of bargaining between state and society. In sum, diffuse resources give the state incentives to generate tax compliance via inducements in the form of public goods, rather than rely on their comparative advantage in coercion. Diffuse resources increase also the problems of collective action that societies face in attempting to self-provide these public goods, giving society an incentive to contract for their provision. In contrast, concentrated resources give the state incentives to generate tax compliance via coercion or direct

monopolization, increasing the likelihood that revenue will be generated internally and obviate the need for taxes. Moreover, concentrated resources lead to market structures characterized by fewer producers with larger market shares, and thus potentially encompassing interests in the self-provision of public goods. Therefore,

H_1: *Resource diffuseness is positively associated with tax capacity.*

For any distribution of preferences over the extent of taxation, transaction costs will affect the outcome. Mountainous terrain is significant for the fiscal contract because it increases the transaction costs associated with gather information, bargaining, and finally monitoring and enforcing cooperation. While there are factors that might affect the degree to which societies can overcome these difficulties—shared religion, culture, economic institutions like regional marketplaces—mountainous terrain has been demonstrated to exert an impact on the strength of these non-state institutions as well. Therefore,

H_2: *(Share of) mountainous terrain is negatively associated with tax capacity.*

The next section introduces the strategy for testing these hypotheses, discusses the data, and presents the model.

4.4. The Model: Data and Estimation

4.4.1. The Dependent Variable

The dependent variable is total taxes as a percentage of GDP in a given country-year. It is the most widely used measure of the ability of the state to extract resources

from private actors, facilitating the direct comparison of these results with the extant literature.

At the transition to the 21st century, there exist massive cross-country disparities in overall levels of taxation, even at relatively low levels of economic development. Even among those countries with a GDP per capita of less than 500 USD, there is a striking difference between Moldova, in which taxation accounts for 26 percent of GDP, and the Democratic Republic of Congo, where it accounts for just 4.05 percent. The data indicate that while the industrialized countries of Western Europe, North America, Oceania and Japan pay, on average, almost a third of the countries' annual economic production in taxes, the countries of the developing world, especially Latin America, Asia and Africa, pay less than a sixth.

Though these regional differences are striking in their own right, it bears mentioning that the economies of Asia, Latin America and Sub-Saharan Africa have significant informal components that are not captured by data on gross domestic product or taxation. With the informal economy equaling 42 percent of GNI for Africa, 41 percent for Central and South America, and 35 percent for Eastern Europe and former Soviet Union, versus 18 percent and 13.5 percent for the OECD countries of Western Europe and North America and Asia, respectively, it is likely that the lower tax/GDP values for Asia, Africa and Latin America are significantly over-inflated (Schneider and Enste 2002). That is, total taxation of the national economy is probably much lower in these countries than the data indicate.[14] Because the addition of the informal economy would increase the value in the denominator (economic output) but not the numerator

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14 Unfortunately, the estimates for the size of the informal economy are available only since 1999, hindering their usefulness for times series analysis.

(taxes) and because size of the informal economy is negative correlated (r^2=-.32), its inclusion would accentuate differences between low- and high-tax economies, strengthening the results. The data, as with many indicators used in this chapter, are taken from the World Bank Development Indicators.

4.4.2. The Independent Variables

To capture the effect of geography, I focus on two primary operationalizations. The first, *Climate Scale*, was developed by Hibbs and Olsson (2004) and is designed to capture the degree to which climatic conditions are favorable to annual heavy grasses such as wheat, maize, oats, and millet—temperate staple crops. In line with the argument of chapter three, this variable proxies resource diffuseness, with higher values associated with more diffuse resource bases. The variable is measured on a four-point, continuous scale, ordered in ascending value: 1 for dry tropical (desert), 2 for wet tropical (rainforest), 3 for temperate humid subtropical and temperate continental, and 4 for dry, hot summers and wet winters. This scale is based on the Köppen-Geiger climate system, which classifies climate according to average annual precipitation and temperature, and is calculated by summing these values weighted by the proportion of national territory falling within these categories. The mean value is 2.12 with a standard deviation of 1, bounded on the lower end by a host of desert countries (1) and the upper end by Ireland, Belgium, Greece, Portugal, Uruguay, and the Netherlands (4). In practice, this measure is similar to the temperate climate "ecozone" variable used by Gallup, Sachs and Mellinger (1999), though its distribution is more normal and provides a more nuanced

operationalization of the core concept. It is highly correlated also with absolute latitude of the country capital city ($r^2 = 0.54$) reported by La Porta et al. (1999). Models run with the alternate specification return results similar to those reported here.

Figure 4.1 shows a scatter plot of between the mean total taxes as a share of GDP, on the vertical axis, and climate scale. In the cross section, total taxes/GDP and climate scale are highly positively correlated ($r^2 = 0.6$).
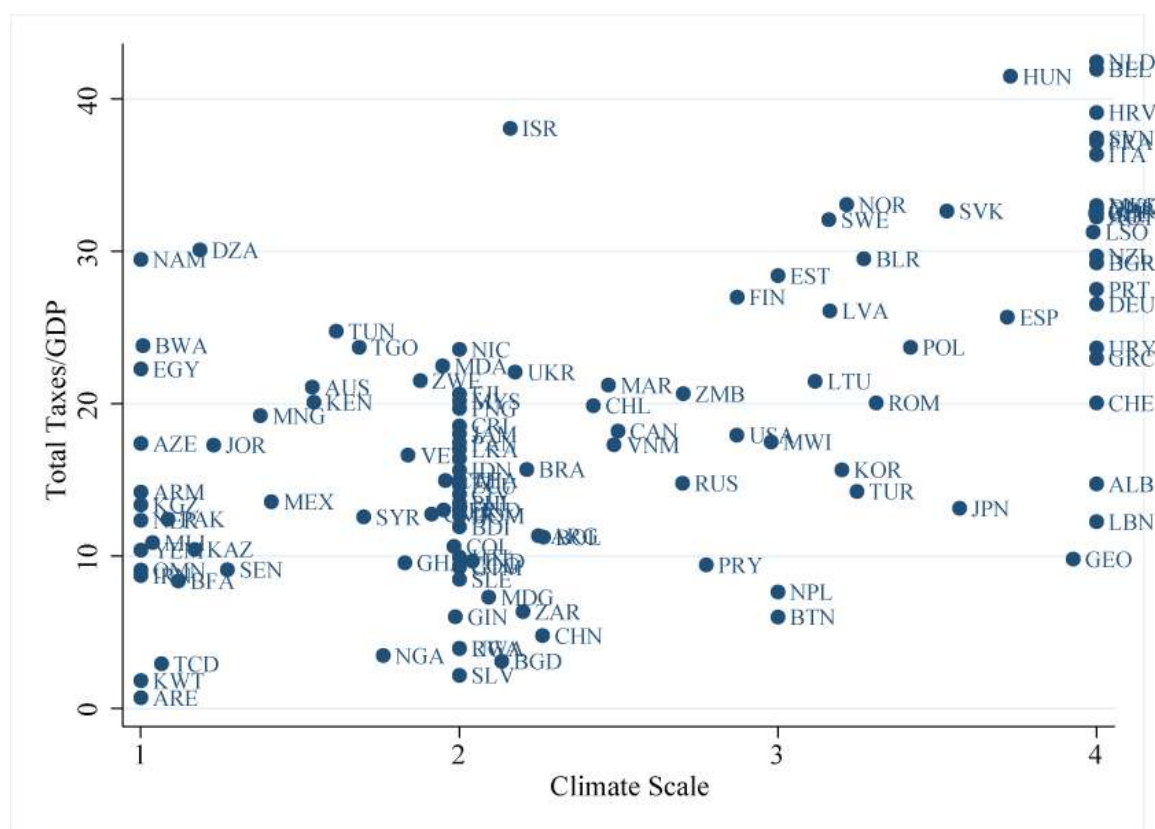
Figure 4.1. Total Taxes/GDP and Climate Scale

Figure 4.2 shows the spatial distribution of values for climate scale. As the scale is constructed to capture climate suitability for temperate agriculture, countries with high values on this scale are found at higher (though not the highest) latitudes.
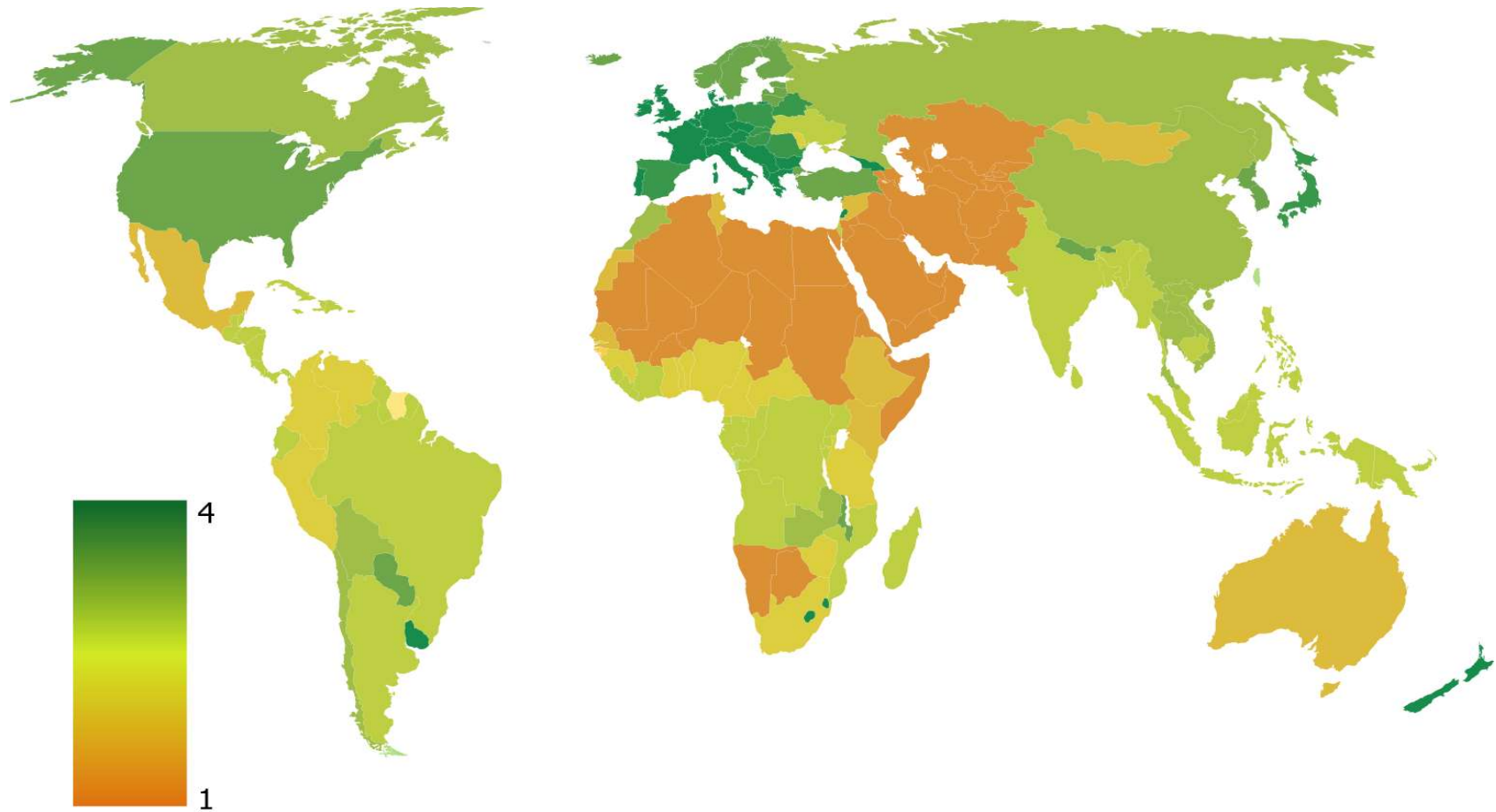
Figure 4.2. Climate Scale
Climate scale variable based on data from, Hibbs, Jr., Douglas A.,
and Ola Olsson, 2004. "Geography, biogeography, and why some
countries are rich and others are poor." *Proceedings of the
National Academy of Sciences* 101: 3715-3720.

The second, logged mountainous terrain, is taken from the Fearon and Laitin (2003) dataset on insurgency. The data were coded by A.J. Gerrard and filled in by Fearon and Laitin for a small subset of cases. The mean value is 2.10 with a standard deviation of 1.44, bounded on the lower end by a host of flat countries and on the upper end by Bhutan (4.557) and the mountain kingdom of Lesotho (4.42).

Figure 4.3 shows a scatter plot of between the mean total taxes as a share of GDP, on the vertical axis, and mountainous terrain. In the cross section, total taxes/GDP and climate scale are somewhat less strongly, and negatively, correlated ($r^2 = -.21$). Figure 4.4 shows the spatial distribution.
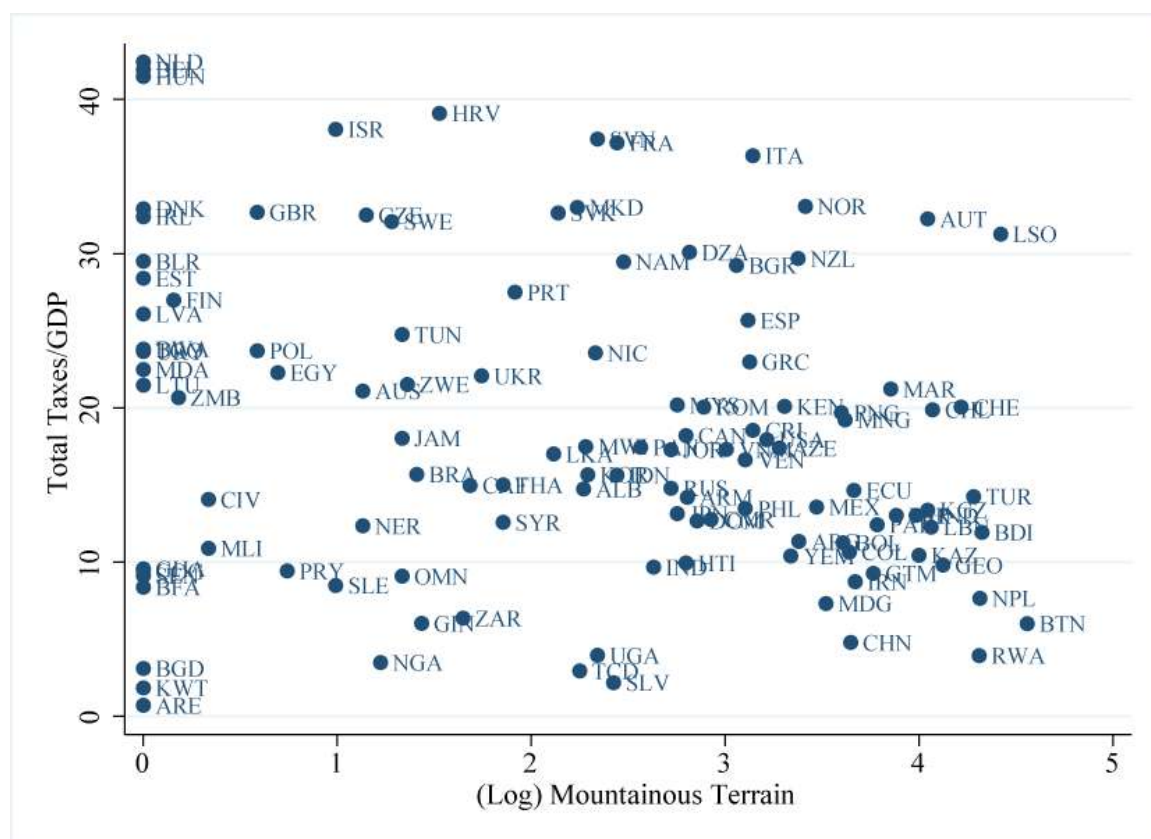
Figure 4.3. Total Taxes/GDP and Mountainous Terrain
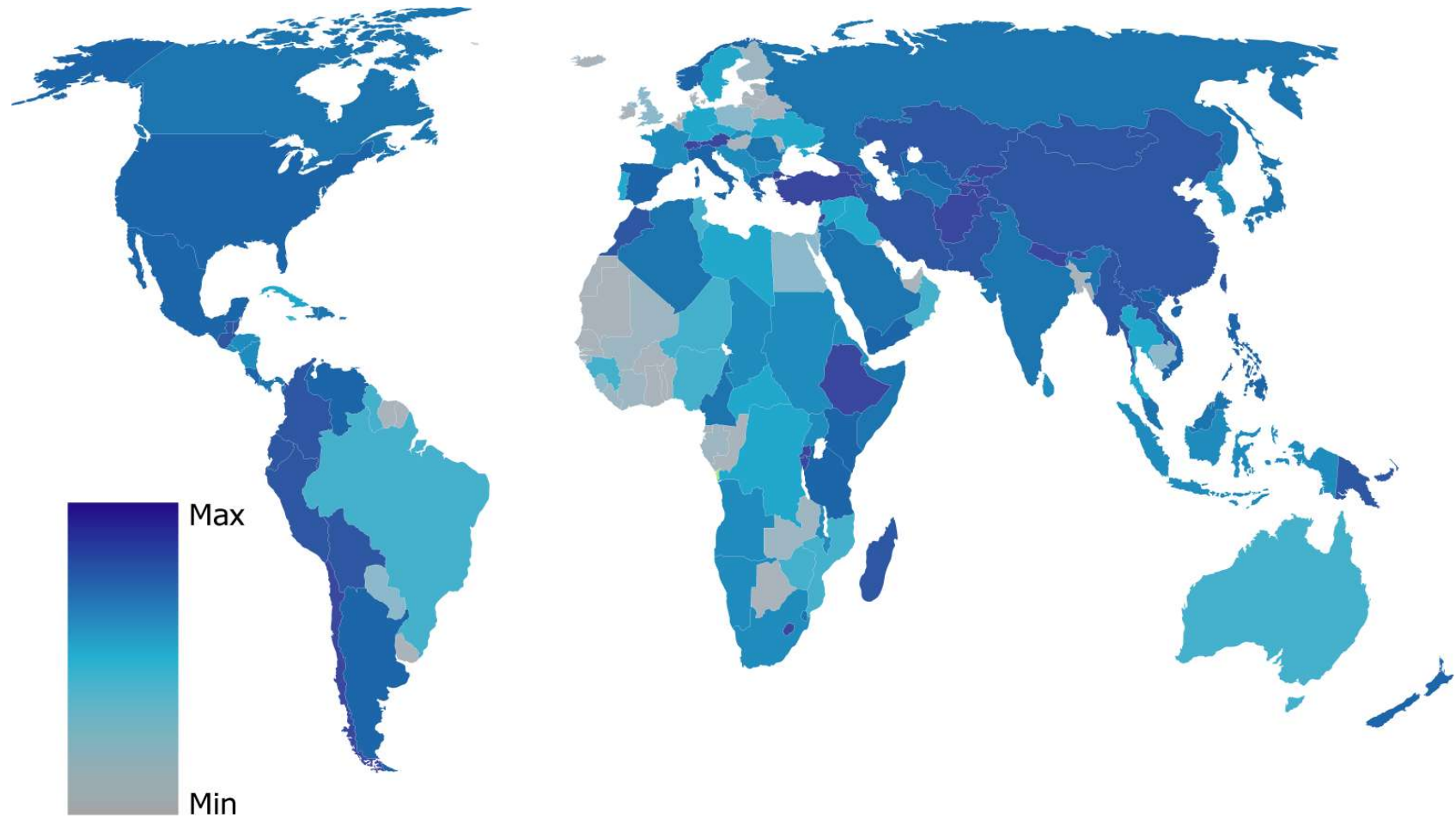
Figure 4.4. Mountainous Terrain
Mountainous terrain variable based on data from, Fearon, James
D., and David D. Laitin, 2003. "Ethnicity, Insurgency, and Civil
War." *American Political Science Review* 97 (1): 75-90.

As the two geographic variables are virtually uncorrelated ($r^2 = .02$), partial correlations, which hold the other independent variable constant when calculating the correlation between the independent and dependent variables, do not change much, though the strength of the correlation between mountainous terrain and total taxes/GDP increases (($r^2 = .61$ and $r^2 = -.27$).

4.4.3. Control Variables

In addition to these hypothesized variables of interest, I include several controls found in the public finance and political science literatures on total taxes/GDP First, I include measures of economic development and inequality: the logged GDP per capita (lagged) and the GINI coefficient. Virtually all studies find a strong relationship between level of development and total tax share (Wagner's Law). The GINI Coefficient is included to control for the fact that more economically diverse populations may have differing preferences over levels of public services and total taxation (Easterly and Levine 1997, 2003, Alesina, Baqir and Easterly 1999, Timmons 2005).

Second, I include several political variables, in order to capture the effect of regime type. The first is the lagged POLITY2 score, which is the difference between the (positive) democracy score and the (negative) autocracy score, yielding a scale from –10 (complete autocracy) to 10 (institutionalized democracy). In order to check for threshold effects, I include also dummy variables for whether the country was a democracy (Polity2≥5) or autocracy (Polity2≤-5). These measures are lagged as well.

Third, I include controls for the structure of population and the national economy

that come directly from the public finance literature. I include population density and the percentage of the population living in rural areas to account for the contention that denser populations, more urban populations allow tax authorities to benefit from economies of scale, facilitating higher levels of collection (and reliance on more administratively costly tax instruments; see Riezman and Slemrod 1987). Finally, I include a measure of percentage of the economically active population involved in agriculture. Several authors have argued that the size of the agricultural economy is a decent proxy for the importance of the subsistence sector of the economy, which, not benefiting from a convenient tax handle, should have a negative effect on total tax share (Musgrave 1969, Snider 1990, Cheibub 1998). In light of the large regional disparities identified in section two, I include a series of regional dummy variables to address spatial and regional trends that are otherwise unmodeled, as well as a dummy for the countries of the Organization for Economic Cooperation and Development.[15] As these countries represent those at the highest levels of industrial development, they should, according to Wagner's Law, sustain higher levels of taxation.

4.4.4. Missing Data and Imputation

My dataset contains data on 157 countries during the time period 1980-2002, a total of 3374 potential country-year observations. However, missing data are a significant problem: removal of these cases via list-wise deletion typically results in a loss of around half of potential observations. Moreover, as Ross (2006) has argued, the

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15 For those countries that joined the OECD since 1980, they are coded as belonging in the year they join and thereafter.

missing data are not randomly distributed; high performing authoritarian states are much less likely to report development indicators than more poorly performing states, which are much more likely to report development indicators as part of their engagement with international development institutions. Because of the non-random nature of the missing data, estimates that do not account for this bias may lead to incorrect inferences, as has been demonstrated by Ross as well as by King, Honaker, Joseph and Scheve (2001).

Table 4.1. Descriptive Statistics and Missing Data

The problems associated with missing data that are non-randomly distributed has been addressed at length by Ross, Michael L., 2006. "Is Democracy Good for the Poor?" *American Journal of Political Science* 50 (4): 860-874. The non-random nature of the missing data is accounted for via multiple imputation using chained equations.

Variable	Obs	Mean	Std. Dev.	Min	Max
Tax as % of GDP	1991	19.6	10.11	0.05	102.75
Climate Scale	3164	2.13	1.01	0.02	4
GDP per capita	3152	7.44	1.59	0	10.76
GINI Coefficient	2568	40.77	10.15	24.44	63.2
Logged Mountainous Terrain	3291	2.1	1.44	0	4.56
Polity2, Lagged	3185	0.73	7.44	-10	10
Democracy dummy	3374	0.44	0.5	0	1
Autocracy dummy	3374	0.39	0.49	0	1
Population Density	3310	129.51	457.69	1.06	6826.23
Percent Rural Population	3328	49.92	24.19	0	96.11
Percent Employed, Agriculture	1440	23.24	22.04	0	100
OECD dummy	3374	0.16	0.36	0	1
Eastern Europe dummy	3374	0.11	0.32	0	1
Latin America dummy	3374	0.16	0.36	0	1
Sub-Saharan Africa dummy	3374	0.3	0.46	0	1
Asia dummy	3374	0.16	0.36	0	1

In order to address the problem of missing data, I employ multiple imputation using chained equations (MICE) (Royston 2004, 2005). Instead of returning point estimates, multiple imputation produces N imputed data sets, the variance across which

reflects the degree of uncertainty over the imputed value. MICE imputes the values of missing data based on each conditional density of a variable based on values for all other non-missing variables, allowing missing data to violate the strong assumption of multivariate normality required for more common imputation techniques based on joint distributions for all variables. Once the imputed datasets are generated, the model is then run with each of the N datasets (in this case, five), and point estimates for coefficients are generated by averaging across the N sets of results.

4.4.5. The Model

Despite the inclusion of many controls, the dependent variable still displays both a degree of serial autocorrelation and significant country-specific effects. In order to mitigate these sources of bias, I utilize Prais-Winsten regression with panel-corrected standard errors and a first order autoregressive disturbance term. I report results for three models. Model 1 includes the full, imputed sample, while Models 2 and 3 are split samples, dividing the sample into country-years of democracy (Polity2≥5) and autocracy (Polity2≤-5). The table reports coefficient estimates with z-scores below, in parentheses.

The results in Table 4.2 suggest three main findings. The first is the strength of the hypothesized relationship between climate scale and taxation. A quartile-to-quartile change in the climate scale variable predicts a 4.67 percent increase in total tax share; similar to the estimated increase (4.77 percent) associated with a quartile-to-quartile shift in GDP per capita. Moreover, the point estimates are consistent across the split samples, though they are slightly higher for autocracies than democracies.

Table 4.2. Prais-Winsten Regression with Clustered Standard Errorsand AR(1) Disturbances, Taxation as percentage of GDP

	Full Sample (Imputed Data)	Autocracies (Imputed Data)	Democracies (Imputed Data)
Climate Scale	3.29	3.40	3.07
	(18.964)***	(11.502)***	(9.006)***
Logged Mountainous Terrain	-0.50	-0.21	-0.99
	(7.628)***	1.30	(4.232)***
Logged GDP per capita, lagged	1.93	1.97	1.49
	(7.27)***	(4.854)**	(3.81)**
GINI Coefficient	-0.07	-0.06	-0.05
	(1.756)*	(1.938)*	(1.826)*
Polity2, Lagged	0.23	0.27	0.14
	(3.986)**	(2.076)**	(2.018)**
Democracy dummy	-0.90		
	0.65		
Autocracy dummy	-0.69		
	0.17		
Population Density	-0.01	-0.01	-0.01
	(20.53)***	(5.686)***	(5.51)***
Percent Rural Population	0.04	0.05	-0.01
	(1.702)*	(2.25)**	0.24
Percent Employed, Agriculture	0.00	0.01	-0.01
	0.86	0.89	0.47
OECD dummy	-1.38	-0.47	-1.63
	1.11	0.39	1.51
Eastern Europe dummy	3.13	6.04	1.62
	1.36	(4.142)***	1.24
Latin America dummy	-2.65	DROPPED	-3.85
	(1.962)**	DROPPED	(2.454)**
Sub-Saharan Africa dummy	0.24	2.69	-1.36
	0.88	1.61	0.70
Asia dummy	-4.02	-2.95	-3.40
	(2.756)**	(1.964)**	(2.002)**
N. Africa & Middle East dummy	-2.52	-0.52	2.46
	1.60	0.69	0.43
Constant	1.44	-6.29	8.39
	0.50	(1.87)*	(1.848)*
Observations	3374	1317	1495
R Squared	0.63	0.56	0.74

* significant at 10%; ** significant at 5%, *** significant at 1%

This finding is surprising, given the fact that the effect of geography is most likely significantly underestimated, as it has been demonstrated to operate as well through its

effect on economic development and political institutions.

The second main finding is that the mountainous terrain variable is significant and in the hypothesized direction. However, the relationship is not quite as robust, as it is not significant in the autocratic sub-sample. Nor is it as strong: the quartile-to-quartile shift is associated with only a 1.31 percent reduction in total tax share. This finding is consistent with the argument developed in chapter three, which places the resource difffuseness, as proxied by climate scale, at the center of the theoretical story, with mountainous terrain playing a subordinate role by affecting the transaction costs associate with policing the fiscal contract.

Third, the effects of the regional dummies were not always significant, though the relationships are largely in the expected direction. The OECD dummy is opposite the expected direction, which may be attributable to the relatively recent membership of newly industrialized and middle income countries like South Korea and Mexico, though it may also be due to the fact that the geographic and economic variables systematically over-predict total tax share in these countries. The point estimates on the Eastern Europe dummy (which includes the Soviet successor states) is in the expected direction, though significant only for autocracies. Among autocracies, the former Eastern Bloc and Soviet successor states are still collecting more taxes than the model would otherwise indicate, which is likely the residual effect of highly centralized, command economies and comparatively large state bureaucracies, given their level of economic development. Latin America and Asia collect lower taxes than the model predicts. Sub-Saharan Africa, however, appears to be captured well by the baseline model, which in and of itself is surprising, as many researchers have identified a persistent, otherwise unmodeled effect

of the "Africa dummy" in cross-national models of several political and economic

variables (Barro 1991, Easterly and Levine 1997, Englebert 2000).

Table 4.3. Cross Section Estimates of Total Taxes/GDP,
Panel Medians and Means

	Median Cross Section (Listwise Del.)	Means Cross Section (Listwise Del.)
Climate Scale	4.08	3.77
	(4.53)***	(3.98)***
Logged Mountainous Terrain	-0.99	-1.02
	(1.94)*	(2.00)**
Logged GDP per capita, lagged	2.32	2.07
	(1.88)*	1.6
GINI Coefficient	-0.11	-0.1
	1.06	0.93
Polity2, Lagged	-0.05	0.31
	0.11	0.5
Democracy dummy	1.41	-0.39
	0.37	0.06
Autocracy dummy	1.8	3.84
	0.57	0.7
Population Density	-0.01	-0.01
	1.59	1.38
Percent Rural Population	0.05	0.06
	0.8	0.87
Percent Employed, Agriculture	-0.04	-0.05
	0.87	1.11
OECD dummy	-5.32	-3.22
	1.07	0.63
Eastern Europe dummy	-0.26	2.26
	0.05	0.44
Latin America dummy	-3.9	-1.77
	0.69	0.32
Sub-Saharan Africa dummy	-3.74	-0.98
	0.63	0.17
Asia dummy	-4.12	-2.14
	0.71	0.37
N. Africa & Middle East dummy	0.91	4.44
	0.18	0.86
Constant	2.27	1.43
	0.16	0.1
Observations	115	115
R Squared	0.64	0.63

* significant at 10%; ** significant at 5%, *** significant at 1%

Because the climate scale and mountainous terrain variables are stationary, it is reasonable to counter that time-series cross-sectional analysis will report biased standard errors, inflating statistical significance by "recounting" observations that, in practice, vary little from year to year. Table 4.3 demonstrates that the findings are not artifacts of the assumptions entailed in the TSCS model specification or the imputation process. It reports the results of a simple cross-section OLS regression on country median and mean values, addressing missing data with list-wise deletion of cases with missing data. The cross-sectional analysis may capture most of the significant variation, without running the risk of over-inflating the number of observations.

Table 4.3 shows that he point estimates on the geographic variables are highly significant and similar in magnitude to those estimated in the time-series cross-sectional analysis. Climate scale is positively associated with total taxes/GDP, while mountainous terrain is negatively, and somewhat more weakly, associated with total taxes/GDP. These findings are consistent with the simple bivariate correlations reported earlier, and are significant in spite of the inclusion of many endogenous indicators of the total taxes/GDP.

Turning to the control variables, GDP per capita displays the expected sign and is highly significant (though not as highly as climate scale) under each time-series cross-sectional specification, though it does not achieve significance in simple cross sectional analysis. Though neither dummy coding achieves significance, the level of democracy appears to exert a consistent and positive linear effect (quartile-to-quartile shift in POLITY2 predicts an increase in tax share of 3.45 percent). Finally, the controls emanating from the public finance literature are either insignificant or with the sign in the wrong direction. This may be attributable to the fact that many of these control variables,

such as agricultural employment, rural population, and population density are all correlated with the geographic variables, relationships that are inherent to the theoretical framework developed in chapter three. The only significant finding regards population density, which, controlling for other factors, is associated with lower levels of taxation.

A potential criticism of the findings is that the climate scale and mountainous terrain variables are designed simply to capture the effect of being "European." In particular, the climate scale variable is designed to capture climatic suitability for the kind of cold-season cereal grain-based agriculture that characterizes North-West Europe. If these variables are simply capturing Europeness, then my findings are simply capturing the fact that Europe's political and economic trajectory has been different than that of other parts of the world—not a novel finding.

Table 4.4 addresses the question of whether Europe exerts undue influence on the model. Column one shows the results of the cross-sectional model with the countries of Western Europe (United Kingdom, France, Germany, Italy, Belgium, the Netherlands, Portugal, Spain and Greece[16]), as defined by membership in the Western European Union, excluded. Column two shows the model with the additional countries of Eastern Europe and the former Soviet Union excluded as well.[17] The results in column one indicate that the the full model is not simply capturing Western Europe; climate scale and mountainous terrain are still strongly and significantly associated with total taxes/GDP, and in the expected directions. Excluding Western Europe does seem to exert an effect on the significance levels of several controls: the relationship between taxation and logged GDP

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16 Luxembourg is also a member of the Western European Union, but because of its small population is not included in the sample.

17 Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

per capita is strengthened, and the point estimates on the GINI coefficient and percentage of labor force employed in agriculture are significant and in the expected directions. Curiously, higher population densities are associated with lower levels of taxation, though the magnitude of the effect is not large: a quartile-to-quartile shift in this variable would produce a change in total taxes/GDP of less than one percentage point.

Table 4.4. Cross Section Estimates of Total Taxes/GDP,
Excluding Europe

	Excluding Western Europe Cross Section (Listwise Del.)	Excluding Western & Eastern Europe Cross Section (Listwise Del.)
Climate Scale	2.67	2.14
	(3.00)***	(1.92)*
Logged Mountainous Terrain	-1.06	-0.63
	(2.32)*	1.16
Logged GDP per capita, lagged	2.49	2.71
	(2.14)**	(2.08)**
GINI Coefficient	-0.19	-0.12
	2.4	1.32
Polity2, Lagged	0.36	0.45
	0.33	1.2
Democracy dummy	-0.55	-2.2
	0.18	0.61
Autocracy dummy	1.95	1.28
	0.57	0.32
Population Density	-0.02	-0.02
	(2.74)***	(2.37)**
Percent Rural Population	0.05	0.05
	0.05	0.9
Percent Employed, Agriculture	-0.003	-0.003
	(2.18)**	(1.74)*
Observations	107	85
R Squared	0.53	0.44

Excluding both Eastern and Western Europe diminishes the explanatory power of the model. Climate scale is still positively associated with total taxes/GDP, but the statistical significance of the relationship is much weaker (t-value = 1.92). Moreover, the

relationship between mountainous terrain and total taxes/GDP fails to attain statistical significance, though the sign on the point estimate is in the right direction. I attribute this finding to the fact that the exclusion of the countries of the former Soviet Union causes the exclusion of many of the countries of Central Asia, a region with particularly high values on the mountainous terrain variable. The other controls perform as they did in the model that excluded only Western Europe, save for the GINI coefficient, which did not attain statistical significance. These findings suggest that the the exclusion of Europe does reduce the explanatory power of the model, but does not render it useless.

4.5. Discussion and Conclusions

My findings suggest a large proportion of cross-national variation in the total tax share is explained by geographic factors, specifically climate and mountainous terrain. These findings stand up to inclusion of controls for economic development, the structure of population and the economy, and otherwise unmodeled regional factors. These findings are remarkable in light of the well-documented and widely understood fact that geography and climate already exert consistent and strong indirect effects mediated by their effect on economic development and political institutions. Indeed, one of the shortcomings of the preliminary theoretical argument presented here is the fact that were the effect of geography completely mediated by its effect on political and economic development, we would expect no independent effect once the variables are included in the model.

The idea that our natural environment exerts such powerful effects on the

organization of human societies is both intuitive and profoundly unsettling. If "getting the institutions right," as the World Bank has advocated, is the best path toward sustainable economic development and responsible political representation, the fact that such a large portion of the fiscal relationship between citizens and the state is geographically determined should occasion a moment of pause.

This chapter establishes the statistical relationship between climate suitability for temperate agriculture, mountainous terrain, and the strength of the fiscal contract, as measured by tax capacity. In the following chapter, this relationship is exploited to gain traction on the question of why some states are more capable at deterring violent internal challenge to their authority than others.

Chapter Five
"Head for the Hills!" or This Hard Land?
Geography, State Capacity, and Civil Conflict

Guerrilla fighting will not always take place in country most favorable to the employment of its tactics; but when it does, that is, when the guerrilla band is located in zones difficult to reach, either because of dense forests, steep mountains, impassable deserts or marshes, the general tactics, based on the fundamental postulates of guerrilla warfare, must always be the same.

Ernesto Che Guevara, *Guerrilla Warfare*

5.1. Introduction

The preceding quotation is representative of the dominant thinking regarding the relationship between geography and civil conflict. The posited causal mechanism is straightforward: especially in the early stages of rebellion, the insurgents must above all else avoid capture, as government forces are almost certainly better armed and more numerous than the rebels. In order to survive, therefore, the rebels must be able to hide. Remote and difficult terrain, it is argued, provides good hiding places, reducing the asymmetry of forces between states and insurgents and thereby diminishing the startup costs to—and increasing the likelihood of—rebellion.

Intuitively, there must be something to this, as both astute students and practitioners of insurgency contend that rough terrain approaches a necessary condition for sustaining conflict (Mao 1961, Guevara 1968, US Army 1992, 2007, Buhaug and Gates 2002, Fearon and Laitin 2003, Fearon 2004). Discussions of counterinsurgency in the media, particularly the ongoing struggles of multinational forces to pursue Taliban fighters in the Safed Koh mountains of Afghanistan, contribute to the received wisdom that geography affects conflict primarily by providing (or not) a favorable strategic and

tactical environment for the practice of guerrilla warfare.

In emphasizing the role of geography in the tactical considerations of insurgents, I argue that we are not casting our theoretical and empirical nets sufficiently widely. Opportunity models of civil conflict (Fearon and Laitin 2003, Collier and Hoeffler 2002, 2004) contend that what matters most in explaining conflict is the capacity of the state to deter violent challengers, and they typically look to indirect measures of said capacity, such as GDP per capita, the coherence of political institutions, and reliance on primary commodity exports to statistically estimate the impact. Alternately, I view the state's ability to tax, measured as the tax/GDP ratio, as a more direct measure of state capacity, and I argue that the state's ability to tax is constrained by environmental and geographic factors.

I contend that current differences in the tax capacity of states were determined historically by 1) the factor endowments facing states and societies during the preindustrial period of state formation, and 2) the transaction costs to bargaining in areas where traditional military forces have difficulty projecting power. The nature of economic resources in the preindustrial era, whether point-source or diffuse, was key. Where diffuse resources, proxied by climate suitability for temperate agriculture, were prevalent, both states and societies faced significant economic incentives to develop a strong fiscal contract. Where point-source resources dominated, these incentives did not exist. Moreover, mountainous terrain is significant for the fiscal contract because it increases the transaction costs associated with gather information, bargaining, and finally monitoring and enforcing cooperation, thus diminishing the strength of the fiscal contract and lowering tax capacity. Therefore, the primary effect of the environment and

geography on conflict incidence may be indirect, mediated by its effect on the capacity of states against which insurgents rebel, rather than a direct, strategic and tactical effect.

The potential for an indirect effect, and the clear issue of endogeneity it raises, is a significant limitation of the extant literature, which relies on endogenous explanatory variables. These endogenous indicators beg more questions than they answer: for instance, does state capacity affect conflict, or does conflict affect state capacity? Typically, this problem has been partially addressed by using lagged indicators, which is an imperfect solution at best.

In order to address issues of endogeneity and indirect causation, I use two-stage probit least squares models to estimate the effects of the environment and geography on the incidence of civil conflict as mediated by my preferred measure of state capacity: the tax/GDP ratio. In the first stage, I use three instruments for the tax/GDP ratio. First, climate scale, developed by Hibbs and Olsson (2004), which captures the degree to which climatic conditions are favorable to annual, cold-cereal heavy grasses such as wheat, maize, oats, and millet, is my proxy for resource diffuseness. Second, the log-transformed percentage of mountainous terrain, as coded by Gerrard and published by Fearon and Laitin (2003), is my proxy for terrain penetrability. Third, the percent of land area in malarious zones (Gallup, Sachs, and Mellinger 1999) is used to control for the potential confounding effect of disease environment. In the second stage, I estimate the effect of the instrumented taxation variable on the incidence of civil conflict from 1970-2002.

In line with the findings of chapter three, I find strong, robust first-order relationships between the tax/GDP ratio and climate scale and mountainous terrain, with

the two instruments explaining 62.5 percent of the variance in the ratio. More importantly, I find that once properly instrumented, the tax/GDP ratio is strongly and negatively associated with the incidence of conflict: as taxation increases as a share of national economic output, conflict becomes less likely. This relationship holds even in the presence of the three most robust explanatory variables in the conflict literature: GDP per capita, the coherence of political institutions, and reliance on oil exports (Henderson and Singer 2000, Hegre, Ellingsen, Gates and Gleditsch 2001, Collier and Hoeffler 2002, Fearon and Laitin 2003, Hegre and Sambanis 2006). Moreover, once the climatic and geographic effects on state capacity are accounted for, these widely accepted explanatory variables do not affect the incidence of conflict, apart from their indirect effects on the tax/GDP ratio. In a like manner, the direct effect of geography on conflict disappears. This is both an interesting substantive finding and a requirement of my estimation strategy.

These findings point to two main conclusions. The first is that geography and climate are significant determinants of state capacity, and affect conflict incidence through this channel. The extant literature addressing geography and conflict is dedicated to identifying the effects of access to valuable natural resources (Buhaug and Lujala 2004), cross-border safe havens (Salehyan and Gleditsch 2006, Salehyan 2007), and the presence or absence of rough terrain (Collier and Hoeffler 2002, Fearon and Laitin 2003, Fearon 2004) on the strategic and tactical considerations of potential insurgents. This literature has not interacted with the expanding literature on geography and long-run development, which holds that geography and climate are significant determinants of the massive present-day gaps in wealth and institutional quality across countries (Acemoglu,

Johnson, and Robinson 2001, 2005, Easterly and Levine 2003, Rodrik, Subramanian, and Trebbi 2004, Hibbs and Olsson 2004), although Djankov and Reynal-Querol (2007) is a notable exception. In doing so, it has missed a crucial way in which geography affects conflict incidence: by affecting the capacity of states against which insurgents rebel.

The second conclusion is that the effects of geography are pronounced when aggregate, national measures are used. Much of the recent work linking geography and civil conflict has been aimed at disaggregating the geographic unit of analysis and focusing on smaller grid cells or regional conflict zones (Buhaug and Gates 2002, Buhaug and Lujala 2005, Lujala, Gleditsch and Gilmore 2005, Buhaug and Rød 2006, Raleigh and Urdal 2007, Meier and Bond 2007). Disaggregating the unit of analysis may allow more direct tests of the strategic and/or tactical role of rough terrain, as well as a host of other variables, such as the presence of lootable commodities, access to cross-border havens, and differences in wealth, that are non-constant over the territory of the state. However, the emphasis on the present, disaggregated effects of these variables may obfuscate the point that the decision to rebel takes into account not only the proximate opportunity structure but also the repressive capacity of the state at large.

The example of Iraq is illustrative of this point. The current Iraqi civil war is a largely urban phenomenon, with the majority of fighting and dying occurring in and around the cities of Baghdad, Fallujah, Nasiriya, Karbala, and Basra: locations that disaggregated analyses suggest would be the areas of greatest state strength and therefore lowest likelihood of conflict. This case could therefore be interpreted as evidence for the null hypothesis (no relationship) linking geography and conflict. This narrow view of the impact of geography would miss the fact that the Iraqi state's dependence on oil for

revenue and low state capacity—both influenced by its environmental and geographic context—may inhibit the ability of Iraqi state forces to engage insurgents militarily, provide the public services necessary to undermine their bases of political support, and increase the perceived value of successful state capture. Moreover, this situation prevailed in Iraq before the fall of the Hussein regime, during which Iraq experienced two separate civil wars involving Kurdish and Shiite insurgent groups. Hence, the effect of geography in the current conflict may be quite large, the absence of a perceptible tactical effect notwithstanding.

The organization of this chapter is as follows. The next section summarizes the current state of the literature linking geography, civil conflict, and long-run development. Section three presents the arguments for the tactical effect of terrain on insurgency, expanding the logic to argue that the incentives to develop tax capacity are a function of environmentally and geographically determined resource bases, and derives hypotheses regarding these effects on tax capacity and subsequently conflict incidence. Section four discusses key variables, the two-stage estimation strategy, and presents results and robustness checks. Section five concludes with a summary of the significant findings and some possible empirical extensions of the argument.

5.2. Literature Review

There is a large literature on opportunity models of civil conflict, which seek to explain conflict as a function of the economic and political incentives and deterrents facing potential rebels, rather than objective societal grievances (Grossman 1991, 1999;

Collier and Hoeffler 2002, 2004; Elbadawi and Sambanis 2002, Fearon and Laitin 2003, Smith 2004, Hegre and Sambanis 2006). Across these various studies, three explanatory variables have proven most robust to a variety of model specifications: economic development, the coherence of political institutions[18], and dependence on primary commodity exports (especially oil and other "lootable" resources) for revenue. The consensus positions are that a) more wealthy countries are less likely to experience civil wars, b) countries with more coherent political institutions are less likely to experience civil wars, and finally c) countries that are less dependent on primary commodity exports are less likely to experience civil wars. As a theoretical literature, this branch focuses on states' capacities to deter violent challenges to their authority, with these variables the most common operationalizations of said capacity.[19]

Despite less consensus on its explanatory power, geography has begun to play a large role in this debate, in terms of access to valuable natural resources (Buhaug and Lujala 2004), the diffusion of conflicts across borders (Salehyan and Gleditsch 2006), and the presence or absence of terrain conducive to guerrilla warfare (Collier and Hoeffler 2002, Fearon and Laitin 2003, Raleigh 2004). I will be focusing on this final mechanism.

The standard argument is that rough terrain confers tactical advantages on insurgents that mitigate the advantages enjoyed by state armies. Insurgents are typically

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18 Though not democratic quality thereof; levels of political democracy (typically operationalized as the POLITY score on the -10 to 10 scale) have consistently failed to attain significance when included along with measures of political institutional coherence. Recent contributions (especially Djankov and Reynal-Querol 2007) focus on more conceptual, expert opinion-based measures of institutional quality, such as inferring institutional quality from expert assessments of the risk of asset expropriation by the state.

19 Another contribution to this literature focuses on a more direct, fiscal measures of state capacity. Benson and Kugler (1998) argue that the government's relative extractive capacity, measured as the ratio of total revenue extraction to predicted revenue extraction, affects conflict severity. They find that relative extractive capacity is negatively associated with the severity of conflict: countries that are better able to access the resources of the societies they govern are less likely to experience intense civil conflicts.

outnumbered and out-gunned (especially at early stages of rebellion), and as such they must be able to both avoid direct engagement and have access to safe havens in which to rest, recruit, and replenish supplies (Fearon and Laitin 2003, Kalyvas 2006). Rough terrain, it is argued, facilitates both. Collier and Hoeffler (2002) test two alternate operationalizations, percentage of mountainous terrain and percentage of forested terrain, and find mountainous terrain to be significant and positive under several model specifications, whereas forested terrain is not a significant covariate. Using the log-transformed percentage of mountainous terrain as their operationalization, Fearon and Laitin find a significant, positive relationship between rough terrain and conflict onset. Cederman (2004) argues also for the importance of mountainous terrain but posits a different causal mechanism: because peripheral ethnic groups are more likely to inhabit peripheral territory, mountainous terrain may serve as a proxy for mechanisms of nationalist identity formation, as mountains inhibit the ability of dominant national groups to project authority into these regions. Using agent-based modeling techniques, Cederman contents that violent separatist movements are much more likely to occur in mountainous territories.

This perspective has been criticized on at least three counts. The first is that applying aggregate measures of rough terrain to models of conflict onset does not account for whether conflicts are located in areas characterized by rough terrain, a point made by Buhaug and Gates (2002) and Buhaug and Rød (2006). Moreover, Herbst (2000) and Raleigh (2004) have argued that modern insurgencies are as likely to be based in urban areas as rural ones. This criticism attacks the use of mountainous terrain on the basis of construct validity, as the variable may not accurately proxy the existence of safe havens

or the tactical conditions necessary for insurgency. Second, the possibilities of finding safe havens in neighboring states with porous borders combine to lessen the importance of rough terrain; if hiding places are available in neighboring counties, rough terrain may be irrelevant (Salehyan and Gleditsch 2006, Salehyan 2007). Finally, there is the argument that economic and political factors trump geographic variables. Raleigh argues that weak states, defined as those with low GDP per capita and weak political institutions, are limited in their ability to project political authority within their national boundaries, regardless of terrain, a perspective shared by Hegre et al. (2001). Controlling for these foreign safe havens and levels of economic and political development, Raleigh finds that rough terrain, as defined by Fearon and Laitin, is not a significant covariate of conflict onset, although it does appear to affect duration.
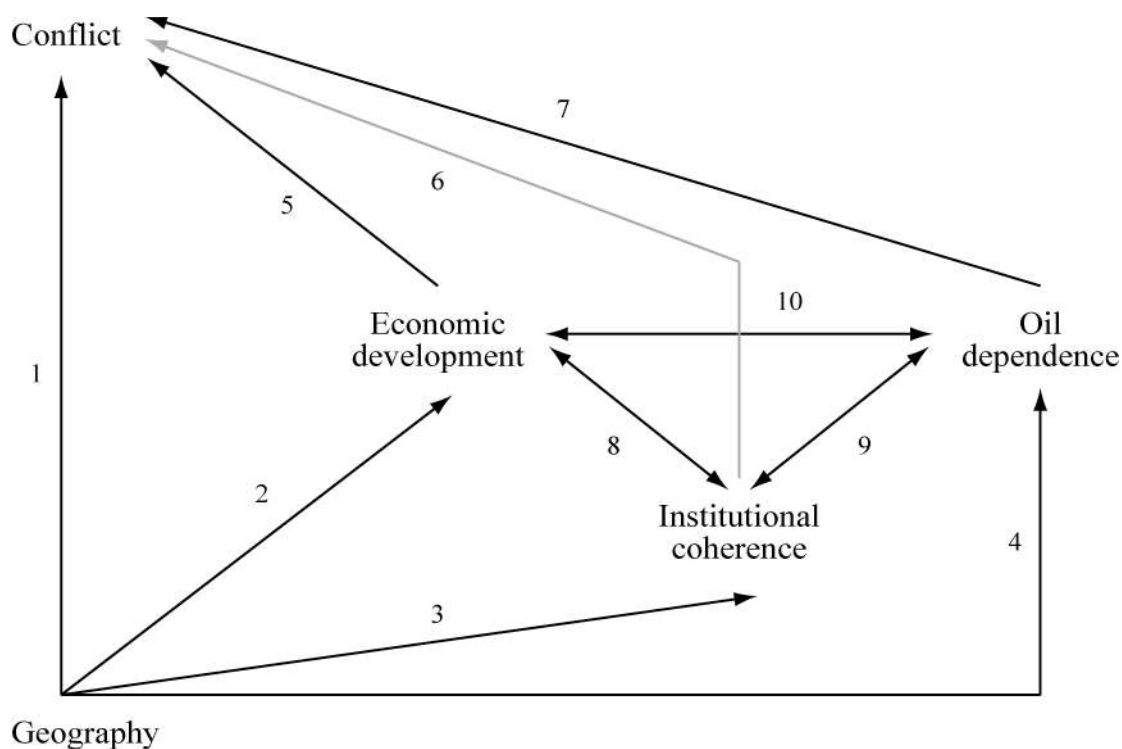
Figure 5.1. Causal Mechanisms and Endogeneity

Discussions of endogeneity and indirect causation largely have been absent from this debate. Figure 5.1 represents the various causal relationships posited in the literature. To the extent that the conflict literature has addressed geographic variables, these variables are typically included on the right hand side of the equation along with various measures of economic development, strength and coherence of political institutions, and dependence on valuable natural resources. That is, causal mechanism 1 (the direct effect of geography on conflict incidence) is pitted against causal mechanisms 5 (the direct effect of economic development on conflict incidence), 6 (institutional coherence), and 7 (oil export dependence). This design is common to Collier and Hoeffler, Fearon and Laitin, and Hegre and Sambanis, although differences in model specification lead them to differing conclusions.

Setting aside the various and well-documented problems of endogeneity that arise from the interplay of political institutions, patterns of economic development, and resource dependence (mechanisms 8-10), the criticisms of the rough terrain hypothesis beg the question of whether geography may exert an indirect effect, mediated by mechanisms 2-4. In order to address this, we must ask whether these other factors are endogenous to geography. If geography exerts an indirect effect through the economic and political attributes of states, then its effect has been both significantly underestimated empirically and not adequately accounted for theoretically. Doing so is the main goal of this chapter.

There is mounting evidence that environmental and geographic factors play a large indirect role in political and economic development. Diamond (1997) has argued that the timing of the transition from hunter-gatherer societies to sedentary, agricultural

societies has had an immense impact on present-day levels of economic development. He argues that the human populations of Eurasia benefited from a large expanse of territory lying along the east-west axis, thereby positioning Eurasian peoples to benefit from agglomeration effects and technological diffusion. Olsson and Hibbs (2004) use prehistorical data on initial biological endowments at the time of the transition to agriculture to estimate present day levels of wealth, finding that areas with appropriate endowments of domesticable plant and animal life are indeed more wealthy than those with less accommodating biological endowments, even in the presence of controls for institutional quality. Moreover, Gallup, Sachs, and Mellinger (1999) have demonstrated that geography affects long-run economic growth by influencing agricultural productivity, access to markets, and the disease environment.

Engerman and Sokoloff (1997) have emphasized the negative consequences for institutional development of certain geographically determined factor endowments that engender extremely unequal resource distribution. Specifically, they argue that the suitability of the Caribbean and Andean regions to plantation-based cultivation of valuable luxury crops such as sugar and coffee led to the massive importation of slaves and the development of institutions that facilitated the concentration of wealth and political influence. Acemoglu, Johnson, and Robinson (2001) and Rodrik, Subramanian, and Trebbi (2004) have affirmed this position, arguing that geography has a strong indirect effect on economic growth by influencing the quality of political and legal institutions. Their arguments hinge on the effects of settler mortality rates on the types of political and legal institutions that developed. Where geographic conditions approximated those in continental Europe, colonizers were more likely to establish

European-like institutions, with protections on private property and checks and balances against government expropriation. Where geographic conditions did not sustain large settler populations, extractive (and therefore non-capital forming) institutions were likely to be put in place. Djankov and Reynal-Querol (2007) use this same theoretical and empirical framework to argue for a direct effect of colonial institutions on the incidence of civil conflict. This perspective sets aside the question of whether geography, in part, determined whether European powers were successful in their attempts to subjugate foreign populations, a subject at the heart of Diamond's analysis.

The connection between oil export dependence and geography is seemingly the most straightforward. An obvious precondition for oil export dependence is the presence of petroleum deposits within the national territory or close to its coastline. Beyond the existence of oil to exploit, a second necessary condition for oil export dependence would appear to be a relative incapacity to sustain other types of export-oriented industries, which would affect oil export dependence both by increasing domestic demand (ostensibly freeing up less product for export to international markets) and balancing the export portfolio of the country. This may be due to a variety of factors. Some are political. Oil production is less dependent on dense complex networks of information and transactions than either manufacturing or services, and therefore production is less likely to suffer from political and economic instability.[20] Oil production may succeed in contexts where many other types of economic activity cannot. Moreover, mineral wealth typically raises the value of the national currency, making manufactured goods and services less competitive in international markets (the dreaded "Dutch Disease"). Other

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20 The current situation in Iraq suggests that this contention is not airtight, as insurgent attacks on infrastructure have crippled that country's ability to bring its substantial oil wealth to market.

factors may be ecological. As Diamond and others have argued, some climates are more hostile to the development of large-scale agriculture and the attendant benefits of technological diffusion. If this were the case, we would expect countries with climates hostile to large-scale agriculture to be more dependent on petroleum (contingent on its existence).

The United States is an illustrative example of the necessity of both conditions. Throughout the post-war era, the United States has been a massive oil producer, with average daily production equaled or surpassed only by the Soviet Union (and its successor states) and Saudi Arabia in several country-year observations (author's calculations, based on Humphreys' (2003) data). Massive domestic demand and a diversified export portfolio, however, mean that the United States can not accurately be described as an oil export-dependent economy, with fuel exports as a percentage of merchandise exports averaging only 3.2 percent in the sample.

5.3. Theory and Hypotheses

In this section, I present a theory that broadens the conceptual link between geography and conflict to encompass both strategic and tactical issues (the focus of the conflict literature) and environmental and geographic constraints (the focus of the development literature) on the fiscal-military development of the state. I argue that the case for indirect effects of the environment and geography on conflict, mediated through state capacity, is more convincing, and I develop hypotheses to test the argument.

5.3.1. Geography, Guerrilla Warfare, and "Close Terrain": Direct Effects

The direct, strategic and tactical effect of geography on conflict is on the ability of potential insurgents to engage in what is known as guerrilla warfare. Guerrilla warfare involves the use of small, lightly armed bands of fighters operating in remote areas, using hit-and-run and ambush tactics to engage numerically and technologically superior state forces. Fearon and Laitin (2003) argue that mountainous terrain increases the feasibility of insurgency because it endows insurgents with places to hide safely, thereby diminishing the power and organizational asymmetry between state forces and insurgents. This effect is especially important during the early stages of insurgent organization. Unlike states, insurgent groups usually do not have standing military capacity. The recruitment, training, and arming of combatants—in addition to the development of a resource base to fund these activities—takes place once the decision to fight has been made, and must occur in the shadow of a much larger, more organized state fighting force. These efforts are more likely to be successful when geographic conditions create remote, largely inaccessible safe havens, or to use Kalyvas's (2006, 88) terminology, "zones of insurgent control," in which these activities can take place.

The canonical example of this strategy is the "Yenan way" pursued by the Communist Party of China following the Long March of 1934-1935. Having lost over 90 percent of their personnel during the year-long retreat, the remaining Communist forces built their new base in Yenan, the rugged, arid hills of northern Shaanxi province. The remoteness of the region gave Communist organizers both the territorial autonomy necessary to organize and a base of peasants with virtually nonexistent linkages to the

KMT government in Nanjing from which to recruit (Selden 1971). The ultimate results were the creation of a territory in which the insurgents developed state-like institutions for mobilizing resources and popular support, the ascendancy of Mao Zedong to leadership of the Chinese Communist Party, and the eventual victory of his forces in 1949.

The case of China (Mao 1961), and to a lesser extent those of French Indochina and later Vietnam (Desai and Eckstein 1990, Nagl 2002, Elliott 2003), have dominated thinking about rural insurgency and informed the hypotheses present in the conflict literature. To the extent that geography exerts an impact on civil conflict onset, the rough-terrain-as-insurgent-haven paradigm is representative of the dominant thinking on the subject.

In these studies, geography is conceptualized entirely in terms of penetrability: the degree to which terrain impedes the surveillance capacity and mobility of state forces. Surveillance capacity refers to the ability of forces to observe the actions of opposition forces and local populations. If being able to hide is crucial in the early stages of insurgency, terrain must offer good hiding places. In military terminology, mobility refers to the degree to which forces retain their ability to fulfill their primary mission while in motion. Mobility is therefore a function of the composition of fighting forces and the trafficability of the environment in which they operate. A mechanized, heavily armored force such as the US Army's "Iron Horse" Fourth Division might be highly mobile across open, rolling country, sparsely populated by trees and rivers, but virtually immobile in mountainous areas. The preceding are examples of what is called close terrain, an environment of poor visibility and trafficability (O'Sullivan and Miller 1983).

This type of terrain facilitates insurgency by diminishing the advantages conferred by superiority of numbers and firepower, as state forces operating in these areas are necessarily much more like the guerrilla bands they face: small and lightly armed.[21]

5.3.2. Environment, Geography, and State Capacity: Indirect Effects

In this section, I argue that the environment and geography are the key determinants of the institutional attributes of sovereign states, and thus establish a more plausible mechanism through which macro-level geographic features affect conflict. This position is informed by three observations, two empirical and one theoretical.

First, a closer look at the illustrative example of the "Yenan way" demonstrates that rough terrain need not dominate the national territory for an insurgency to be successful. Fearon and Laitin establish a linear relationship between the log-transformed percentage of mountainous terrain in a country and the likelihood of conflict onset, which they argue is evidence of this strategic/tactical effect. China, however, is an extremely large country with varied topography. The Yenan region of Shaanxi province, the base of operations for the Chinese Communist forces from 1935-1948, makes up a tiny fraction of the national territory, yet is an area roughly twice the size of the US state of Maryland: over 60,000 square kilometers. There is nothing in the tactical or strategic theory of insurgency, as espoused by Mao or Guevara, to suggest that rough terrain need dominate the national territory. Its existence may approach a necessary condition for both Mao and Guevara, but it cannot possibly be construed as sufficient, as virtually all countries are

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21 Some of the most effective counter-insurgent forces, from Rhodesia's Selous Scouts to the US Special Forces ("Green Berets"), typically operate in teams of no more than 12-15.

characterized by some rough terrain. This point is augmented by Herbst (2000) and Raleigh (2004), who observe that modern insurgencies are just as likely to take place in urban environments as in the hinterlands.

Second, cross-border safe havens may act as direct substitutes for rough terrain, facilitating insurgent organization. Because states are territorially bounded, they have markedly diminished capacity to project force beyond their borders. Social actors, such as rebel movements, may be able to organize transnationally, using international borders as a check on the ability of the state to suppress insurgent activity. Though not all insurgent movements have access to cross-border havens, 55 percent of insurgent groups operating between 1951 and 1999 utilized territory outside of the borders of the state against which they were in rebellion (Salehyan 2007). Though this finding suggests further empirical questions regarding the circumstances under which such havens will be available to potential insurgents, it does suggest that the strategy and tactics of insurgency may not be as dependent on rough terrain as has been thought.
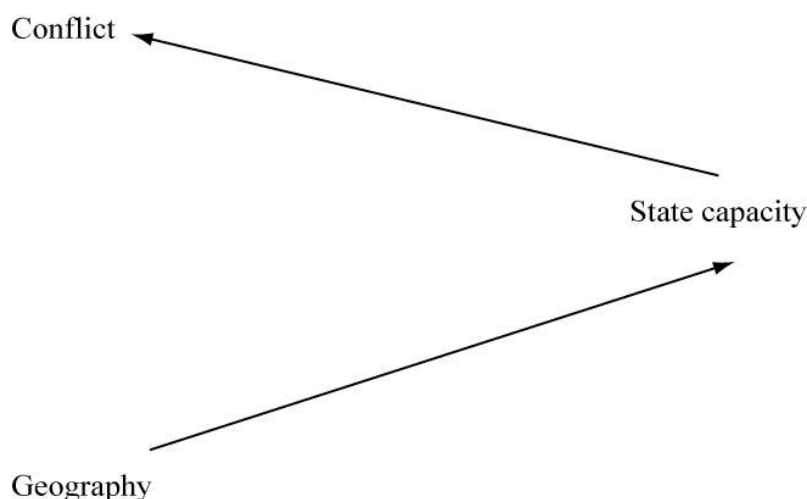
Figure 5.2. Geography and Conflict, Mediated by State Capacity

The third, theoretical, and most important observation is that in singularly fixating on geography in terms of facilitating the military technology of insurgency, we have not asked whether states may be subject to environmentally- and geographically-determined systems of incentives and constraints on their form and function, leading to an indirect effect of geography on conflict, mediated through its effect on state capacity.

Building on the theoretical argument of chapter three, I contend that geographic factors, specifically 1) resource diffusion in the preindustrial period of state formation, and 2) mountainous terrain, affect the capacity of the state to deter violent challenges to its authority. In sum, diffuse resources give the state incentives to generate tax compliance via inducements in the form of public goods, rather than rely on their comparative advantage in coercion. Diffuse resources increase increase also the problems of collective action that societies face in attempting to self-provide these public goods, giving society an incentive to contract for their provision. In contrast, concentrated resources give the state incentives to generate tax compliance via coercion or direct monopolization, increasing the likelihood that revenue will be generated internally and obviate the need for taxes. Moreover, concentrated resources lead to market structures characterized by fewer producers with larger market shares, and thus potentially encompassing interests in the self-provision of public goods. Therefore,

H_1: Resource diffuseness is positively associated with tax capacity.

For any distribution of preferences over the extent of taxation, transaction costs will affect the outcome. Mountainous terrain is significant for the fiscal contract because it increases the transaction costs associated with gather information, bargaining, and finally monitoring and enforcing cooperation. While there are factors that might affect

the degree to which societies can overcome these difficulties—shared religion, culture, economic institutions like regional marketplaces—mountainous terrain has been demonstrated to exert an impact on the strength of these non-state institutions as well. Therefore,

H₂: Terrain mountainousness is negatively associated with tax capacity.
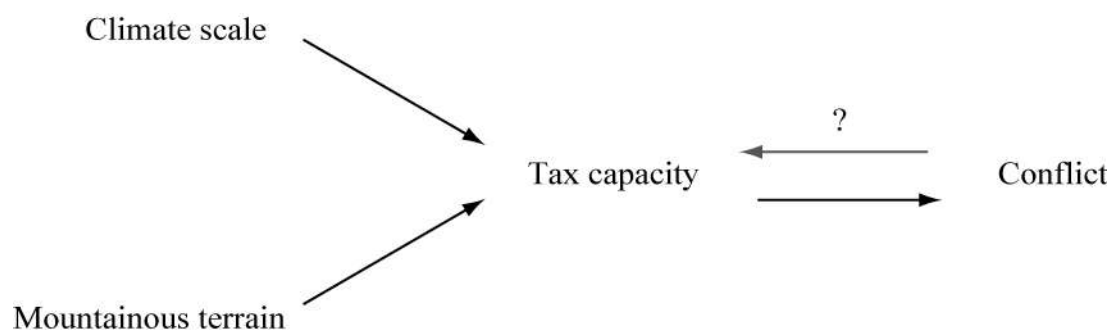
Figure 5.3. The Causal Mechanisms

The agroclimatically-determined resource base and terrain affect the form and capacity of state institutions by establishing incentives for investment in the capacity to tax. The capacity of state institutions, defined in terms of tax capacity, subsequently affects the ability of the state to deter violent challenges to its authority, and thus the incidence of conflict. The causal argument is schematically summarized in Figure 5.3, and generates the following testable hypothesis:

H₃: Tax capacity is negatively associated with the incidence of civil conflict.

The implication of this schematic is clear: once the effects of the resource base and terrain on tax capacity are accounted for, there should be no direct effect of the two on conflict. Thus, my argument contradicts both the standard "rough terrain" hypothesis, which entails a direct effect, and the "natural resources as prize" hypothesis, commonly

proposed to explain the relationship between oil and conflict, which argues for a more direct effect of the resource portfolio. However, there is the question of whether conflict might affect taxation, and therefore lead to yet another problem of endogeneity. This question will be addressed directly in the following section.

5.4. Data, Estimation, Results, and Robustness Checks

The preceding argument links 1) resource diffuseness and 2) terrain openness in the preindustrial era to state capacity, which subsequently affects the likelihood of civil conflict. Moreover, it holds that once the impacts of these factors on state capacity are accounted for, the diffuseness of resources and terrain openness will exert no direct effects. This is both an implication of my theoretical argument and a requirement of the two-stage, cross-sectional estimation strategy I employ. In this section, I discuss operationalizations of the dependent and independent variables and the estimation strategy, and I present the findings of my analysis and robustness checks.

5.4.1. The Dependent Variable: Incidence of Conflict, 1970-2002

The dependent variable is a dummy that has a value of 1 if the country experienced a civil war that began between 1970 and 2002, 0 otherwise. Two codings of this variable will be used: that used by Fearon and Laitin (2003), and that developed by the Uppsala Conflict Data Project/International Peace Research Institute, Oslo (UCDP/PRIO). Fearon and Laitin define insurgency as:

> 1. The presence of groups who sought either to take control of a government, take power in a region, or use violence to bring about a change in government policies.
> 2. A conflict that killed or has killed as least 1000 over its course, with a yearly average of at least 100.
> 3. At least 100 of the dead are on the side of the government (including civilians attacked by rebels) (2003, 76).

The UCDP/PRIO data define conflict as a violent incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths per year. Largely due to the lower casualty threshold, the UCDP/PRIO data include more incidents, with conflicts occurring in 54.3 percent of states in the sample, in comparison to 33.8 percent according to the Fearon and Laitin coding.

In focusing on the incidence of conflict, rather than conflict onset, this analysis departs somewhat from the more common subject of the theoretical and empirical literature. This decision is motivated by the fact that the causal argument focuses on variables that, by their very nature, do not vary (perceptibly) over time. Arguments that place causal weight on stationary variables are unsuitable for explaining the specific timing of conflict, but may nevertheless capture the long-term developmental trends that have led to conflict during the window of observation.

5.4.2. The Independent Variable: Tax Capacity, or the Tax/GDP Ratio

My analysis focuses on state capacity as the most significant determinant of conflict. Emanating from the microeconomic theory of the state (North 1981, Lake 1992, Timmons 2005), my preferred operationalization is the ability of the state to secure

payment for the provision of goods and services via taxation, measured by total tax share as a percentage of GDP and averaged over the period 1980-2002, total taxes/GDP. The data are from the *World Development Indicators*. In principle, these values should be endogenous to conflict, as they are taken from the window of observation. However, the instrumental variables approach, described in the following section, offers a solution to this particular problem. While some debate exists over the construct validity of this measure (for an insightful discussion, see Lieberman 2002), it is the most widely used measure of the ability of the state to extract resources from private actors, and one of the more widely accepted operationalizations of state capacity (Levi 1988, Cheibub 1998).

5.4.3. Instrumental Variables Analysis with a Binary Dependent Variable

As Miguel, Satyanath and Sergenti (2004) note, much of the conflict literature does not rigorously address the endogeneity of economic and political variables to conflict, and therefore does not make convincing causal arguments. The potential for conflict to affect taxation—i.e., reverse causality—in particular is high: conflict itself could directly interfere with the ability of the state to collect taxes, lowering observed levels of taxation. This causal link is the exact opposite of my argument, but would be observationally equivalent in a single-stage estimation strategy. Alternately, conflict could cause the state to increase its tax effort in order to pay for increases in military spending, which would lead to inferences linking higher tax/GDP ratios with conflict.

The potential for endogeneity and reverse causality is not peculiar to taxation. The extant literature tends to rely on endogenous variables, specifically measures of

economic development, strength and coherence of political institutions, and natural resource dependence as predictors of conflict. Typically, this problem has been addressed partially by using lagged indicators. The problems with this solution are amplified by the effect of coding the onset of conflict according to battle deaths, which may cause us to overlook the effects of lower intensity conflicts on these indicators.[22]

Instrumental variable, or two-stage, approaches offer a qualified solution to the problem of endogeneity and reverse causality. In the first stage, exogenous variables—which are uncorrelated with the ultimate outcome variable, save for their mediated impacts—and controls are used to instrument for the endogenous indicator (in this case, tax/GDP ratio) using cross-sectional, ordinary least-squares regression. In the second stage, the effect of the instrumented endogenous indicator on the outcome variable (in this case, conflict) is estimated using maximum likelihood probit models.

The qualification is that instrumental variables approaches require valid instruments: exogenous variables that are correlated with the endogenous explanatory variable but that, subject to the inclusion of appropriate control variables, do not exert an impact on the ultimate outcome variable, other than through their effects on the endogenous variable (Alvarez and Glasgow 1999, Acemoglu, Johnson, and Robinson 2001). In the subsequent sections, I describe my choices of instruments in greater detail.

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22 Two well known examples of this problem are the Cuban Revolution, which is coded in the Fearon and Laitin dataset as having begun in 1958 (1957 according to the UCDP/PRIO), even though Castro had been organizing his 82-person fighting force in Mexico since 1955 and the first battle of conflict (the landing at *Playa Las Coloradas* on December 2) occurred in 1956. An even more egregious example is that of the Nicaraguan Revolution, coded in both datasets as having begun in 1978 even though the primary rebel group, the FSLN, had been constituted in 1961.

5.4.4. The Instruments

The theoretical argument outlined in section 3 suggests that resource diffuseness and terrain were significant determinants of the form and scope of states in the preindustrial era. Because both climate and terrain are almost entirely exogenous to human activity, they are prime candidates for instruments for state capacity. To instrument for the tax/GDP ratio, I focus on two exogenous, geographic indicators. The first, climate scale, was developed by Hibbs and Olsson (2004) and is designed to capture the degree to which climatic conditions are favorable to annual, cold-cereal heavy grasses such as wheat, maize, oats, and millet—the agricultural products that most closely approximate diffuse resources. The variable is measured on a four point scale, ordered in ascending value: 1 for dry tropical (desert), 2 for wet tropical (rainforest), 3 for temperate humid subtropical and temperate continental, and 4 for dry, hot summers and wet winters.[23] This scale is based on the Köppen-Geiger climate system, which classifies climate according to average annual precipitation and temperature, and is calculated by summing these values, weighted by the proportion of national territory falling within these categories. The mean country value is 2.33 with a standard deviation of 0.99, bounded on the lower end by a host of desert countries such as Saudi Arabia (1.0) and on the upper end by Ireland, Belgium, Greece, Portugal, Uruguay, and the Netherlands (4.0). The measure is highly correlated with the Food and Agriculture Organization's land suitability for rain-fed wheat agriculture variable ($r^2 = 0.67$), though the climate scale measure is preferred because several variables used in calculating the FAO measure are

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23 The treatment of highland climate (Köppen-Geiger zone h) is somewhat problematic. Most analyses ascribe to highland climate the climatic conditions of surrounding, non-highland territory. This study follows that convention.

clearly endogenous to human activity.[24] It is virtually uncorrelated with land suitability for rain-fed maize and rice agriculture ($r^2 = -0.02$, $r^2 = -0.11$).[25] Higher values should be positively associated with tax capacity.

The second indicator is a proxy for the penetrability of terrain. I use the log-transformed percentage of mountainous terrain, which is taken from the Fearon and Laitin (2003) dataset on insurgency. The data were coded by A.J. Gerrard and filled in by Fearon and Laitin for a small subset of cases. The mean country value is 2.14 with a standard deviation of 1.44, bounded on the lower end by a host of flat countries and on the upper end by Bhutan (4.56) and the mountain kingdom of Lesotho (4.42). Higher values indicate less penetrable terrain, and should be negatively associated with tax capacity.

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24 For instance, the FAO takes account of population, land degradation, land use and land cover (http://www.fao.org/ag/agl/agll/aez.stm).

25 This fact is attributable to the additive construction of the variable, which does not perfectly measure climate suitability for cold-season cereal, and maize and rice agriculture, as two ends of a continuum. Dropping climate scale values lower than 2.0 (i.e., values associated with desert climate) strengthens the negative correlation between climate scale and suitability for rice agriculture to $r^2 = -0.5$, suggesting that the confounding effect is due to the lower end of the distribution being dominated by countries that are largely unsuitable for rain-fed agriculture in general.

Figure 5.4. Climate, Terrain, and Total Taxes/GDP, 1980-2002
A useful way of thinking about the Y-axis is that higher values would
be for countries with flat terrain and climates perfectly suitable for
Eurasian staple crop agriculture. Lower values would be associated
with more mountainous terrain, or more desert-like conditions, or both.
This accounts for the similar values of Rwanda, Kazakhstan, and Iran.

Figure 5.4 depicts the strong relationship between climate scale, the inverse of

log-transformed mountainous terrain[26], and the tax/GDP ratio, with the geographic

variables normalized to one and interacted. The first-stage relationship is quite strong:

together, the climate scale and mountainous terrain variables explain 62.5 percent of the

observed variation in the tax/GDP ratio. The robustness of this relationship is established

at length in the preceding chapter.

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26 The inverse is used simply to facilitate the creation of the interaction term, in which higher values are
presumably associated with higher tax capacity. A useful way of thinking about the Y-axis is that higher
values would be for countries with flat terrain and climates perfectly suitable for Eurasian staple crop
agriculture. Lower values would be associated with more mountainous terrain, or more desert-like
conditions, or both. This accounts for the similar values of Rwanda, Kazakhstan, and Iran.

One potential threat to the validity of climate scale as an instrument for resource diffuseness is that it could also pick up variation in the disease environment, which is largely climatically determined and which others have argued is a significant determinant of present-day state institutions and levels of development (Acemoglu, Johnson, and Robinson 2001, Sachs and Malaney 2002, Rodrik, Subramanian, and Trebbi 2004). To control for this possibility, I introduce a third instrument: the percentage of the country's land area in zones of malaria transmission in 1946, the earliest date for which such data are widely available (Gallup, Sachs, and Mellinger 1999).[27] Climate scale and land area in zones of malaria transmission are weakly negatively correlated ($r^2 = -0.21$). Climate scale and mountainous terrain exhibit virtually no correlation ($r^2 = 0.03$).

5.4.5. Results and Robustness Checks

My analysis indicates both a strong first-stage relationship between climate, terrain, and state capacity, as measured by the tax/GDP ratio, and a strong, robust second-stage relationship between the tax/GDP ratio and the incidence of civil conflict, especially larger conflicts. As the tax/GDP ratio increases, conflict becomes less likely. This relationship holds in the presence of the three most robust explanatory variables in the conflict literature: GDP per capita, the coherence of political institutions, and reliance on oil exports, and is relatively robust across codings of the dependent variable. Moreover, once the climatic and geographic effects on state capacity are accounted for, the impacts

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27 Percent land area in zones of malarial transmission is the least plausibly exogenous of the three instruments, as human attempts to control malaria, including the draining of swamps, have been effective in many areas. While this does suggest that the variable is not fully exogenous, it the least likely to be affected by proximate political factors, such as civil wars or changing levels of taxation.

of these widely accepted explanatory variables are significantly diminished or disappear entirely, apart from their indirect effect on the tax/GDP ratio. In a like manner, the direct effect of geography on conflict disappears.

Table 5.2 reports two-stage probit models of conflict incidence and the tax/GDP ratio, as instrumented by the climate scale and percentage of mountainous terrain, along with several control variables. I report results for six different specifications, each estimated on the Fearon and Latin and UCDP/PRIO codings of the dependent variable, for a total of twelve models. Model 1 includes only the exogenous instruments in the first stage, and the instrumented tax/GDP ratio in the second. Model 2 adds a control for log-transformed GDP per capita in 1970[28], to control for possible wealth effects at the outset of the window of observation (1970-2002). Model 3 adds a control for the stability/consolidation of political institutions, Polity 2 squared, as measured in 1970, and model 4 introduces a dummy control for whether or not the country derives more than 33 percent of its export revenue from petroleum, as coded by Fearon and Laitin, in 1970. Data availability, especially for the taxation variable, somewhat limits the number of countries included in the samples, though with respect to geography, the differences between the omitted and included countries are very small.[29] Entries in the table are coefficients, with standard errors reported below.

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28 All controls discussed in this section are taken from Fearon and Laitin (2003).
29 The mean values for climate scale and mountainous terrain are 2.43 and 2.24 in the sample, 2.16 and 2.01 in the excluded cases. Conflicts occur in 54.3 percent of states in the sample (according to the UCDP/PRIO coding), 54.2 percent in the excluded cases.

Table 5.1. Two-Stage Probit Estimates of Incidence of Civil Conflict, 1970-2002

	1 (COW)	1 (PRIO)	2 (COW)	2 (PRIO)	3 (COW)	3 (PRIO)	4 (COW)	4 (PRIO)	5 (COW)	5 (PRIO)	6 (COW)	6 (PRIO)
Tax/GDP	**-0.086*** **	**-0.073*** **	**-0.117*** **	**-0.059** **	**-0.129*** **	**-0.059** **	**-0.129*** **	**-0.053***	**-0.152*** **	**-0.031**	**-0.114*** **	**-0.054**
	0.020	0.016	0.032	0.027	0.030	0.029	0.032	0.033	0.021	0.063	0.039	0.035
Log GDP per capita, 1970			-0.106	-0.374*	-0.141	-0.367*	-0.151	-0.405*	-0.028	-0.453*	-0.318	0.265
			0.222	0.213	0.217	0.212	0.240	0.229	0.219	0.243	0.265	0.238
Polity2 Squared, 1970					0.008*	0.000	0.008	-0.001	0.008*	-0.002	0.008	-0.001
					0.005	0.005	0.005	0.005	0.004	0.006	0.005	0.005
Oil Exporter, 1970							0.095	0.258	0.025	0.287	0.321	0.252
							0.464	0.483	0.421	0.488	0.496	0.489
Climate Scale									**0.316**	**-0.139**		
									0.220	0.327		
Log Mountainous Terrain											**0.217**	**-0.007**
											0.134	0.111
Constant	1.020***	1.355***	1.526***	1.437***	1.312***	1.452***	1.308**	1.370***	1.029**	1.406***	0.567	1.396**
	0.376	0.312	0.480	0.410	0.466	0.416	0.495	0.458	0.448	0.501	0.727	0.622
First Stage Regression for Tax/GDP												
Climate Scale	**5.417*** **		**4.683*** **		**4.564*** **				**4.254*** **			
	0.738		0.867		0.876				0.930			
Log Mountainous Terrain	**-1.421*** **		**-1.533*** **		**-1.475*** **				**-1.446*** **			
	0.497		0.528		0.532				0.532			
Percentage Land Area in Malarious Zones	-4.419**		-4.523**		-3.960*				-4.082*			
	1.839		2.300		2.372				2.376			
Log GDP per capita, 1970			1.504		1.297				1.499			
			0.953		0.977				0.998			
Polity 2 Squared, 1970					0.026				0.028			
					0.027				0.027			
Oil Exporter, 1970									-2.412			
									2.447			
Constant	11.167***		11.825***		10.226***				11.044***			
	2.668		3.110		3.517				3.614			
R^2	0.43		0.48		0.49				0.49			
Observations	116		94		94				94			

* significant at 10%; ** significant at 5%, ***significant at 1%

The results in Table 5.1 suggest four main findings. First, the first-stage relationship between climate and terrain and the tax/GDP ratio is extremely strong and robust. In all specifications, climate scale and percentage mountainous terrain are highly significant, with point estimates that are stable to the inclusion of other endogenous control variables. Once the effects of climate and terrain are accounted for, the relationship between the tax/GDP ratio and GDP per capita, known as Wagner's Law, disappears. The variable is insignificant in all first-stage specifications, as are controls for oil export dependence and the strength and coherence of political institutions. Regarding oil export dependence, this finding provides some *prima facie* evidence for the fact that it is not oil as a prize, but rather a lack of taxable economic alternatives, that links oil to diminished state capacity (Ross 2001, Humphreys 2003).

Second, the effect of state capacity on the incidence of conflict is strong and relatively robust. The tax/GDP ratio is highly significant in ten out of twelve models, including all of the models at the higher coding threshold. The findings indicate, however, that the causal argument does a better job of explaining the incidence of larger conflicts than smaller ones: levels of statistical significance are consistently lower in models using the UCDP/PRIO coding, and none of the variables is a significant correlate of conflict incidence once the exogenous instruments are included in the model to check whether the instruments satisfy the exclusion rule. I attribute this to the fact that the lower coding threshold includes many conflicts that are quite small. As the window of observation covers such a long time period, it is difficult to devise a cross-sectional estimation strategy that will effectively separate out countries that may have experienced a single, low-level episode of civil conflict in a 32-year period.

Third, once effects on state capacity are captured, climate scale and mountainous terrain do not exert direct effects on the incidence of conflict. This points to two conclusions, both substantive. First, this suggests that the exclusion rule, which requires that exogenous instruments not exert a direct effect on the outcome variable, is satisfied. Second, this finding provides significant evidence that the effects of macro-geographic indicators on conflict in the extant literature are attributable to otherwise unmodeled state capacity, rather than the tactical/strategic considerations of potential insurgents.

Fourth, once climatic and geographic effects on state capacity are accounted for, the impacts of the widely accepted explanatory variables—GDP per capita, Polity 2 squared, and oil export dependence—are significantly diminished or disappear entirely, apart from their indirect effects on the tax/GDP ratio. I attribute this finding to two factors. The first is that most of the robust covariates in the conflict literature are intended, in the absence of more direct measures, to proxy the capacity of states to deter violent challenge to authority. Thus, by estimating the effect of state capacity more directly, my analysis captures this vector of variance. The second is that the cross-sectional design of this study, and the emphasis on incidence of conflict, rather than intensity or duration, does not differentiate between countries that experience a single relatively small, short-lived conflict and those where conflict is endemic. It is probably the case that poorer, less politically consolidated, and more oil dependent countries are likely to experience multiple conflicts (the conflict trap, see Collier et al. 2003). Whereas these countries would be counted several times in a country-year model of conflict onset, they are counted a single time here.

The validity of my two-stage probit analysis hinges on the assumption that, subject to the inclusion of appropriate controls, climate scale and mountainous terrain exert no direct effects on conflict incidence, other than their effects on the tax/GDP ratio. This presumption may be problematic to some, so in this section I bolster my analysis by controlling for several possible variables that could covary with both tax capacity and conflict incidence: total government revenue, military capacity, and colonial history.

First, I address the potential effect of total revenue. If the tax/GDP ratio is just a measure of total state revenue, then the estimated effect of taxation on conflict may just be capturing variation in total state resources that can be invested in repression and/or accommodation (Benson and Kugler 1998, Ross 1999, 2001, Smith 2004). In order to control for this possibility, I introduce a control for total government revenue as a percentage of GDP, averaged over the period 1980-1997 (data are from Ross 2004). The tax/GDP ratio and total revenue are highly correlated ($r^2 = 0.73$), which introduces a problematic level of collinearity into the first stage estimation. To address this problem, I regress the tax/GDP ratio on total revenue, and include the residuals from that regression as a control for total revenue. Many of the highest residuals (total revenue − predicted revenue, given tax/GDP ratio) belong to those countries that derive large revenues from oil and primary commodity exports (Kuwait, Oman, Republic of Congo, Botswana) and former Communist countries with large public sectors and networks of state-owned enterprises (Romania, Poland, Hungary). By construction, the residuals or total revenue are uncorrelated with the tax/GDP ratio.

Second, I include controls for the military capacity of governments. It is possible that military capacity may matter more for conflict incidence than measures that proxy

bureaucratic development and tax capacity, as the ability to repress or deter violent challenges may simply be a function of military size and spending. To this end, I include controls for military personnel per capita in 1970, and log-transformed military spending per soldier in 1970, as the distribution is highly skewed. Both are taken from the Correlates of War National Material Capabilities dataset, version 3.02 (Singer, Bremer, and Stuckey 1972). Military personnel per capita is a cross-sectional yardstick for comparing the relative size of military forces to the societies they police, while spending per soldier is intended to proxy the technological sophistication of the fighting force, both in terms of human (training) and capital (weaponry, logistic support) inputs.

Finally, I include controls for colonial heritage. Scholars representing a broad swath of the social sciences contend that the colonial experience had detrimental effects for state capacity in much of the developing world, as political and economic institutions were designed for the benefit of the colonial power, rather than local populations (Cardoso and Faletto 1969, Wallerstein 1974, Young 1994, La Porta et al. 1998, 1999, Acemoglu, Johnson, and Robinson 2001, Djankov and Reynal-Querol 2007). In order to control for this potential effect, I include a dummy variable for whether or not the country had ever been colonized, as well as separate dummy variables indicating whether or not the country had been a British or French colony, to account for whether institutional differences in the colonizing country may exert an effect (Hayek 1960, La Porta et al. 1998, 1999).

Table 5.2. Two-Stage Probit Estimates of Incidence of Civil Conflict, 1970-2002,
Robustness Checks

	7 (COW)	7 (PRIO)	8 (COW)	8 (PRIO)	9 (COW)	9 (PRIO)	10 (COW)	10 (PRIO)
Tax/GDP	**-0.121***	**-0.054**	**-0.136***	**-0.047**	**-0.141***	**-0.042**	**-0.147***	**-0.054**
	0.035	0.033	0.034	0.040	0.033	0.047	0.030	0.046
Log GDP per capita, 1970	-0.153	-0.392	-0.142	-0.184	-0.119	-0.202	0.000	-0.033
	0.267	0.247	0.298	0.278	0.298	0.285	0.317	0.314
Polity2 Squared, 1970	0.009*	-0.001	0.008	-0.002	0.007	-0.002	0.007	-0.004
	0.005	0.005	0.005	0.006	0.005	0.006	0.005	0.006
Oil Exporter, 1970	0.391	0.334	0.338	0.350	0.302	0.371	0.254	0.236
	0.508	0.499	0.489	0.503	0.491	0.511	0.486	0.532
Total Revenue Residuals	-0.048	-0.022	-0.050	-0.013	-0.048	-0.012	-0.053*	-0.020
(controlling for Tax/GDP)	0.032	0.025	0.031	0.023	0.030	0.023	0.031	0.027
Military Personnel per Capita, 1970			0.033	-0.038	0.031	-0.036	0.030	-0.030
			0.025	0.031	0.028	0.031	0.027	0.032
Log Military Expenditure per Soldier, 1970			0.110	-0.210	0.110	-0.210	0.090	-0.170
			0.222	0.228	0.218	0.229	0.219	0.233
Colonized (1=Yes, 0=No)					-0.138	0.093	-0.340	-0.110
					0.486	0.483	0.543	0.555
British Colony							0.194	-0.111
							0.419	0.456
French Colony							0.334	1.204**
							0.427	0.607
Constant	1.060*	1.401***	0.330	3.056*	0.548	2.903*	0.823	2.763
	0.597	0.498	1.622	1.584	1.752	1.735	1.771	1.788
			First Stage Regression for Tax/GDP					
Climate Scale	**4.096***		**3.270***		**2.712****		**2.730****	
	0.946		0.964		1.145		1.162	
Log Mountainous Terrain	**-1.608***		**-1.810***		**-1.810***		**-1.772***	
	0.567		0.560		0.560		0.589	
Percentage Land Area in Malarious Zones	-3.982		-2.455		-2.245		-2.166	
	2.401		2.511		2.502		2.551	
Log GDP per capita, 1970	1.845*		2.155*		2.272*		2.378*	
	1.034		1.265		1.273		1.351	
Polity 2 Squared, 1970	0.021		0.014		0.013		0.011	
	0.028		0.027		0.027		0.028	
Oil Exporter, 1970	-1.965		-1.202		-1.389		-1.429	
	2.562		2.453		2.465		2.516	
Total Revenue Residuals	-0.084		-0.224**		-0.221**		-0.222**	
(controlling for Tax/GDP)	0.101		0.105		0.105		0.108	
Military Personnel per Capita, 1970			.225**		0.197		0.198	
			0.111		0.126		0.129	
Log Military Expenditure per Soldier, 1970			0.832		0.718		0.729	
			1.107		1.115		1.165	
Colonized (1=Yes, 0=No)					-2.129		-2.288	
					2.352		2.719	
British Colony							0.112	
							2.346	
French Colony							0.675	
							2.495	
Constant	11.910***		4.932		8.848		8.530	
	3.679		9.352		10.314		10.699	
R^2	0.50		0.56		0.56		0.56	
Observations	91		89		89		89	

* significant at 10%; ** significant at 5%, ***significant at 1%

Table 5.2 reports two-stage probit models of conflict incidence with the aforementioned controls for total revenue, military capacity and colonial heritage.

Overall, I find that the results reported in Table 5.2 change very little with the inclusion of these controls. Most importantly, the coefficient estimates on climate scale and mountainous terrain in the first stage, and the tax/GDP ratio in the second stage, are consistent. However, the model continues to perform better in explaining the incidence of larger conflicts than smaller ones.

Total revenue, adjusted for taxes, is significant in the first stage (models 8-10), but generally insignificant in the second stage, though the sign is in the expected direction: more non-tax state revenue is associated with a diminished likelihood of conflict incidence, though the finding is not robust. This suggests that the structure of revenue—whether derived from taxation or not—matters more for conflict incidence than the total amount (Benson and Kugler 1998). As such, the finding is in line with my theoretical argument.

Neither measure of military capacity is remotely significant in the second stage, and the signs on the the point estimates flip depending on the size of conflict. These findings can be interpreted two ways. First, they can be interpreted as evidence that military capacity, on its own, does not explain the incidence of conflict in the window of observation. Second, it may be taken as evidence that these measures are unsatisfactory operationalizations of the concepts of relative military size and technological sophistication. Military spending is known to be positively associated with corruption (Gupta, de Mello, and Sharan 2001), which suggests that a measure of military spending, controlling for corruption, would perhaps be a better operationalization of the core concept.

Finally, neither former colonial status, nor British or French colonial heritage, are

remotely significant in the first stage, and are by and large insignificant in the second. Only in the second stage, and at the lower coding threshold, is French colonial heritage significant and associated with a higher incidence of conflict (model 10). While somewhat counterintuitive, this finding makes sense in light of the literature on geography and colonialism, which argues that local environmental, geographic, and disease-related factors, rather than the political institutions and legal systems of the colonizing countries, best explain the institutions colonial powers left behind (Engerman and Sokoloff 1997, Acemoglu, Johnson, and Robinson 2001, Engerman and Sokoloff 1997, Djankov and Reynal-Querol 2007). Because the effects of climate, terrain, and disease environment are captured by the exogenous instruments in the first stage, it is entirely consistent with the argument of this chapter that measures of colonial heritage are by and large insignificant.

5.5. Conclusions

This chapter addresses the relationship between the environment, geography, and conflict from a novel perspective. Instead of focusing on the strategic and tactical considerations of insurgents, I investigate the impacts of climate and geography on the capacity of states, as measured by the tax/GDP ratio. I contend that current differences in the tax capacity of states were determined historically by 1) the economic resources at their disposal in the preindustrial period of state formation, and 2) the costs of enforcing compliance in areas where traditional military forces have difficulty projecting power. The nature of economic resources in the preindustrial era, whether point-source or

diffuse, was key. Where point-source resources dominated, state-building actors could extract resources relatively easily without developing large, bureaucratically organized, and territorially delineated state institutions. Where diffuse resources dominated, state-building actors had to develop these institutions because their efforts at taxation were only profitable at scale. Secondarily, the strategic and tactical environments affected the ability of state-building actors to tax. Where rough terrain dominated, state-building actors faced higher costs to projecting authority, and were less able to enforce compliance with taxation.

I then use two-stage probit models to estimate the indirect effects of climate and geography on conflict incidence as mediated by my preferred measure of state capacity: the tax/GDP ratio. I find strong, robust first-order relationships between climate scale and mountainous terrain and taxes and the tax/GDP ratio. More importantly, I find that once properly instrumented, as the tax/GDP ratio increases, conflict becomes less likely. This relationship is robust to controls for GDP per capita, the coherence of political institutions, and reliance on oil exports. Moreover, once the climatic and geographic effects on state capacity are accounted for, the effects of widely accepted explanatory variables are reduced or disappear, apart from their indirect effect on the tax/GDP ratio. In a like manner, the direct effect of geography on conflict disappears.

These findings point to two main conclusions. The first is that climate and geography are significant determinants of state capacity. By focusing almost exclusively on the geographically-determined incentives facing potential rebels, the opportunity literature has not addressed the expanding literature on geography and long-run development, which holds that geography and climate are significant determinants of the

massive present-day gaps in wealth and institutional quality across countries. This chapter builds a needed bridge between the two, and in doing so offers a new approach to answering an old question.

The second conclusion is that the effects of geography are pronounced when aggregate, national measures are used. Disaggregating the unit of analysis may allow us to test more directly the role of rough terrain, as well as a host of other variables such as the presence of lootable commodities, access to cross-border havens, and differences in wealth, that are non-constant over the territory of a state. However, the emphasis on the present effects of these variables may cause us to lose sight of the fact that the decision to rebel takes into account not only the geographically proximate opportunity structure, but also the capacity of the state at large. Insurgent forces are relatively mobile and, more importantly, strategic about how and where they prosecute their war aims. In these considerations, the capacity of the state against which they rebel is paramount.

This analysis suggests at least two areas for further research. The first concerns the specific causal mechanisms through which taxation affects the incidence of conflict. Though taxation is a more theoretically satisfying operationalization of state capacity than many of the extant operationalizations, it could still affect conflict through a variety of causal mechanisms: taxation could cause state-building actors to develop better mechanisms for monitoring the actions of their citizens, thus providing them with information on the identities of potential insurgents and their activities (Kalyvas 2006). Or, taxation could simply mean greater resources for the state to invest in either repression or accommodation of dissident groups, though my robustness checks suggest this is not the case (Ross 2001, Smith 2004). Or, it could be evidence of the state's

greater legitimacy and effectiveness at providing goods and services, as the tax morale literature implies (Levi 1988, 1997, Alm, Sanchez, and de Juan 1995, Andreoni, Erard, and Feinstein 1998). While I believe the informational argument to be the most likely candidate, all of these mechanisms are consistent with the findings presented here. My next goal is to test between these competing causal mechanisms.

The second area of further research concerns the military organization of states. The theory suggests ostensibly testable hypotheses about the military organization of states as a function of their strategic and tactical environment, which most students of military history argue are largely determined by terrain (O'Sullivan and Miller 1983, Doyle and Bennett 2002). If it is the case that military organization and incentives to tax are jointly determined, it may be the case that the instrumented tax/GDP ratio is capturing otherwise unmeasured variance in the military capacities of states, even when controlling for military size and spending, as in the previous section. Data that more accurately operationalize both the size and technological sophistication of state forces will be needed to sort out this potential problem.

This chapter began with Guevara's observation that some types of terrain are more favorable than others to the tactical, hit-and-run conduct of insurgency. The central argument of this chapter has not been to refute Guevara's point—terrain clearly matters— but rather to establish a more plausible mechanism by which macro-indicators of climate and geography might affect conflict: through their effects on the state's capacity to tax. The central finding of this chapter is that once environmental and geographic instruments are used to produce non-biased estimates of tax capacity, their mediated effect on conflict incidence is strong and trumps that of both more common explanatory variables and the

direct, tactical effect of geography. While much work needs to be done to clarify the specific causal chain that connects taxation with reduced incidence of conflict, this analysis will hopefully motivate students of civil conflict to refocus their aim on the states against which insurgents rebel.

Chapter Six
Trends and Triggers:
Climate, Climate Change, and Civil Conflict
in Sub-Saharan Africa[30]

6.1. Introduction

The study of international security is expanding to include threats from a changing global environment. The Independent Commission on Human Security identifies three sources of threats: consumption of fossil fuels and increased pollution in urban environments; land degradation due to overuse, erosion, and desertification; and the buildup of greenhouse gases that "threaten widespread climate change" (Commission on Human Security 2003, 17). The causal link between climate change and threats to security, however, is not specified.

This oversight is curious, as a growing literature relates environmental scarcity to conflict, emphasizing the role of renewable resources such as fresh water and arable land (Homer-Dixon 1994, Hauge and Ellingsen 1998, Homer-Dixon 1999, de Soysa 2002, Urdal 2005). This literature is based on the neo-Malthusian notion of a monotonically dwindling resource pool. As natural resources become degraded due to overexploitation and global warming, it is argued, rising human populations will be forced to migrate internally or cross borders (Gleditsch, Nordås, and Salehyan 2007) and distributional conflicts will arise as populations compete for pieces of an ever-dwindling pie.

An alternate perspective is that increasing climatic variability may lead to

conflict. The environmental consequences of greater variability are declines in system predictability and stability, and increases in extreme events such as tropical storms (IPCC 2001), all of which may affect access to resources. Because the effects of resource scarcity are mediated by existing asymmetries of access and wealth, these effects are especially threatening to Sub-Saharan Africa, the population of which is primarily rural, poor, and dependent on forests for fuel and rain fed subsistence agriculture.

We investigate these arguments from two complementary perspectives. First, the effects of climate change on the onset of conflict must be conceived of as 1) long term trends that may lead to a higher baseline probability of conflict, and 2) short term triggers that affect the interannual variability in that probability. We estimate the impact of both long term trends (operationalized as climate suitability for heavy grass agriculture, land degradation, and freshwater availability per capita) and short term triggers (operationalized as the lagged percent change in annual rainfall) on the onset of civil conflict in Sub-Saharan Africa. We find that both operationalizations have a significant impact on the likelihood of conflict onset, even in the presence of controls typical of the conflict literature. An analysis of marginal effects leads us to conclude that interannual variability matters more than the specter of changes in overall climate that take place over long time periods.

Second, we assess the outlook for the future based on an analysis of predicted changes in precipitation means and variability generated by NCAR-PCM[31], a general circulation model (GCM). Using simulated values for precipitation over the period 2000-2099, we find that total annual precipitation flux is expected to increase in western Africa

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31 National Center for Atmospheric Research Parallel Climate Model. A more detailed description of the model can be found at http://www.cgd.ucar.edu/pcm/.

and the Sahel while decreasing in southern Africa. Moreover, few significant trends are found in our measure of interannual variability throughout the region.

These findings point to two conclusions. The first is that the future for Africa is not necessarily one defined by increasing interannual variability in rainfall, the most significant climatic variable in our analysis of conflict onset. The second regards policy. Our findings suggest that reducing dependence on rainwater for agriculture may mitigate conflict, even as rainfall variability is not predicted to increase over time.

The article proceeds as follows. Section two presents a review of attempts to link environmental change and conflict. Section three develops the argument that increases in interannual rainfall variability may be more significant in triggering conflict than more long term processes of land degradation and climate change, and presents hypotheses. Section four covers our identification strategy, summarizes our choices of variables and tests the model. Section five extends our discussion into the future, analyzing simulations derived from the GCM. Section six summarizes our significant findings and concludes.

6.2. Literature Review

The conventional discourse linking climate change to conflict focuses on long term changes in the climatic means that define ecosystems and their subsequent impact on access to renewable natural resources. The 18 GCMs that form the core findings of the Intergovernmental Panel on Climate Change (IPCC) project increases in mean global temperature between 1.8 and 4.0 degrees Celsius over the next 100 years (IPCC 2007).

As mean temperatures rise, the models project increased incidents of droughts, desertification and severe precipitation events. Human populations will experience decreased land productivity and freshwater availability.

This discourse has its roots in neo-Malthusian notions of carrying capacity. Neo-Malthusians argue that human population growth, coinciding with increases in affluence and per capita rates of consumption, will cause exponentially increasing demands on natural resources, leading inevitably to shortages, land and water degradation, and distributional conflicts (Ehrlich 1969, Ehrlich and Ehrlich 1990, Goldstone 1991, Homer-Dixon 1999, Goldstone 2002). The potential of technological innovation as a solution to these problems (Simon 1981) is considered remote due to lower stocks of human capital and therefore latent innovative capacity (Boserup 1965), which ultimately produces an ingenuity gap between innovative and stagnant societies that exacerbates existing asymmetries of access (Homer-Dixon 2000).

This perspective is criticized on theoretical and empirical grounds (Gleditsch 1998, de Soysa 2002, Nordås and Gleditsch 2007). Gleditsch argued that the causal mechanisms are too elaborate (operating through multiple paths of causality and several layers of intervening variables) and failed to account for differing levels of economic and political development on resource consumption and conflict—that is, highly developed economies and polities may experience lessened conflict over resources even as demand increases.

Even assuming the conventional causal mechanisms are valid, neo-Malthusian analysis does not identify short term causes that trigger the outbreak of conflict. It does predict conflict over access to resources, but the causal mechanisms are so complex, and

the environmental changes so gradual, that identifying theoretical or empirical thresholds that trigger violence once crossed is difficult. Hauge and Ellingsen (1998) concluded that countries subject to environmental damage, including deforestation and land degradation, were more likely to experience internal and external conflict. However, their coding of these variables was subjective and based on somewhat arbitrary cut points for collapsing continuous variables into dichotomous variables, and all their environmental measures were stationary. Stationary measures are those explanatory variables that do not vary within the window of observation. Because they are time-invariant, they are not well-suited to models designed to explain the specific timing of conflict onset. Moreover, a recent reanalysis by Theisen (2006) found that the study could not be replicated. Esty et al. (1998) found no relationship between environmental degradation and various types of state failure, including civil conflict.

Skeptical of the neo-Malthusian position, de Soysa (2002) tested similar hypotheses against an alternate (yet still stationary) operationalization of resource abundance and found that resource-rich areas were less likely to experience conflict, suggesting that resource scarcity led to greater resource strain and an increased likelihood of conflict. Contrarily, de Soysa found also that resource wealth was associated with lower economic growth rates and thus higher incidence of conflict. Therefore, the impacts of resource abundance and scarcity on conflict were both direct and indirect. The joint impact of population growth and resource degradation was studied by Urdal (2005), who found only weak support for the hypothesis that increased resource scarcity led to conflict.

More recent contributions to the study of environmental conflict depart from the

extant literature in two main ways. First, these studies make use of temporally variant measures of natural resource scarcity. Miguel, Satyanath, and Sergenti (2004) estimated the effect of economic shocks on the likelihood of civil conflict in Sub-Saharan Africa. Because the region is agrarian and irrigation is not widely practiced, they contended that rainfall was a plausible instrument for economic growth. Using data on rainfall variability, they found that increased rainfall had a positive impact on income growth and a negative impact on the likelihood of conflict, mediated by its effect on economic growth. The relationships between rainfall and other measures of environmental resource scarcity, however, were not addressed.

Second, several recent studies disaggregate the unit of analysis, departing from the traditional country-year research design and focusing instead on sub-national, geographically defined units. Raleigh and Urdal (2007) and Levy et al. (2005) represent two such analyses, applying geo-referenced data to small geographical units. Raleigh and Urdal found that freshwater availability had a negative impact on the likelihood of conflict. Moreover, they found this relationship was compounded by higher population densities and therefore more competition for resources. Applying a similar approach, Levy et al. found that when rainfall was significantly below normal, the likelihood of conflict outbreak was higher the subsequent year. While their study made use of economic and political control variables, the state-level resolution at which these data were available was a limiting factor. The conflict-mitigating effects of freshwater availability are examined (and partially contradicted) in the literature on interstate conflict by Gleditsch et al. (2006), who found that shared river basins increased the likelihood of conflict between neighboring countries.

Ultimately, our analysis makes use of time-variant measures of resource scarcity but does not disaggregate geographically. Disaggregation allows the testing of many arguments in the conflict literature that reference geographic features like rough terrain (Gates and Buhaug 2002) and resource endowments (Buhaug and Lujala 2005) that are non-constant across the territory of a state, relatively immobile, and for which precise data are available. In contrast, insurgent and state forces are relatively mobile and, more importantly, strategic about where they choose to prosecute their war aims. Without detailed knowledge about the leadership and personnel of the various movements, disaggregated analyses might lead to inferences that mistake strategic decisions about where rebels organize and fight for the grievances or opportunities that motivate them. At this point, the relative strengths and weaknesses of country-level, on the one hand, and geographically-disaggregated analyses, on the other, are varied enough to justify competitive coexistence.

Thus framed, we address two open questions in the literature. The first is how to combine stationary trend measures with temporally variant trigger measures in order to model the environmental conditions that lead to conflict. The second regards the neo-Malthusian tendency to assume a) that resources are dwindling, and b) that fewer resources lead inexorably to conflict.

6.3. The Argument and Hypotheses

6.3.1. The Argument

Much of the economic literature on civil war explains participation in rebellion as the result of rational cost-benefit analysis. This logic is rooted in Becker (1968) and Ehrlich (1973), who argued that the propensity to commit crime (in this case, the crime of rebellion) was a function of the payoffs and punishments associated with criminal activity.[32] This literature focuses on the costs authorities can impose on would-be criminals, defined as the benefit of criminal activity minus the expected severity of punishment, adjusted for the expected likelihood of apprehension. A second branch of this literature focuses on the opportunity cost to wages in the legal economy. Collier (2000) and Collier and Hoeffler (2002, 2004) contended that the gap between the expected economic returns from joining the rebels relative to those from conventional economic activity drove the empirical relationship between low income and the onset of civil war. Miguel, Satyanath, and Sergenti (2004) interpreted their findings regarding rainfall and conflict in precisely these terms. A particularly good year of rain increased the expected returns to participation in farming. Conversely, as agricultural productivity declined due to diminished rainfall, the opportunity cost to violence diminished.

Viewed from this perspective, we can generate hypotheses regarding the effects of land degradation, climatic conditions, and freshwater abundance on the likelihood of

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32 This would appear to be the implicit position of Fearon and Laitin (2003), who argued that the most significant determinant of civil war onset is the ability of the state to dissuade potential rebels. Wealthier, more politically consolidated and less geographically challenged states are less prone to conflict because potential rebels expect the likelihood of apprehension and therefore costs to rebellion to be high.

conflict. Land degradation refers to processes that negatively affect land productivity, which can be caused by overuse and mismanagement. If productivity is defined as the expected benefit per unit of effort, then we expect higher levels of land degradation to be associated with lower returns to agriculture and therefore a higher likelihood of conflict, *ceterus paribus*.

Climatic conditions may also affect conflict. Gallup, Sachs and Mellinger (1999) estimated that tropical agriculture suffered from a productivity gap of up to 50 percent compared with agriculture in more temperate zones. They argued that the mechanisms linking tropical climates to lower agricultural productivity were the unsuitability of tropical soil to large-scale, heavy grass agriculture and increased disease burden. We therefore expect climates less suitable for temperate agriculture to be associated with lower economic returns, more skewed income distribution, and therefore a lower opportunity cost to—and higher likelihood of—conflict, *ceterus paribus*.

Finally, freshwater resources may have an impact on expected returns to participation in agriculture, though the nature of this relationship is potentially complicated. One might suspect that larger stocks of freshwater resources would be associated with greater returns to agriculture. Therefore, the hypothesized relationship would be negative. However, large stocks of freshwater may be found in tropical zones that receive large amounts of rainfall but are characterized also by poor soil quality. As such, the hypothesized relationship between freshwater availability and conflict may be positive. We test both hypotheses.

The preceding interpretations ignore the fact that land degradation and climate change occur over long time spans, and, as such, represent trends to which human beings

have proven remarkably adaptive. Conflict is one possible outcome of increased resource scarcity, but it is hardly the only conceivable one. Observed solutions to persistent problems of land degradation and scarcity include the adoption of new agricultural technology, income diversification through participation in the wage-based economy, and internal migration (Reardon and Taylor 1996).

The problems associated with long term changes in land quality are present also in response to interannual variability in climate. However, short term variability leads to changes in income that leave less time for adaptation. Household studies of income diversification in Sub-Saharan Africa suggest that short term variability presents very different problems for agriculturalists, and that the negative effects of economic downturns are felt primarily by those at the lowest end of the economic spectrum operating in areas with few non-agricultural or agriculturally-linked alternate sources of income. These individuals are typically young men with low levels of social status— those most likely to take up arms.

This discussion suggests that a better identification strategy might focus on short term changes. Rainfall is one well-documented source of interannual variability. Therefore, we expect that higher levels of rainfall relative to previous years will be associated with higher returns to agriculture, and therefore lower risk of conflict *ceterus paribus*.[33]

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33 Of course, this relationship cannot be purely linear; too much rainfall may cause flooding and massive soil erosion. However, we were unable to identify such threshold effects (results not shown) in our analysis.

6.3.2. Hypotheses

H_1: Measures of land degradation are positively associated with the risk of civil war onset.

H_2: Measures of climate suitability for temperate agriculture are negatively associated with the risk of civil war onset.

H_3: Measures of freshwater availability are negatively associated with the risk of civil war onset.

H_4: Measures of freshwater availability are positively associated with the risk of civil war onset.

H_5: Contemporaneous measures of increased (decreased) rainfall are negatively (positively) associated with the risk of civil war onset.

H_6: Lagged measures of increased (decreased) rainfall are negatively (positively) associated with the risk of civil war onset.

In addition to these hypotheses, we investigate whether the effects of changes in rainfall are amplified by existing resource scarcity. Returning to the opportunity cost analogy, if expected wages are already low and alternatives scarce, negative changes in rainfall will affect to a greater extent those operating in already marginal lands or less suitable climates.

H_7: The interaction of increased (decreased) rainfall and land degradation should be negatively (positively) associated with the risk of civil war onset.

H_8: The interaction of increased (decreased) rainfall and climate suitability for heavy grass agriculture should be negatively (positively) associated with the risk of civil war onset.

H_9: The interaction of increased (decreased) rainfall and freshwater availability should be negatively (positively) associated with the risk of civil war onset.

6.4. Data, Estimation, and Results

6.4.1. The Dependent Variable: Civil Conflict Onset

The dependent variable is the onset of civil war in a given country-year in Sub-Saharan Africa. We rely on the coding developed by the PRIO/Uppsala Conflict Data Project (Gleditsch et al. 2002). The variable is coded as 1 for the year of onset only and 0 for all years thereafter. Though the data now cover the time period 1946-2006, we restrict our analysis to the period 1981-2002 due to availability of explanatory variables. Onset years make up 9.6 percent of all country-year observations.[34]

6.4.2. The Independent Variables: Trends and Triggers

Trends

The primary operationalizations of trends are measures of land degradation, overall ecological suitability for heavy grass agriculture, and renewable freshwater resources per capita. Land degradation is defined as the temporary or permanent reduction in the productive capacity of land as a result of human action (Bot et al. 2000). We use the negative of the total percentage of land degraded, which has a mean value of -.283 and a standard deviation of .266, bounded on the lower end by South Africa, the Sudan, Mauritania, Côte D'Ivoire, Zimbabwe, Zambia and Guinea (appreciable

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34 We utilized Fearon and Laitin's coding for civil conflict onset as a robustness check and to investigate whether smaller and larger conflicts operate according to similar causal logics. Due to its much higher casualty threshold (1000 versus 25), onset years make up only 2.9 percent of observed country-years.

degradation 0) and Kenya on the higher end (-1). Therefore, the expected sign on the coefficient for total degradation will be negative, rather than positive, as the hypothesis suggests. We do this in order to facilitate the construction and interpretation of the interaction terms. Unfortunately, these values are static within countries. The data are available from the Food and Agricultural Organization (FAO) Terrastat website (http://www.fao.org/ag/agl/agll/terrastat/); for a detailed discussion of variable construction, see Bot et al. (2000).

We include also a measure of climate suitability for heavy grass agriculture of the type that typifies the Eurasian land mass. The variable, climate scale, is similar to that used by Hibbs and Olsson (2004) and is measured on a four point scale, ordered in ascending value: 1 for dry tropical (desert) and highland, 2 for wet tropical (rainforest), 3 for temperate humid subtropical and temperate continental, and 4 for dry, hot summers and wet winters. This scale is based on the Köppen-Geiger climate system, which classifies climate according to mean annual precipitation and temperature, and is calculated by summing these values weighted by the proportion of national territory falling within these categories. The mean value is 1.79 with a standard deviation of 0.68, bounded on the lower end by Ethiopia (1) and on the higher end by the kingdom of Lesotho (3.989). Sub-Saharan Africa as a region has the second lowest mean value for this measure, with only the Sahara-dominated region of North Africa and the Middle East being less suited to agriculture. These values, while also static within each country, are a closer approximation to the concept of climate change induced by global warming, as land degradation is by definition endogenous to land use.

Finally, we operationalize freshwater availability as total renewable water

resources (in thousands of cubic meters) per capita. The data have a mean value of 24.12 with a standard deviation of 55.9, and are highly skewed (the median value is 5.44). It is bounded on the lower end by Rwanda (.63) and the higher end by the Republic of Congo (432.9). Data are available at five-year intervals from the FAO Aquastat website (http://www.fao.org/ag/agl/agll/aquastat/).

Triggers

Miguel, Satyanath, and Sergenti (2004) coded percent change in rainfall from the previous period from the Global Precipitation Climatology Project (GPCP) database of annual rainfall estimates. The data are available at a resolution of 2.5 by 2.5 degrees and cover the time period 1979 to 1999. Their method of coding nodes as "belonging" to a country was whether the exact node fell within national borders, and as such lacks some of the precision of our alternate coding (see Appendix 2). We update Miguel, Satyanath, and Sergenti's data through 2002 using the newest version of GPCP data (Adler et al. 2003).

Our operationalization of an environmental trigger is the percent change in annual rainfall in country i in year t from the year previous, henceforth rainfall trigger. This measure controls for cross-country variation in average levels of rainfall and captures interannual variability, a measurement many expect to increase with future increases in atmospheric levels of greenhouse gases. We generate also dummy variables to identify changes that are greater than +/- one and +/- two standard deviations from mean rainfall.

6.4.3. Control Variables

Most of the control variables used here (GDP per capita, oil producer, percentage of mountainous terrain) are taken from the Fearon and Laitin (2003) dataset on civil conflict and have been updated through 2002. Other control variables are taken from Miguel, Satyanath, and Sergenti (2004) and the World Development Indicators 2005 CD-ROM. Descriptive statistics for all variables used in this article can be found in Appendix 1.

6.4.4. Estimation and Results

Our analysis indicates both short and long term climatic factors affect conflict, though their effects are present only when other political, economic and geographic factors are included. Specifically, we find the lagged rainfall trigger and climate scale measures to predict significantly onset. Table 6.1 reports maximum-likelihood logit models of conflict onset and resource scarcity, alternately specified in terms of long term trends and short term triggers. The equations follow the general functional form

where $\mathrm{Pr}(Onset_{it})$ is the probability of conflict onset in country i and year t, X_{it} is the rainfall trigger (both current and lagged with respect to the year of onset), Y_i is the measure of land degradation, climate scale, and/or freshwater resources per capita in country i, Z_{it} is a matrix of lagged control variables, and ε_{it} is an error term. The coefficients of interest are b and c, the effect of short term climatic triggers and long term climatic trends on conflict onset. We use Huber-White robust standard errors because we

expect observations are not independent within countries.

We report results for three models. Model 1 includes only the hypothesized variables of interest. Model 2 adds controls for level of economic development (GDP per capita), economic growth (GDP growth), population, the logged percentage of mountainous terrain, and whether the country derives over 33 percent of its export revenue from oil. We select these controls for their prevalence in the conflict literature and their robustness to changes in model specification (see Hegre and Sambanis 2006). We lag all time-variant indicators on period in order to mitigate potential endogeneity. Model 3 includes interaction terms between the lagged rainfall trigger and the various trend variables (land degradation, climate scale, and freshwater resources per capita).[35]

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35 Results for robustness checks using the Fearon and Laitin coding are not reported. Our model proves better suited to explaining the onset of smaller conflicts than larger ones. While all three models using the lower coding threshold are significant (p-value for the Chi^2 <.05), only model 3 was significant with respect to the higher casualty threshold coding. Only GDP per capita, the most robust covariate in the empirical literature on conflict, and freshwater resources per capita are significant across the two specifications, with comparable signs on the coefficients and point estimates.

Table 6.1. Logit Analysis of Climate, Climate Change, and Conflict Onset, 1981-2002

Explanatory Variable	Model 1	Model 2	Model 3
Rainfall Trigger	-0.026	0.129	0.135
	0.513	0.632	0.630
Rainfall Trigger $_{t-1}$	-1.927***	-2.055***	-1.743
	0.560	0.617	2.167
Total Degradation	-1.079	-0.739	-0.818
	0.707	0.570	0.551
Climate Scale	-0.340	-0.588**	0.565**
	0.264	0.255	0.253
Freshwater Resources per capita	0.003*	0.008***	0.008***
	0.002	0.002	0.002
GDP per capita $_{t-1}$		-1.655***	-1.654***
		0.412	0.414
GDP growth $_{t-1}$		-0.023	-0.022
		0.017	0.017
ln(Population) $_{t-1}$		-0.278*	-0.272*
		0.163	0.164
ln(% Mountainous)		0.243**	0.245**
		0.107	0.106
Oil Producer		1.363**	1.357**
		0.586	0.59
Trigger $_{t-1*}$Total Degradation			-2.108
			1.955
Trigger $_{t-1*}$Climate Scale			0.478
			0.769
Trigger $_{t-1*}$Freshwater			-0.002
			0.005
Constant	-2.078***	3.894	3.249
	0.530	2.905	2.783
n	816	814	814
Pseudo Log-Likelihood	-247.002	-225.890	-226.883
Prob > Chi^2	0.019	0	0
* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.001			
Huber-White robust standard errors below coefficient estimates.			

The results in Table 6.1 suggest four main findings. First, our trend and trigger measures are not associated with the onset of conflict in the absence of economic, political and demographic control variables. Only the lagged rainfall trigger is significant in model 1. This finding suggests two inferences. The first is that the political effects of climate and freshwater availability are not apparent absent control variables typical of the civil conflict literature. The second, and more interesting from a developmental perspective, is that these endogenous control variables are not fully determined by exogenous factors such as climate (see Gallup, Sachs and Mellinger 1999, Acemoglu, Johnson, and Robinson 2001, Rodrik, Subramanian, and Trebbi 2004). Were that the case, we would expect the effect of climate and rainfall variability to swamp the effects of our economic, political, and demographic indicators.

Second, the evidence regarding the effects of our long term trend variables is not consistent. Total land degradation is not significant under any specification, though the relationship is positive, as hypothesized. Our measure of climate suitability for heavy grass agriculture is highly significant and negative in models 2 and 3, lending support to hypothesis two. Freshwater resources per capita is highly significant and positive in models 2 and 3, suggesting that greater availability of freshwater resources per capita is associated with a higher likelihood of conflict.

Third, the lagged rainfall trigger is significant in two of three specifications, with the sign always in the hypothesized direction. However, the contemporaneous measure of rainfall trigger is not remotely significant under any specification. In addition, none of the dummy codings for +/- one or +/- two standard deviations from the mean are significant in any of the models (results not shown). Taken together, this lends a good

deal of support to hypothesis six.

Fourth, none of the interaction terms between lagged rainfall trigger and our trend measures approaches significance in any of the specifications, though their inclusion in the models did affect the significance of their constituent variables. Therefore, the hypothesized potential for magnified effects of rainfall triggers in countries with differing levels of degradation, ecological suitability for heavy grass agriculture, and freshwater availability are not substantiated. Rather, the impacts of interannual variability in rainfall are consistent across countries with different ecological realities and natural resource endowments.
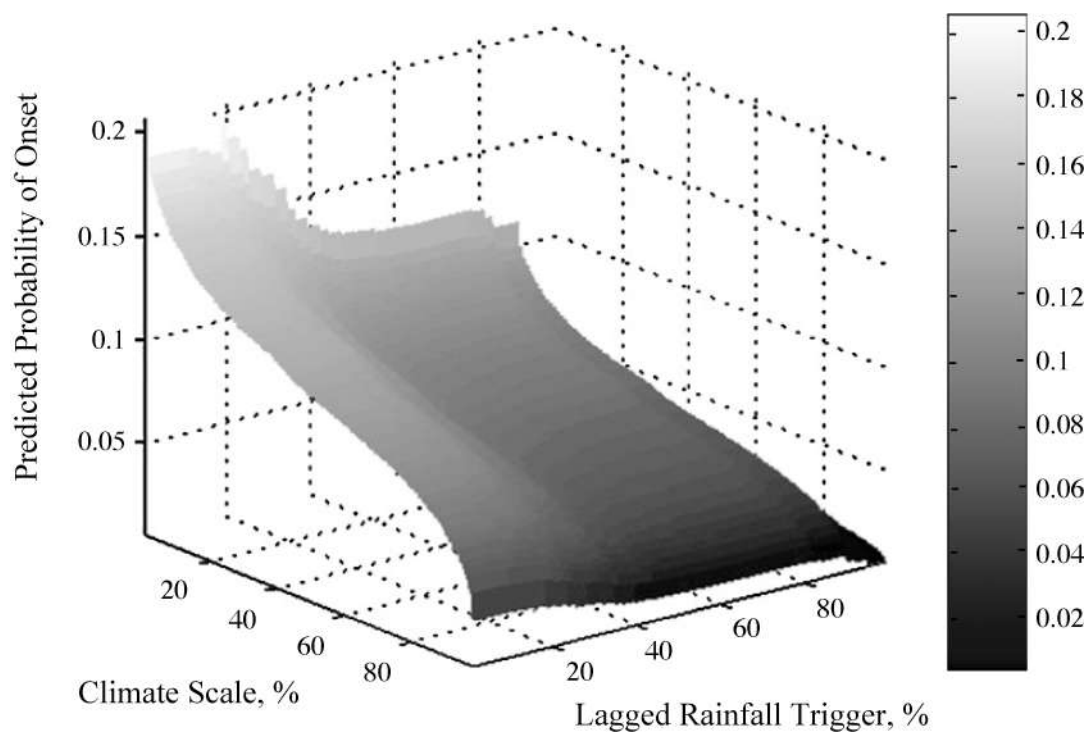
Figure 6.1. Marginal Effects of Lagged Rainfall Trigger and Climate Scale, by Percentile

We present the marginal effects of changes in our variables of interest in Figures 6.1-6.3. Using CLARIFY (King, Tomz and Wittenberg 2000), we estimate that moving from the 25th to 75th percentile values for lagged rainfall trigger decreases the predicted probability of conflict onset by an average of 34 percent. The marginal effect of a commensurate quartile-to-quartile change in the climate scale is virtually identical, decreasing the predicted probability of conflict onset by an average of 32 percent. Quartile-to-quartile shifts in both variables generate a decline in the predicted probability of conflict onset of 55 percent.
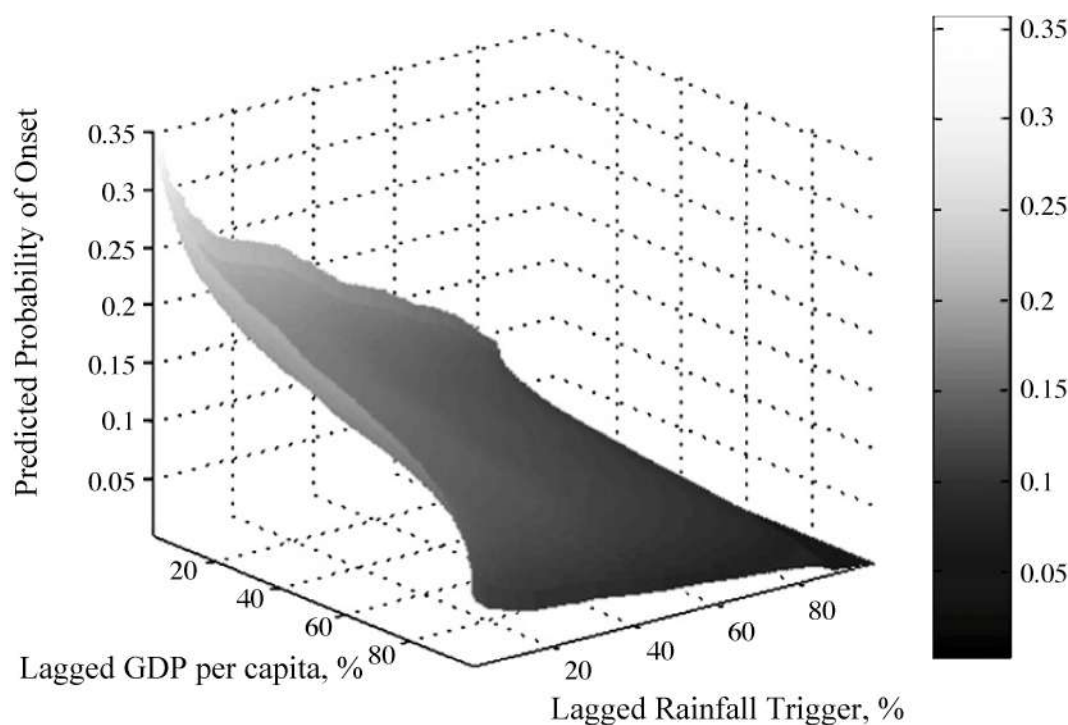

Figure 6.2. Marginal Effects of Lagged Rainfall Trigger and Lagged GDP per capita, by Percentile

This is comparable to the average 51 percent decrease in the predicted probability of conflict onset produced by a quartile-to-quartile shift in GDP per capita—the most

powerful covariate of conflict in the literature. Results suggest that the marginal effects of interannual variability in rainfall are much greater than the marginal effects of changes in climate. This point is underscored by the time periods over which climate change is expected to take place. Given that no model of climate change projects anything near a one standard deviation change in the suitability of climate for large-scale agriculture on a year-to-year basis, we are less confident drawing conclusions about the marginal impact of this variable without turning to its effects on long term economic development and political consolidation, topics beyond the scope of this chapter. Similar quartile-to-quartile analysis of the renewable freshwater resources per capita variable yields a change in the predicted probability of onset of only five percent.
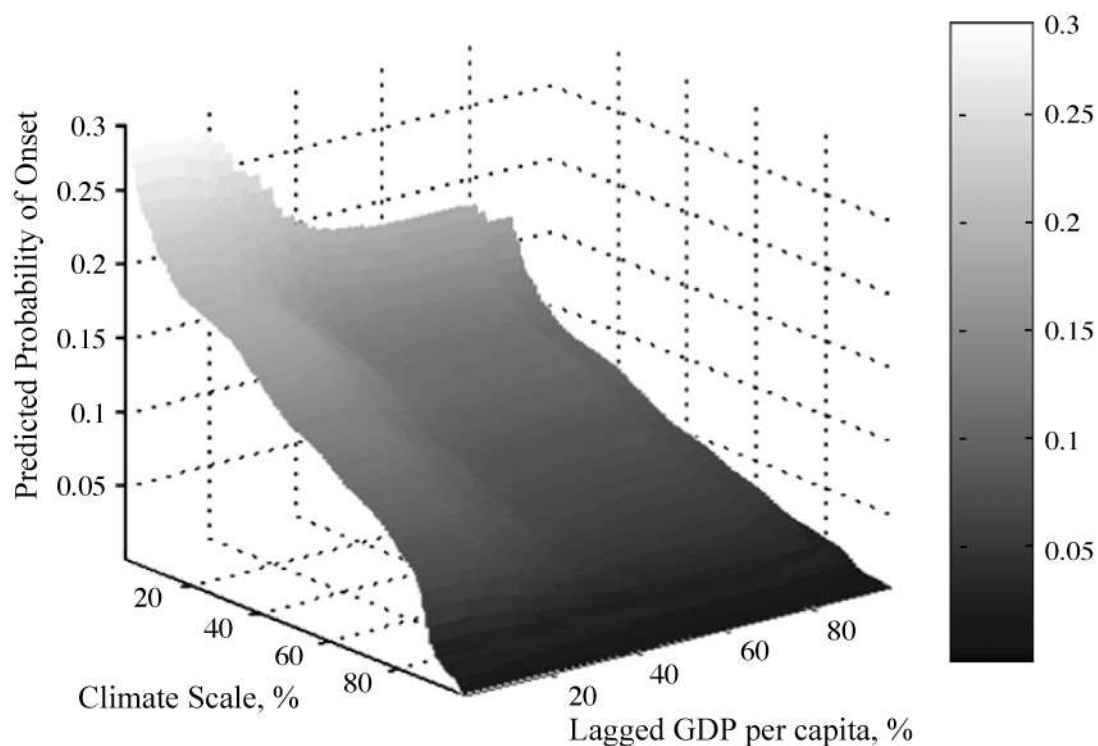

Figure 6.3. Marginal Effects of Climate Scale and Lagged GDP per capita, by Percentile

6.5. Looking into the Future: Precipitation in Sub-Saharan Africa

We have demonstrated that short term triggers in precipitation (to a greater extent) and long term trends in freshwater availability and suitability of climate for heavy grass agriculture (to varying extents) affect the onset of civil conflict in Sub-Saharan Africa. Our political model uses data from 1981-2002, during which much of Africa experienced significant droughts, especially in the Sahel region (Nicholson 1993). Should we expect future rainfall patterns to resemble those from this period? We now analyze simulated changes in Sub-Saharan precipitation to assess the potential for future conflict in the region; we further investigate the effect of spatial aggregation on our results.

6.5.1. Background

The increasing validation and application of coupled ocean-atmosphere general circulation models (GCMs) have enhanced understanding of global climate and improved projections decades into the future. The Intergovernmental Panel on Climate Change (IPCC) collects and analyzes data from eighteen GCMs produced by various research institutions. These models are driven by increases in atmospheric greenhouse gases (primarily CO_2) and use balanced thermodynamic mass equations and statistical parameterizations to simulate changes in climatic and hydrologic parameters (Washington et al. 2000, IPCC 2001). Models project an increase in globally averaged surface air temperature of between 1.8 and 4.0 degrees Celsius resulting from a doubling of atmospheric CO_2 through the 21st century (IPCC 2007), patterns that have been validated

by a host of studies (Rowell 1998, Gonzalez-Rouco et al. 2000, IPCC 2001, Douville et al. 2002, Landman and Goddard 2002, Srinivasan 2003, Bartman et al. 2003, Rahmstorf et al. 2007). The IPCC Special Report on Emissions Scenarios (SRES) outlines a suite of future scenarios for comparative purposes; each scenario contains plausible trajectories for a plethora of social variables such as population size, economic growth, technological development, government regulations, and pollution emissions. Scenarios produce varying estimates of carbon production and hence different magnitudes of warming. This study analyzes three scenarios: A1B (medium warming), A2 (higher warming), and B1 (lower warming).

A key finding of GCM simulations is that climate change will be manifest in the global hydrologic cycle (Gonzalez-Rouco et al. 2000, Washington et al. 2000). Greater intra- and interannual variability in temperature and precipitation on a global scale may result in increased extreme regional events such as flooding, drought, or storm activity (Rowell 1998, IPCC 2001, Benestad 2006, Tebaldi et al. 2006). Rising temperatures will increase surface evaporation over the oceans and atmospheric water vapor holding capacity, ultimately resulting in increased atmospheric water content and precipitation (Rowell 1998, Washington et al. 2000, Gonzalez-Rouco et al. 2000, IPCC 2001, Douville et al. 2002, Landman and Goddard 2002, Srinivasan 2003, Bartman et al. 2003). Terrestrial systems will respond with decreased rates of evaporation, increased soil moisture, and/or increased streamflow and runoff (Nijssen et al. 2001).

Few studies analyze GCM results for Africa. Hulme et al. (2001) undertake a comprehensive comparison of results from seven GCMs under four SRES scenarios on the African continent. They calculate an increase in surface temperature of between 0.2°

and 0.5° C per decade. While results are robust between models for temperature, the story is more varied for precipitation. Under scenarios of low warming (B1), equatorial east Africa experiences increases in rainfall in winter and decreases in summer, while the rest of Africa remains statistically stable. Under medium and high warming scenarios (respectively A1, A2, and B2), winter precipitation decreases in southern Africa while increasing in equatorial east Africa. Summer precipitation decreases across the Horn of Africa while increasing in the central Sahel.

With these models, scale matters: global results are generally robust, but on the regional scale parameter sensitivity and local variability contribute to differences between observed data and model projections, as well as between models (Hulme et al. 2001, IPCC 2001). Such uncertainties arise partially from the spatial resolution of GCMs, typically several degrees of longitude by several degrees of latitude. Statistical downscaling methods provide higher resolution spatial data and are preferred for regional analyses (Srinivasan 2003), but these models are extremely computationally intensive. Herein lies a central difficulty combining physical and geopolitical data: the differing spatial scales (geographically-referenced point estimates versus means aggregated at the nation level) complicate using both types of data in one model. For example, some nations may fall entirely within the resolution of the model grids (e.g., Lesotho), while others contain tens of point estimates. For this reason, we undertake analysis at three scales of spatial aggregation.

Despite these sources of uncertainty, studies comparing GCM results with downscaled models demonstrate that global models can replicate observed regional patterns in rainfall variability (Rowell 1998, Gonzalez-Rouco et al. 2000, Bartman et al.

2001, Landman and Goddard 2002, Srinivasan 2003, and Paeth 2004). The African continent experiences important climatic teleconnections that link global climate change to regional changes in precipitation: ocean forcing (including the El Niño Southern Oscillation) is the dominant cause of variability in western Africa (Bartman et al. 2003) and global sea surface temperatures are strongly correlated with total precipitation in southern Africa (Vizy and Cook 2001). We heed Hulme et al's (2001) caution about using GCM rainfall data for Africa; nevertheless, we agree with their conclusion that general circulation models can yield insights when various scenarios are analyzed in concert. We use the results from our political model to thus guide our analysis of rainfall projections.

6.5.2. The General Circulation Model

We analyze rainfall data from the United States Department of Energy National Center for Atmospheric Research Parallel Climate Model (NCAR-PCM), available online through the IPCC Data Distribution Center (http://www.ipcc-data.org/). This model was chosen because it has the highest spatial resolution (2.8º x 2.8º) and because data are available for three SRES scenarios (A1B, A2, and B1). Data are from model runs used in the IPCC Fourth Assessment Report (AR4). Calibrations of this model to real data show that NCAR-PCM replicates rainfall patterns in Sub-Saharan Africa (Srinivasan 2003). In our sample, real rainfall (GPCP 1981-1999) and model-simulated rainfall (NCAR-PCM 1981-1999) are correlated at 0.6.

6.5.3. Data Analysis

Data are obtained as monthly mean precipitation flux [$kg/m^2/s$] for a given 2.8º x 2.8º coordinate; we analyze the period 2000-2099. We investigate measures associated with rainfall that are significant covariates of conflict: overall freshwater availability (represented somewhat imperfectly by total annual precipitation flux) and rainfall trigger (percent change in rainfall from the previous year).[36] Linear time series regressions are employed at three scales of aggregation: a region-wide Sub-Saharan scale, the country scale, and the individual grid cell scale. This captures the broad patterns of variability that GCMs are capable of reproducing without demanding unreasonable spatial complexity from globally derived data. Time series are standardized to the seasonal (month specific) mean and standard deviation (mean of zero, standard deviation of one). To aggregate at the country level, precipitation data nodes are assigned to a country and weighted according to the percentage of the cell that resides in a given country (see Appendix 2 for details). In all cases, we compare the three SRES scenarios (A1B, A2, and B1).

6.5.4. Results and Discussion

When averaged over the Sub-Saharan region, neither total annual rainfall nor rainfall trigger contain statistically significant trends. Significant trends do exist at the

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36 We also analyzed time series of intra-annual variability and positive and negative rainfall shocks (+/- two standard deviations from the mean). Significant trends were not found. These operationalizations of rainfall variability were not significant predictors in our political model, and we therefore do not discuss them further.

two higher resolution scales; Table 6.2 compares results for total annual rainfall flux and rainfall trigger at the country and grid cell scales. Rainfall trigger rarely increases under any scenario: at most, under scenario B1, four percent of grid cells have increases in variability, and only scenario A2 simulates increases in variability at the country scale. Total annual rainfall does contain significant trends under all scenarios. As expected, scenarios with medium and high warming also contain more grid cells and countries with changes in total precipitation. However, precipitation does not uniformly increase; about 50 percent of these time series contain decreasing trends, as do a significant number of countries. Table 6.3 lists countries that contain aggregated trends in both total annual rainfall and rainfall trigger.

Table 6.2. Number of Time Series, out of 290 Grid Cells or 41 Countries,
with Significant Linear Trends ($p < 0.05$)

	Grid Cell Scale ($n = 290$)			Country Scale ($n = 41$)		
	A1B	A2	B1	A1B	A2	B1
Total Annual Rainfall	48 (21)	73 (45)	9 (2)	11 (4)	12 (12)	4 (1)
Rainfall Trigger	8 (3)	9 (6)	11 (10)	1 (0)	4 (2)	2 (0)

Parentheticals are the number of positive trends.

Figure 6.4 maps spatial patterns in changes in rainfall under the mid-range warming scenario A1B. At the grid cell scale, increases in total annual rainfall are scattered throughout western Africa, the Sahel, and equatorial Africa. At the country scale, significant increasing trends are restricted to western Africa (Table 6.3). Decreases in total annual rainfall are primarily clustered in southern Africa, and these grid cell

patterns are reflected in the country scale aggregation as well. Our projected patterns are similar to those found by other researchers (Bartman et al. 2001, Hulme et al. 2001, Landman and Goddard 2002, Paeth 2004, Tebaldi et al. 2006, IPCC 2007). Tebaldi et al. (2006) analyzed GCM simulations of extreme events in temperature and precipitation for 9 GCMs used in the IPCC AR4. They found increasing trends for various measure of rainfall variability such as consecutive dry days, days with rainfall greater than 10 mm, and maximum five day total, among others. While their measures of rainfall intensity are different from our measure of rainfall trigger, their results suggest that other operationalizations of rainfall variability may be a fruitful line of future investigation.

Table 6.3. Countries in Sub-Saharan Africa Containing Significant Trends (either Increasing or Decreasing) in Two Measures of Precipitation
Total annual rainfall flux [$km/m^2/s$] and rainfall trigger [interannual variability]. Comparison is for three IPCC SRES scenarios of different relative degrees of carbon dioxide forcing.

	A1B (medium warming)		A2 (high warming)		B1 (low warming)	
	Increasing	Decreasing	Increasing	Decreasing	Increasing	Decreasing
Total Annual Rainfall	Equatorial Guinea Ivory Coast Liberia Sierra Leone	Guinea Bissau Zimbabwe South Africa Namibia Lesotho Botswana Swaziland	Guinea Bissau Equatorial Guinea Ivory Coast Guinea Sierra Leone Ghana Togo Cameroon Nigeria Gabon Uganda Kenya		Equatorial Guinea	Guinea Bissau Ethiopia Eritrea
Rainfall Trigger		Uganda	Ghana Zimbabwe	Namibia Swaziland		Togo Rwanda

We are interested in investigating the effects of spatial aggregation on results because of recent growth in geographically disaggregated analysis (Raleigh and Urdal

2007, Levy et al. 2005). The highest resolution available is the grid cell scale. Aggregating at the regional scale (averaging across the entire Sub-Sahara) clearly causes smaller scale patterns to be missed. Aggregating at the country level captures many of the patterns found at the grid cell scale: similar patterns emerge at both spatial scales in southern, central, and western Africa. However, some hotspots of changes in rainfall are missed by looking at country scale mean values. For example, under A1B, patterns of increasing total rainfall are seen in north-central and southern Sudan, northern Uganda, and western Mauritania but these patterns are lost at country scale aggregation (Figure 6.4).[37] Under A2, Ghana and Zimbabwe show increasing rainfall triggers, while at the grid cell scale such results are not found. In our study, country scale aggregation captures the majority of significant patterns, but our results suggest it is important to verify these patterns at multiple spatial scales.

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[37] Some points are off-shore. The points describe a 2.5 degree by 2.5 degree square centered on the points, and as such the slightly off-shore points reference land area.
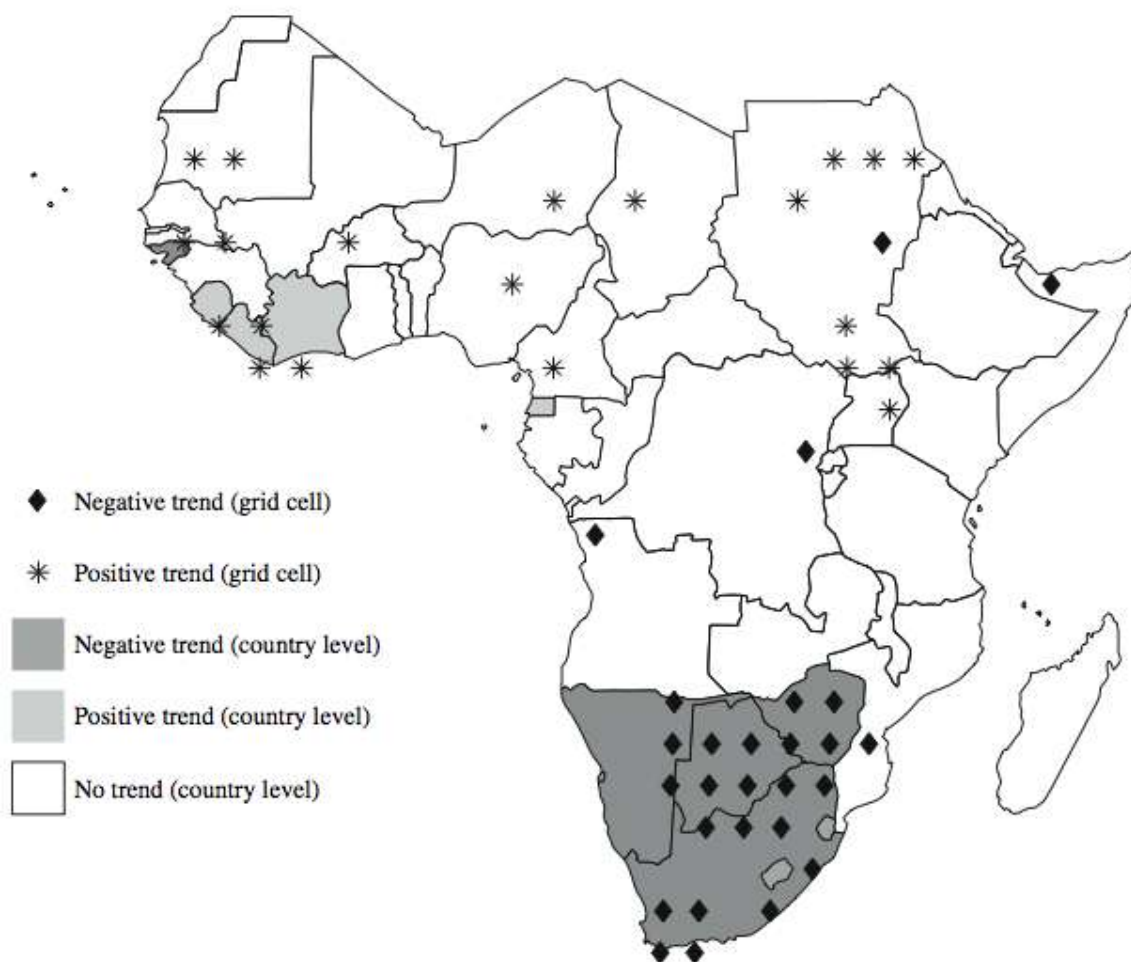
Figure 6.4. Effects of Spatial Aggregation on Total Annual Rainfall Estimates,
2000-2099, Scenario A1B

Our inability to detect widespread significant trends in rainfall triggers does not suggest a future increase in civil conflict in Sub-Saharan Africa resulting from our measure of interannual rainfall variability. Other measures of rainfall variability may increase in the future (Benestad 2006, Tebaldi et al. 2006), and this is a fertile area for future investigation. Moreover, as the spatial resolution and uncertainties associated with GCMs improve (IPCC 2007), continued analysis of precipitation models, as well as the impact of scale aggregation, will enhance predictions of socio-political events.

6.6. Discussion and Conclusions

This chapter addresses the relationship between climate and the onset of civil conflict from two complementary perspectives. The first is a model of conflict onset in which the variables of interest are measures of a) trends: land degradation, climate suitability for heavy grass agriculture, and freshwater resources per capita, and b) triggers: interannual variability in rainfall. Our findings suggest that interannual variability in rainfall is a more significant determinant of conflict than our measures of climate, land degradation, and freshwater resources. Admittedly, these results may be biased due to stationarity in the trend measures, a problem addressed critically in section two but which ultimately proves insurmountable in our analysis due to constraints on available data.

The lack of a strong finding regarding GDP growth is interesting in its own right, especially in light of the centrality of economic concerns to our causal argument. We broach two interpretations. The first is that aggregate measures such as GDP tend to be unreliable in highly stratified, primarily rural developing countries (Heston 1994). However, our finding regarding GDP per capita is strong and robust, indicating that the problem may not be the accuracy of our macroeconomic indicators. The second and more theoretically interesting interpretation is that GDP growth does not accurately capture the opportunity cost to participation in rebellion. While aggregate measures of income inequality have not been found to be significant correlates of conflict in the extant literature, disaggregated studies of drought and its effects on income in Africa suggest that drought has significant, differential impacts on income across economic classes

(Reardon and Taylor 1996, Reardon 1997). The problem with all of these conjectures, of course, is that good data are hard to find.

The second perspective involves assessing the outlook for the future based on an analysis of simulated changes in precipitation means and variability. We find that while overall levels of precipitation are expected to increase in the next hundred years in western Africa and the Sahel and decrease in southern Africa, interannual variability is not expected to differ significantly from present levels, except for a few locales. This finding is seemingly at odds with the conventional wisdom regarding global warming and the stability of climatic systems, i.e., that variability is projected to increase. There are three possible explanations for our findings. The first is articulated by Hulme et al. (2001): because current generation GCMs do a poor job of replicating El Niño Southern Oscillation variability, simulations of interannual variability in African precipitation are suspect. The second is that we might find significant trends in variability if a baseline further in the past had been used. However, this is doubtful given the work of Hulme et al. (2001) who analyzed GCM data from 1900-2100 and found similar results. Third, the lack of greater interannual variability may turn out to be real in our specific measure of rainfall trigger, while other measures of variability (discussed in section 5.4) may change in the future.

If there are established climatic results affirming the relative stability of Sub-Saharan African climate over the next several decades, why is the region characterized so negatively in the conventional wisdom? We believe this may be due to regional bias. We can locate only one study (Magadza 1994) that attempts to predict the future likelihood of conflict in Africa related to climate change. Magadza describes an increase in conflict

likelihood as a result of widespread drought conditions, a belief that extrapolated the then-current conditions to the future. However, Magadza does not look at any forecast data. This stands in contrast to the comparatively massive literature regarding the impacts of global warming on future trends in climate in developed countries.

We broach two final observations. First, the neo-Malthusian expectation of a decreasing resource base may miss more theoretically interesting mechanisms leading to conflict in resource-scarce environments. Indeed, if the problem were simply availability of freshwater resources, rather than access, the positive finding regarding the impact of freshwater resources on the likelihood of conflict would be puzzling. Unequal access and ineffective distribution, which are central to explaining poverty in the midst of resource wealth (Sachs and Warner 2001, de Soysa 2002) have complex political and economic determinants that merit much closer analysis.

The second point is that the negative effects of interannual variability in rainfall may be mitigated if the relationship of direct dependence of African agriculturalists on rainfall can be broken. Even as rainfall triggers are not projected to increase over time, variability still remains, primarily in the form of rainfall shocks. Our analysis suggests that breaking this relationship of dependence on rain-fed agriculture will have positive effects for mitigating conflict.

6.7. ACKNOWLEDGEMENT

Africa," *Political Geography* 26 (6): 695-715. The dissertation author was the primary author and investigator of this paper.

Appendix 1: Variable Descriptions for Chapter Six

Variable	N	Mean	Std. Dev.	Min
A1B Precipitation (kg/m^2/s)	347,420	3.5 x10^{-5}	5.1 x10^{-6}	0
A2 Precipitation (kg/m^2/s)	348,000	3.5 x10^{-5}	4.9 x10^{-6}	0
B1 Precipitation (kg/m^2/s)	348,000	3.6 x10^{-5}	5.2 x10^{-6}	0
Climate Scale	881	1.82	0.67	1
GDP growth	876	-0.38	6.56	-47.39
GDP per capita (in 1000s 1990 USD)	863	0.999	0.854	0.09
GPCP Annual Precipitation (mm/year)	855	1000.49	506.59	96.1
Lagged Percent Change Rainfall from Previous Year	846	0.01	0.21	-0.55
log(%Mountainous)	881	1.59	1.43	0
ln(Population), lagged	881	15.73	1.16	13.24
Total Degradation	881	-0.28	0.26	-1
Oil Producer	881	0.12	0.32	0
One SD Negative Shock	846	0.17	0.37	0
One SD Positive Shock	846	0.17	0.37	0
Ongoing War	704	0.23	0.42	0
Onset (F&L)	704	0.03	0.17	0
Onset (PRIO/UCDP)	873	0.10	0.30	0
Percent Change Rainfall from Previous Year	846	0.02	0.21	-0.55
Two SD Negative Shock	846	0.02	0.12	0
Two SD Positive Shock	846	0.02	0.13	0

Appendix 2: Coding Precipitation Data

The GPCP data has a resolution of 2.5° by 2.5°. The NCAR-PCM climate model simulates values for temperature and precipitation at a resolution of 2.8 degrees by 2.8 degrees. At these resolutions, each data node references a land area of 77,000 and 96,000 km^2. While these resolutions are among the best returned by the GCMs distributed by the IPCC, many data nodes fall on or near national borders, meaning that coding mechanisms that assign data nodes to countries based on the location of the exact point of intersection will bias estimates.

In order to correct this bias, we divide each grid cell into four quadrants with the data node in the center. Each quadrant is then assigned to the particular country on the basis of majority: if a majority of the territory described by a quadrant fell within given national boundaries, that quadrant was assigned to the particular country even if the node fell across the border. This coding was done by hand using high-resolution maps generated in Matlab 7.0. When calculating annual precipitation based on averages across nodes, the value for each node is weighted according to the proportion of the national territory it describes. This coding method was used also to update the observed GPCP data.

Chapter Seven
Reflections and The Road Ahead

This dissertation began with Jared Diamond's observation that the differences between human societies are best understood as the products of differences in the physical environments in which these societies developed, rather than the largely cosmetic biological differences among the peoples themselves. A common rejoinder to this perspective has been that human ingenuity, specifically the ability to devise technological solutions to our most grave problems, has allowed humans to conquer their natural environment. Political and economic institutions, it is argued, are the intervening variable that confounds any easy and obvious relationship between the natural environment and the political and economic fortunes of human societies.

The central contribution of this dissertation has been to argue and demonstrate empirically that the physical environment, specifically climate and terrain, has conditioned the development of the sovereign state, the institution that lies at the heart of modern notions of governance, order, and prosperity. State capacity, defined as the ability to deter violent internal challenges to its authority and its ability to secure revenue via taxation, are affected by the incentives of states and societies to strike a cooperative, Pareto-improving fiscal contract, in which the state provides local public goods and society pays for these goods by complying with the state's request for revenue.

Climate and terrain determined the 1) distribution of economic resources, and 2) the transaction costs associated with monitoring, policing, and enforcement, that conditioned the fiscal bargain between state and society in the preindustrial era of state formation. The factors, in turn, affected the incentives of the state to either rely on

coercion or bargain with the citizenry for revenue, and the incentives of society to self-provide public goods and the constraints facing society in attempting to hold the state accountable for compliance with its end of the fiscal bargain. These preindustrial contractual relationships persisted into the modern era, leading to divergence between those societies that are capable at providing for domestic order and generating revenue in the form of taxation, and those that are not.

Though subsequent patterns of industrialization, global trade, and massive changes in the value of primary commodities have changed the global distribution of wealth, the relationship between climate, terrain, and the fiscal relationship between state and society, as measured by taxation as a share of GDP, remains both discernible and striking. Via its effect on the level of taxation, geography affects the incidence of civil conflict—a finding that introduces the fiscal contract theory of the state to the notion of state capacity and challenges the conventional wisdom relating geography to civil conflict and insurgency. Having established these findings, the dissertation then turns to the question of whether more proximate, time-variant operationalizations of environment and climate affect the onset of conflict in Sub-Saharan Africa, and whether forecast changes to the global environment will lead to an increase in civil conflict in the future.

The remainder of this chapter is organized as follows: the following section summarizes, chapter by chapter, the key arguments and findings of the dissertation. Section 1 introduces three extensions of the core argument and research design. Section 2 addresses implications of the argument and findings for policy matters, specifically institutional development in failed states and post-conflict societies. Section 3 addresses some policy implications, and section 4 concludes the dissertation with some

observations about geographic determinism, institutions, and the fates of human societies.

1. What has been learned?

This dissertation makes significant contributions to the literatures on the fiscal contract theory of the state, civil conflict and development, and environmental factors and conflict. First, the theory presented in chapter three helps to answer the question of the origins of the fiscal contract. The literature on institutions typically casts the emergence of representative institutions, checks against the sovereign's autonomy, and institutions governing property rights as the result of bargaining between societal and sovereign actors. Yet, this literature is largely silent about how the distribution of resources within society might affect the incentives of states and private actors to develop these institutions, save for the literature on rentier economies and plantation agriculture. This dissertation contributes a unified theoretical framework for addressing the effect of resource diffusion on the incentives necessary for the emergence of a fiscal contract.

Second, the dissertation presents novel findings with applications to the literatures on public finance, extractive capacity, and the fiscal contract theory of the state. My major finding is that climate scale, which proxies the diffuseness of agricultural production in the era of state formation, is strongly and positively associated with total taxes/GDP, and that the magnitude of this effect is similar to that of GDP per capita, perhaps the most robust predictor of total tax share in the public finance literature. This finding is further substantiated in the subsequent chapter, where climate scale and mountainous terrain are used as instruments in order to estimate the unbiased effect of

taxation, as a measure of state capacity, on the incidence of violent internal conflict.

Third, the dissertation presents a novel approach for linking geographic factors to conflict. Most studies of civil conflict focus on the tactical effects of rough terrain. In doing so, they implicitly assume that the same factors that affect the present ability of states to project coercive force did not exert an effect on the development of those same state institutions. This dissertation demonstrates that geographic factors do affect the strength of the state, and that it is via this mechanism that macro-indicators of geography most plausibly affect conflict. By estimating the impact of geography as mediated by the fiscal relationship between state and society, this finding has implications for the literature on civil conflict and insurgency, and for the broader literature on state development.

Fourth, this dissertation demonstrates that short-term variability in climatic factors can also affect patterns of civil conflict, albeit within a restricted sample. Having conceived of climatic factors alternately as (1) long term trends that may lead to a higher baseline probability of conflict, and (2) short term triggers that affect the interannual variability in that probability, chapter six demonstrates the effect of short-term rainfall triggers on civil conflict onset. The findings indicate that these triggers exert almost as great an impact on the onset of conflict as the level of economic development, the most robust covariate of conflict in the entire literature.

Taken as a group, these findings point to a general conclusion: the physical environment humans inhabit has significant effects on the strength of state institutions and the incidence and onset of civil conflict.

2. Where Do We Go from Here?

The central argument and research design, developed in chapters three through five, suggests three main avenues for further research. The first would be to develop a more fully-specified model of endogenous formation of institutions given largely exogenously determined factor endowments. The perspective of this dissertation is that exogenous, environmental determinants of 1) the factor endowments facing states and societies, and 2) the costs of reaching and maintaining a cooperative equilibrium with respect to revenue and public goods, affected the bargaining environment in which state institutions developed. The environmental perspective on institutional development is not without precedent (Engerman and Sokoloff 1997, 2002). What is novel, and what would benefit from a more formalized statement, is the identification and explication of these institutions in terms of the incentives for bargaining they engender for states, unitary actors with a comparative advantage in coercion and protection, and society, a corporate actor with a comparative advantage in the generation of wealth but that requires certain public goods in order to exercise this comparative advantage.

The second would be to undertake a direct, competitive test of the factor endowment hypothesis against the settler mortality hypothesis with respect to colonial institutions. Colonial institutions have emerged as a significant cause of massive disparities in current levels of economic development. But why were certain institutions imposed in certain colonies and not in others? In the literature on the deep determinants of colonial institutions, two answers stand out. The first is the factor endowment argument, which holds that the initial distribution of productive resources conditioned the

form of institutions: where agriculture had significant economies of scale, institutions developed that sustained vastly economic and political inequality, whereas factor endowments with few or no economies of scale led to institutions that sustained relative economic and political equality. The second is the settler mortality argument, which holds that institutions were largely determined by the viability of European settlement: where the disease environment prohibited extensive European settlement, extractive institutions were put in place. Where the disease environment sustained large European settler populations, "European," capital-forming, open-access institutions were put in place.

Testing these arguments directly proves somewhat difficult, as the same underlying geographic and climatic factors that determined agricultural factor endowments also affected the disease environment: for many cases, the two are highly collinear. One way of testing the two in competitive fashion would be to select a sub-set of the universe of cases in which the disease environment sustained European settler populations but variation in climatic factors and soil quality led to variation in agricultural factor endowments. One such sample would be the U.S. colonies and states prior to the Civil War. In the North, the temperate climate sustained a vibrant small shareholder farming society, while in the South, the fertile soils and warm, subtropical climate led to a planter society based on plantation agriculture and the widespread use of slave labor and debt peonage.

These different outcomes are alternately attributable to factor endowments or settler mortality; the availability of historical data on both causes of death and patterns of land tenure, and variation in the local institutions that constrained political and economic

access, such as poll taxes, usury laws, and vagary laws, allow for a direct test of these competing arguments for the development of political and economic institutions. Additionally, the selection of cases with a common colonizing power (England), legal tradition, and relatively similar patterns of access to Atlantic trade would facilitate holding constant several alternative explanations for diverging patterns of economic and institutional development in the Western hemisphere.

The third would be to apply this geographic perspective on state capacity to subnational units. The bargaining logic developed here should be applicable to subnational units in systems where revenue collection is decentralized. Particularly suitable candidates for this type of analysis would be Mexico, India, China, and the United States: large countries with federal institutions and highly varied topography and climate. One potentially complicating factor is that the costs of redeploying either populations or movable assets across intra-national borders, as opposed to international ones, are significantly diminished. Therefore, it would be important to control for neighborhood effects: the potential that taxation levels in adjacent units might exert and independent effect, via either a "race to the bottom," in order to create a more favorable climate for business and investment, or Tiebout sorting: self-segregation of citizens according to preferences over levels of pubic goods provision and taxation (Tiebout 1956, Lake 1992).

With respect to chapter six, which investigates the impact of short-term climatic variability on conflict, there are myriad ways forward. The first would be to use a similar research design to estimate the impact of rainfall triggers on other types of political mobilization, including protests and popular demonstrations. There is not reason to

believe that the theoretical mechanisms linking climatic factors to conflict is applicable only to civil conflict, a particular form of highly organized, large-scale violence. Other forms of political protest, alternately conceived of as opportunities to express grievances or seek rents, may be associated with agroclimatic shocks.

The second involves identifying other environmental trigger mechanisms that may predict the timing of conflict onset and escalation in countries otherwise characterized by a high baseline probability of conflict. The most important advance in the field of conflict studies has been the massive increase in empirical work on the long-run and short-run determinants of civil conflict. This went from being primarily a theoretical literature to a rich and expanding empirical one over the course of the last eight or nine years, with conflict onset, incidence, and duration becoming the subject of large-N analyses. The biggest problem in developing predictive models of civil conflict onset is that the most common explanatory variables do not change markedly from year to year. As such, they are poor candidates for predicting the specific timing of conflict. This problem is even more acute in studies of environmental impacts on conflict, which typically use completely stationary measures of land degradation, soil suitability for agriculture, or access to natural resources in order to test the effects of environmentally determined resource availability on conflict. In order to address this gap in our knowledge, I am undertaking a project to identify and collect data on environmental variables that display a much higher level of interannual variability.

A third direction would be to investigate the effect of climate and climate change on food security. As chapter six notes, less than five percent of agriculture in Sub-Saharan Africa is irrigated, which makes the continent's agricultural yields extremely

contingent on rainfall variability. The potential effects of climate change extend beyond agricultural production, however. Climate change is having dramatic impacts on ocean surface temperatures and currents, two key determinants of the location and size of fish populations. A 2005 World Wildlife Fund report identifies three main effects of global warming on fish populations: die-offs among extremely temperature-sensitive species, a less oxygen-and nutrient-rich environment, leading to stunted growth and lessened reproduction, and by displacing existing fish populations, who flee warmer waters by going deeper and further toward the poles. This last effect will alter patterns of access to marine fisheries, with the largest impacts in the countries of the developing world which lack large, ocean-going industrial fishing fleets and in which a larger portion of the population is dependent on subsistence or artisanal fishing for its dietary protein. In current research, my co-author and I are investigating the impact of inter- and intrastate conflict on marine fish catch. We plan to extend this project to encompass problems of access relating to climatically-driven changes in fish populations and locations.

3. Policy Implications

Teasing out policy implications from macro-historical work is always difficult. The fact that the main causal variables in this dissertation are largely stationary enhances that difficulty. A pessimistic reading of this dissertation, especially with regards to the persistent institutional effects of pre-industrial economic conditions, could yield the conclusion that fundamental institutional change is impossible. Given the prime role that institutions play in our present understanding of economic development, one might

conclude that non-temperate climate amounts to a development death sentence. Yet there are at least two useful lessons that this dissertation can inform.

The first policy implication to be drawn from this analysis is that the admonition that developing countries need "get the institutions right" for economic growth must confront the fact that the institutions of the state are endogenous to distributions of resources and political power, and that institutional change is likely to be ephemeral if their adoption is not attended by a redistribution of resources within society. Institutions are endogenous to distributions of power and resources; without a fundamental change in the nature of the resource base, institutional reform is unlikely to produce positive outcomes. The recent history of the World Bank's attempt to turn Chad's oil wealth, a classic point-source resource, into a source of revenue to be spent on public goods is indicative that the nature of the resource makes it tempting for governments to renege on their promises to society. In 2003, Chadian oil began flowing from fields developed by a consortium of ExxonMobil, Chevron, Petronas and other through a World Bank-financed pipeline, the result of a then-groundbreaking agreement between Chad, the multinational firms, and the World Bank to ensure that Chad's oil wealth benefited Chadian society, one of the world's poorest. Under the agreement, the Chadian government was to spend 80 percent of oil revenues on development projects, in order to maintain access to World Bank lending programs. These loans were suspended in 2006, after Chad's parliament had significantly amended the agreement, abolishing a "future generations" savings clause and authorizing the diversion of public works-related monies to arms purchases. Despite the imposition of World-Bank approved agreements and incentive structures, the point-source nature of oil production makes the temptation to renege on such agreements

a powerful one, as the Chadian government has little incentive to provide public works, given the nature of state revenue. This is but one example that highlights the importance of understanding how and why institutions and state-society relationships develop.

A second implication of the argument is that externally-imposed state-building, or neotrusteeship, as it has been called by Fearon and Laitin (2004), is unlikely to develop self-perpetuating state institutions unless the international community can alter the underlying distribution of economic resources in society. Policymakers must be aware that the modern state, as it exists in Europe, Japan, and a small slice of the post-colonial world, is not the "default" institutional form; indeed, especially in historical perspective, the existence of strong, territorially-defined states that are highly dependent on and responsive to their citizenries are in the clear minority. Even assuming that the US-led coalition forces in Iraq are undertaking a good-faith effort at building legitimate national institutions, the effect of the violence there has been to make the country even more dependent on oil; under these circumstances, it is unlikely that a post-US invasion Iraqi government will be much different than the government under Saddam. The beneficiaries of regime largesse will change, but not the breadth of distribution. In some respects, the inability of the Iraqi government to stabilize the flow of oil might have positive implications for political accountability and the provision of public services, as an inability to generate resources from oil exports may force the government to begin relying on its citizenry for revenue.

The policy implications of chapter six, which addressed the impact of climate and climate change on civil conflict in Sub-Saharan Africa, are somewhat more clear. Fisman and Miguel (forthcoming) have argued that the best way to break the relationship

between economic shocks—environmental or otherwise—would be to establish an emergency aid program, available to African countries experiencing droughts or other adverse economic shocks. While I share the opinion that adverse economic conditions are a significant problem that might be ameliorated by access to emergency funds, I am skeptical as to how efficient delivery mechanisms for these funds might be at targeting benefits to those that most need it. The most plausible linkages between rainfall triggers and conflict flow through young men living in remote areas with few non-agricultural economic linkages to the broader economy—precisely those individuals to whom it would be hardest to distribute these funds. Instead of investing in an insurance scheme, these funds might better be invested in increasing access to drought-resistant seed and accessing the continent's stores of groundwater, two technological solutions to the problem of high, climatically-induced, variability in agricultural yields.

Also, the findings of this chapter suggest that much of the rhetoric revolving around climate change and access to renewable resources needs to be subjected to more rigorous analysis, and that the polemical debate over responses to climate change, particularly in the security community, should be tempered by more mundane, but ultimately more edifying, attempts at forecasting. While our analysis concerns just two facets of climate change, potential changes in year-to-year rainfall variation and overall levels, the findings do not substantiate the position that these rainfall triggers are likely to worsen in the next 100 years. This should not be construed as a suggestion that climate change will not lead to conflict in the future—merely that, given our data, it is unlikely to do so via this mechanism. While that is not in and of itself an Earth-shattering finding, the fact that it was not part of the common knowledge about patterns of rainfall in Sub-

Saharan Africa suggests just how important policy-related work in this area will be.

4. Geography, Prosperity, and Prospects for Change

This dissertation began with the observation that the contemporary discourse addressing climate change and human security presupposes that the dramatic impacts of the environment on human societies are relatively new phenomena, as if environment were, for the first time, affecting the humans that inhabit it. One of the purposes of this dissertation is to demonstrate this relationship is not new: geographic and climatic factors exerted powerful effects on the developmental trajectory of human societies, with particular emphasis on the development and capabilities of the states that populate the international system. Thus, this dissertation contributes to the emerging awareness that the origins, and, by extension, the fates, of human societies have been and will be determined by our relationship with our environment.

The myriad ways in which our environment is changing will have large—and largely unanticipated—consequences, and at present far more is known about the nature of these problems, and the incentives they engender for either conflictual or cooperative interactions, than potential solutions. But by acknowledging these findings, social scientists can start on the hard work of helping devise policy solutions that will help societies adapt to their new environmental realities. One of the ways in which we can help to offer solutions is by focusing our energy on understanding how a changing climate will affect patterns of access to, and ownership of, economic resources. As the theoretical contribution of this dissertation makes clear, the distribution of resources

affects the incentives of states and societal actors to develop a strong fiscal relationship, a relationship that subsequently emerges as a significant determinant of patterns civil conflict incidence. The massive developmental catastrophes that have attended civil conflict make understanding this aspect of the state-society relationship of paramount importance.

To many, the findings of this dissertation will be a source of consternation. The idea that humans are not masters of their environment, but rather products of it, goes against the concepts of human agency and choice, which are ingrained in both our philosophical and normative notions of what make us human in the first place. I would argue that geography, as discussed here, does not determine human fates so much as it embeds human interactions within a system of incentives and constraints. This perspective is consistent with the generally accepted notion that institutions, by establishing incentive structures and norms of interaction, affect human interactions. Thus, my argument is no more deterministic than arguments common to the rational choice literatures on economic and political development. To be sure, my approach in this dissertation strips away much nuance regarding the impact of culture, ideology, and the structure of the economy as determinants of the state-society relationship, which is a potential shortcoming. A greater shortcoming, however, would be to not recognize the impact of our environment on human societies, and propagate the slander that certain peoples are doomed to poor governance and endemic conflict because of their cultural values—or worse, the color of their skin. Humans, above all, are creatures of our environments. We should expect the institutions we build to be no different.

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