International Geopolitics*

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Abstract

Since the Age of Discovery, the world has grown integrated economically thanks to overall growing international trade, while remaining disintegrated politically as a collection of nation states. The nation-state system is robust because borders, as state dividers, interact with economic integration to absorb shocks. We build a tractable general equilibrium model of international trade and national borders in the world. Over a longer time horizon, declining trade costs alter trade volumes across states but also incentivize states to redraw borders, causing states to form, change, and be dissolved. Our model offers rich implications for global politics, including political geography, its interplay with natural geography, state-size distribution, and the frequency and nature of military disputes. These implications are supported by modern and historical data.

Keywords: nation state, geopolitics, endogenous borders, military disputes, trade costs

JEL Classification Numbers: F50, N40.

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1 Introduction

The Age of Discovery created connections between different parts of the world that had previously been separated. Since that time, philosophers and science-fiction writers have envisioned plentiful models of a borderless world as the ultimate home for all humans.[1] A time traveler from the 18th century might have mixed feelings about the present world. Economically, the world has become remarkably integrated. Thanks to low trade costs, consumers purchase what they want globally, so do producers. But politically, the world remains disintegrated: politics are often local, policies are mostly regional, and nation states remain the basic units of global affairs, just as in her time. She needs little time to understand the present world map. Indeed, neither do we need training to understand the Peace of Westphalia. da Gama, Columbus, and technological advancements have changed the international economy far more than they have international politics.

The world has of course not stood at a political standstill during the centuries skipped by the time traveler; in fact, quite the opposite. The last few centuries have been marked by drastic political changes, with powers that have waxed and waned, wars that have been fought and ceased, and in many instances absolutism overthrown and democracy established. In the course of these events and changes, although the nation state system has not died, many individual states have. Nearly half of the states that existed in the 18th century no longer exist today. Recent centuries have served as a platform from which states have come and gone. Economic integration did not necessarily bring political integration, and oftentimes produced the opposite. This contrast is not surprising to some extent, because as foreign trade becomes easier, political opposition among states may become less costly.

In this paper, we provide a general equilibrium model of international trade and national borders in the world. We consider a stylized world populated by a continuum of locales. Locales choose neighbors to form joint states, and in doing so they make tradeoffs between gains from trade and losses in autonomy. The nation-state system is a market of state memberships, with geographical locations serving as locales' endowments. States with better locations have an advantage in setting borders. When the cost of foreign trade shifts, trade volumes change and states adjust their borders. The changes in borders, often negligible in the short run, have far-reaching implications for geopolitics in the long run.

We next discuss five geopolitical implications derived from the above benchmark model. The first implication is on the political geography of the world. In our model, locales closer to the geometric center (GC) of the world have lower trade costs. Therefore, states farther from the world GC set their borders farther apart to keep their price levels low, resulting in larger territories. We collected data from digitized world maps, both modern and historical, which show patterns consistent with this implication. This empirical observation is unlikely to be driven by regional ethnicities in the world, since it holds not only among Eurasian states, but among non-Eurasian states as well. It is unlikely to be driven by specific wars or movements, because it holds for the 18th, 19th, and early 20th centuries. It also holds at the sub-state jurisdiction level. Within four out of the five largest states, provinces closer to the estimated world GC are found to be smaller.

[1] For philosophical works, see for example Rousseau (1756), Kant (1784), and Marx (1848).

The second implication is on island states. Our benchmark model is extended to show that island states have more incentives than continental ones in expanding territories, since surrounding waters create an additional cost pressure. Our empirical results show that Eurasian (i.e., proximal) islands are, on average, larger than Eurasian continental states, and for a unit decrease in the distance from the world GC, Eurasian island states decrease less in territory. In contrast, non-Eurasian (i.e., distal) islands are on average smaller than non-Eurasian continental states, and for a unit increase in the distance from the world GC, non-Eurasian island states increase more in territory. In theory, "islands" here do not have to be geographical. Cultural circles, political unions, and other formal and informal institutions that isolate a few states from the rest of the world have similar effects on the territories of states in them.

The third implication is on the relation between the state at the world GC ("state 0") and the size distribution of other states. When geographically central states contain fewer locales, their marginal locales are released to join neighboring states. This process continues and as a result all other states in the world "move towards" the world GC. Empirically, we rank states in their own periods according to their distances to their contemporary world GCs. A higher rank value means a larger distance from the world GC. We find that a marginal increase in the rank value (farther from the world GC) is associated with a larger increase in distance from the world GC in periods with larger state 0's. This is in line with the core mechanism of our benchmark model — when located more distally, the same-ranked state has to be larger to compensate for its coverage of relatively worse-located locales.

The fourth and fifth implications are on the geography of military disputes in modern history. When military disputes occur, they involve fewer states if they are farther from the world GC (the fourth). We discuss two potential reasons for this association. Additionally, within a given dispute, states farther from the world GC are less likely to propose revisions to the status quo (the fifth). These two implications and their corresponding empirical evidence offer a new perspective in analyzing regional instability. Most military disputes escalate from border tensions, and our model endogenizes border setting, shedding light on where in the world military disputes are more likely and what their causes are.

The major contribution of this paper is providing a unified framework to consolidate international trade and international institutions. Existing studies have examined the connection between international trade and various *domestic* institutions. Since international trade differentially advantage various groups within a state, it has substantial influence on domestic institutions. In the literature, the domestic institutions found to be influenced by trade range from check and balance (Acemoglu, Johnson, and Robinson, 2005) to parliamentary operations (Puga and Trefler, 2014), military operations (Acemoglu and Yared, 2010; Bonfatti and O'Rourke, 2014; Martin, Mayer, and Thoenig, 2008a; Skaperdas and Syropoulos, 2001) and contract enforcement (Anderson, 2009; Ranjan and Lee, 2007). Unlike domestic institutions, international institutions do not directly influence individual welfare, but define the rules for states to interact with each other. Such interactions are found to have enormous impacts on individual welfare indirectly, through feasibility of long-distance trade (Greif, 1994, 2006), domestic interdependence among state economies (Keller and Shiue, 2015), and institutional integration of states (Guiso, Herrera, and Morelli, 2016). These channels mostly operate through nation states in modern times, and we therefore endogenize nation states by endogenizing borders in this paper.

A methodological dilemma emerges as to how to position states as players in international institutions. Specifically, if states in a model act too strategically, the model easily loses micro-foundations at the individual level. If states in a model are plainly benevolent social planners, the model would confront the diversity of political regimes across states. We strike a balance between the two considerations by specifying minimal capacities of states, and focus on the interactions among locales within and across states. All locales in our model seek to maximize their real income. States in our model serve only as the demarcation between domestic trade partners (i.e., without foreign trade costs) and foreign trade partners (i.e., with foreign trade costs), and have no other functions such as providing public goods. The specification of such "hollow" states insulates the mechanism of our model from the studies on the origin of states (Ang, 2015; Bates, Greif, and Singh, 2002; Carneiro, 1970; Hobbes, 1651; Tilly, 1985; de la Sierra, 2015) and the capacities of states (Aghion, Persson, and Rouzet, 2012; Alesina and Reich, 2015; Besley and Persson, 2009; Iyigun, Nunn, and Qian, 2015). Meanwhile, as these elements are shut down rather than replaced, they can be restored individually when the need arises to incorporate them at the interstate level.

Our paper is related to the literature on the efficient size of states (Alesina and Spolaore, 1997, 2005, 2006; Brennan and Buchanan, 1980; Desmet, Le Breton, Ortuño-Ortín, and Weber, 2011; Friedman, 1977). In particular, the tradeoff between gains from trade and losses in autonomy builds on the pioneering model by Alesina, Spolaore, and Wacziarg (2000, 2005). We depart from the literature by incorporating geography. With a world geography specified, state territories are endogenously asymmetric within any period on the theoretical front, and thus are connectable with cross-sectional data of every period on the empirical front. Moreover, including geography in the model enables us to assess every locale's common interests with every other locale, with their own state, and with their neighboring states.[2] The goal of this paper is not characterizing how the number of states evolves over time, as in the literature, but rather rationalizing how the nation-state system serves as a platform for locales to interact with each other within each time period. States in our model emerge, change, and are dissolved through border reshuffling, driven by welfare calculations at the locale level.

Geopolitical analysis, started by Huntington (1907), Mackinder (1904) and Fairgrieve (1917), is not a well-defined discipline or sub-discipline in the social sciences, in spite of its significant influence in the works of historians (Braudel, 1949), human geographers (Diamond, 1999), and political scientists (Morgenthau, 1948; Kissinger, 1994, 2014; Brzezinski, 1997). It is controversial among social scientists because of the determinism to which it alludes. Schools on the liberalism side criticize its lack of moral relevancy (Berlin, 1954; Popper, 1957), while schools on the realism side believe that focusing only on one factor oversimplifies international relations (Morgenthau, 1948). As economists, we agree with the importance of free choice, because in economics endogenous decisions are the foundation of positive and normative analyses. The methodology of economics helps us avoid equating geopolitics with determinism. In our model, geographical positions of locales are exogenous, while their allegiance choices remain endoge-

[2] Lan and Li (2015) analyze different levels of nationalism across regions within a state. They find that regions that receive globalization shocks endorse the existing state configuration less, because they share less (respectively, more) common interests with their domestic peer regions (respectively, the rest of the world).

nous, and different parameters of the model lead to distinct state divisions in the world, even with the same geography assumed. To this end, our paper also provides a general contribution to the social sciences. We believe that more work in this direction will make geopolitics more analytical, tractable, and conclusive.

Perhaps surprisingly, the literature on international trade, where the nation state is both the analytical unit in theory and the administrative unit in practice, has not considered endogeneity in the formation of nation states. Suppose that the division of the world into states adjusts to facilitate trade among locales in the world, then the estimated impacts of trade costs on trade volumes would be biased towards zero. This supposition has a pronounced factual basis, as regional trade agreements — a supranational arrangement in international economics and politics — are extensively documented to be endogenous (Baier and Bergstrand, 2002, 2004; Egger, Larch, Staub, and Winkelmann, 2011; Krishna, 2003; Keller and Shiue, 2014; Shiue, 2005). There also exists plenty of evidence that wars, which often lead to births, deaths, and changes of nation states, are intertwined with trade (Martin, Mayer, and Thoenig, 2008b, 2012; Polachek, 1980, 1992).

There exist two international trade studies relevant to our approach. Anderson and van Wincoop (2003) analyze the effects of crossing-the-border on bilateral trade volumes between US states and Canadian provinces. They show that, for a given unit of border-induced cost, local economies in a smaller country (Canada) substitute foreign trade for domestic trade by a larger magnitude than those in a larger country (the US). Their analysis, despite treating borders as exogenous, demonstrate the asymmetric effects of the same border for economies on its different sides. In our paper, borders are endogenously formed and have asymmetric effects on their two sides, both economically and politically. Allen, Arkolakis, and Takahashi (2014) examine how a social planner would allocate trade costs across given states in the world. States in our model are endogenous and trade costs are the outcome of statehood. Besides, our interest lies in the landscape of states in a decentralized equilibrium with a given world geography, a positive issue that may explain modern political geography.

The rest of the paper is organized as follows. In Section 2, we illustrate why linearity is a reasonable approximation of world geography. We present our benchmark model in Section 3. In Section 4, we derive and empirically test five geopolitical implications of the benchmark model. In Section 5, we conclude.

2 Linear Approximation of the World Geography

To build geopolitics into an economic model, we have to specify a world geography in the first place. Only with geographical locations can states interact to produce geopolitics. The simplest geography is a straight line, different locations along which create simple geographical differentiation. Moreover, the differentiation is easy to quantify, as locations have different distances to the midpoint of the line. The midpoint of a line is the line's geometric center (GC), because it has the shortest total distance from all other points in the line. Therefore, a shorter distance from the midpoint corresponds to a locational advantage. Economic models with differentiated locations have a long tradition of using straight lines, such as Hotelling

(1929) on competition, Dornbusch, Fischer, and Samuelson (1977) on comparative advantage, Black (1948) and Downs (1957) on majority-rule voting, and Ogawa and Fujita (1980) on urban structures. The literature on international trade in the last decade emphasizes the role of differential locations, both theoretically and empirically (Anderson and van Wincoop, 2004; Head and Mayer, 2014). In theoretical model building, being closer to the rest of the world is associated with lower statewide price levels and thus is a locational advantage of a trading state. In empirical analysis of bilateral trade, it has become an econometric convention to address the relative locational advantages of trading states. Both strands of the trade literature underscore the asymmetry in geographical location and the resulting economic (dis)advantages. To account for such (dis)advantages, the line model stands out as a reasonable approximation of the world geography. Just as in other economic literatures, linearity seamlessly bridges locational (dis)advantages in global economy with theoretical tractability.

Before assuming a linear world geography, we find it important to check whether spatial centrality, as the major abstraction of linearity from the 3D-spherical earth surface, is geographically and economically relevant. Notice that the surface of a 3D-sphere has no geometric center, in that any point on the surface has the same *total* distance from all other points on the surface. If the earth is such a perfect 3D-sphere, spatial centrality does not apply, as moving away from any point does not generate any locational advantage or disadvantage. We are fully aware that using a linear world geography risks imposing ungrounded centrality, and therefore conduct two reality checks in this section. We investigate if human habitats, and the economies building in them, demonstrate spatial centrality. Humans live only on landmass that accounts for less than thirty percent of the earth surface and is disconnected into continents with roughly convex shapes. Therefore, spatial centrality may apply approximately, despite of the 3D-spherical shape of the earth.

Notice that circle is an alternative geography of a spatial economy, which is technically tractable and sometimes used in the literature. Unlike lines, circles do not have spatial centrality because all points on a circle have the same total distance from all other points on the circle. It is not the appropriate world geography if human habitats and economies demonstrate spatial centrality. In this regard, the two reality checks in this section also help us determine which simplified geography to use.[3]

Reality Check 1: Geographic Relevance

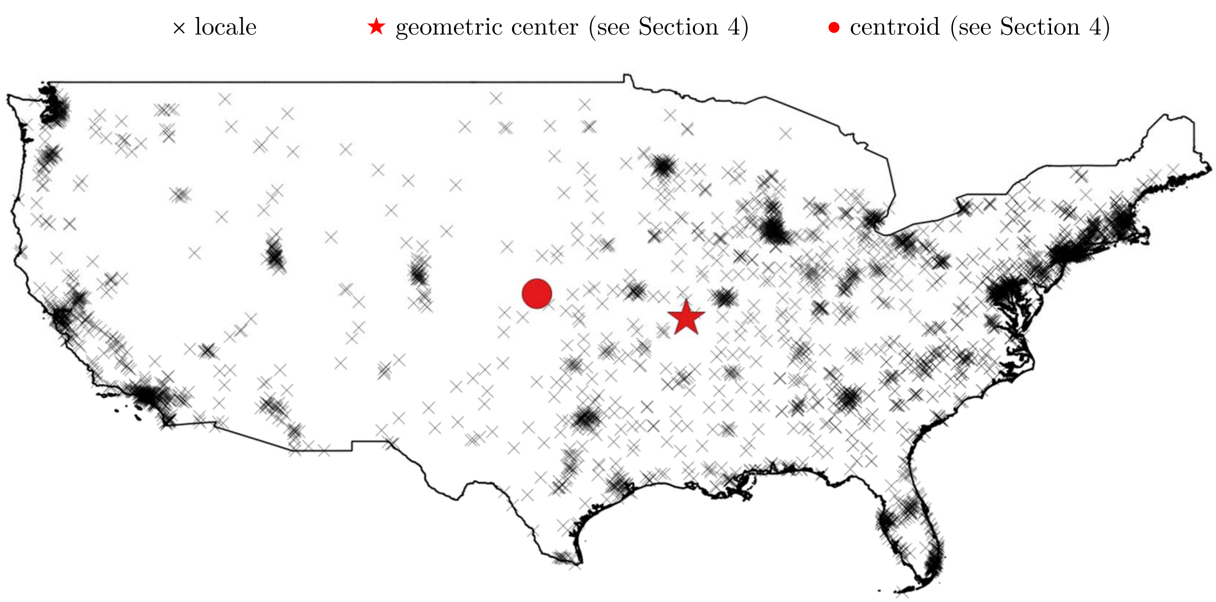
This check is concerned with whether human geography on the earth demonstrates spatial centrality as a linear geography does. Point a in the line $[-1, 1]$ has a distance $|a|$ with the line's GC at $a = 0$. Meanwhile, it has a total distance $a^2 + 1$ from all other points in the line, which is quadratically increasing in $|a|$ and minimized at the GC. Correspondingly, we examine whether the total distance of every human habitat in the world is quadratically increasing in its distance from the world GC.

To conduct the check, we need to locate the world GC. We use the following method to locate the world GC. First, we locate administrative units (henceforth, locales) with population

[3] A circle with a uniform interior (i.e., a disk) displays spatial centrality, though it remains unclear how to model borders in it. The same problem applies to other 2D-convex shapes.

larger than 15,000 in a standard GIS world map. 15,000 is a low population threshold. We use a low threshold because each locale is regarded here as a human habitat.[4] The data on locales are obtained from the GeoNames database (www.geonames.org), where geographical coordinates and population of world administrative units are provided. For the modern time (defined as the year 1994), there are 21,068 such locales. Figure 1 demonstrates locales in the US as an example, in which every locale is represented by a cross symbol (×). The circle and star symbols can be ignored for the moment, as they will be discussed in Section 4.

Figure 1: Locales Viewed in GIS Maps (the US as an Example)



Then, we calculate the total orthodromic distance of each locale with every other locale in the world.[5] We use the locale with the least total distance as the world GC:

$$GC \equiv \arg\min_{t} \sum_{t' \in W} D(t, t'), \tag{1}$$

where $D(t, t')$ denotes the distance between locale t and locale t' and W is the set of world locales. With the world GC located, we next calculate the average bilateral distance between every state in the world and the world GC:

$$Dist(n) \equiv \frac{1}{N_n} \sum_{t \in n} D(t, GC), \tag{2}$$

where N_n is the number of locales in state n.

[4] Lowering that population threshold to zero is equivalent to treating every state as a polygon. We use that as a robustness check later.

[5] Orthodromic distance (great-circle distance) is the shortest distance between two points on the surface of the earth. It is measured along the surface rather than through the interior of the earth.

If the world GC is geographically relevant, we would see a state with a larger $Dist$ is increasingly farther from the rest of the world, specifically, having a quadratically larger total distance from all foreign locales in the world. To implement this check, we construct

$$TDist(n) = \frac{1}{N_n} \sum_{t \in n} \sum_{t' \in W} D(t, t'), \tag{3}$$

as an analog of $a^2 + 1$ in the line model. The check takes the form of regressing $TDist(n)$ on $Dist(n)$ and $Dist(n)^2$, where $Dist(n)$ is an analog of $|a|$. The coefficients of the constant term and $Dist(n)^2$ are expected to be positive.

Data Our baseline map is the world map for the year 1994. Since then, no major border change has occurred in the world. Over a long time horizon, states form and dissolve, and the borders of continuing states change, thereby periodically relocating the world GC. Historical maps are a good supplement for the modern world map. We constructed world GIS maps by digitizing maps in historical atlases of the world, including Barraclough (1994), Rand McNally (1992, 2015) and Overy (2010). We used multiple atlases because maps in historical atlases are provided for different region-time blocks rather than for the whole world over time. Combining different sources enabled us to compile a world map for each period of time (starting from a *base* year and extending to approximately 20-30 years later). We successfully compiled three historical world maps, with base years 1750, 1815, and 1914-1920-1938 (explained below), respectively. For simplicity, we refer to them as 18th century, 19th century, and early 20th century in the rest of the paper.

The selection of historical base years inevitably involves judgments, since a balance has to be struck between historical significance and map availability. In principle, we selected years that follow major wars and precede relatively peaceful 20-30 year periods. World political geography in those base years resulted from the resolution of the power imbalances that triggered the wars, and was marked by temporary regional stability afterwards. Specifically, 1750 followed the War of the Austrian Succession, and 1815 was the year when the Treaty of Paris was signed. It is difficult, using this principle, to find a qualified base year in the early 20th century, because two world wars took place during the first half of the century. WWI was too close to the beginning of the century, and the interwar years (1919-1938) were too short as a peaceful period. In this setting, choosing a single year would risk using a political map filled with persuasive regional tensions that changed borders rapidly. At the same time, the first half of the 20th century, as an exemplar period of struggle in modern history, should not be plainly excluded as we did for similarly convoluted earlier periods (such as the early 19th century). As a compromise, we pooled all states that existed in three separate base years — 1914, 1920, and 1938.[6]

Similar judgments were made when we determined what states from world maps to exclude. In principle, territories with ambiguous sovereignty statuses were excluded. By this principle, small island states were usually excluded, because many of them were dependent territories. There are two exceptions to this principle. First, although colonies had ambiguous sovereignty statuses, they were good examples of border reshuffling and state formation. Thus, colonies

[6]If a state altered its name across the three base years, we treated it as a new state. If a state kept its old name, we treated it as a "steady state" and accordingly averaged its variables across the three base years.

were treated as independent states in their own periods if they later transitioned to independent states. Second, kingdoms in the 18th century were considered to be independent states as long as they were independent from neighboring states that had clear sovereignty statuses. Without making these two exceptions, states in historical periods would be quite small in number.

The above compromises and judgments weakened the accuracy of our historical data. The inaccuracy is aggravated by two other factors. First, historical maps are far less accurate than the modern world map, owing to weak cartographic technologies in the past and the inaccuracy of historical records. Second, there exist no GeoName data corresponding to historical periods, so that we have to use the modern GeoName data to construct the set of human habitat t in equations (1) to (3) for historical periods. For these reasons, historical data play only a supplemental role in this study. The modern period is our primary data source and the results from this period represent our major findings.

Table 1 reports the locations of world GCs over time (last row in each panel), along with variables we will use in later analysis. Details on other variables will be provided when they are used.

Results Using GIS maps, we constructed $Dist$, area, coast dummy, and island dummy, for each state n in its period. Coast dummy (=1) means having access to coastline and island dummy (=1) means being on an island. Panel A of Table 2 reports regression results. The coefficients of the constant term, $Dist$, and $Dist^2$ are all positive and statistically significant. The constant term of the regression corresponds to the 1 in the $TDist$ formula $TDist(a) = a^2+1$. The first-order term is absent in the formula because its GC is precisely at the midpoint of the line (i.e., $a = 0$). When it is not at the midpoint, a first-order term is present. This relation holds for every period and the R^2 statistics are between 0.978 and 0.994, indicating that $TDist(n)$ fits spatial centrality to a high degree. We experiment with including coast and island dummies, as well as continent fixed effects, which do not change the results. They alter the relative sizes of those coefficients, though do not lead to significant R^2 improvement. Panel B of Table 2 elaborates on the modern period by including different orders of $Dist(n)$. As a comparison, its first column reproduces the second regression for the modern period in Panel A. When polynomial regression reaches higher orders, the fitness hardly improves.

Table 1: Summary Statistics

Variable	Obs	Mean	STD	Min	Max	Obs	Mean	STD	Min	Max
	Panel A: Modern period					*Panel B: The 18th century*				
Distance from the world GC (km)	162	5365	3575	132.2	17968	121	4959	3609	364.7	17620
Area (square km)	162	86.41	274.7	0.338	2806	121	71.00	269.7	0.0269	2664
Coast dummy	162	0.753	0.433	0	1	121	0.752	0.434	0	1
Island dummy	162	0.123	0.330	0	1	121	0.182	0.387	0	1
Military expenditure#	156	3.548e+06	9.153e+06	4783	5.700e+07					
Iron and steel production (tons)	156	5054	19802	0	205259					
Primary energy consumption*	156	118773	308762	25.74	2.461e+06					
World GC (Lat, Lon)	Hradec Kralove, Czech Republic (50.21,15.83)					Kisvarda, Austrian Empire (48.22,22.08)				
	Panel C: The 19th century					*Panel D: Early 20th century*				
Distance from the world GC (km)	137	4945	3867	110.9	17970	174	5606	3523	194.0	17968
Area (square km)	137	84.07	308.4	0.0148	2976	174	120.1	387.7	0.338	3401
Coast dummy	137	0.679	0.469	0	1	174	0.828	0.379	0	1
Island dummy	137	0.153	0.362	0	1	174	0.126	0.333	0	1
Military expenditure#	51	5146	4316	14.73	20687	75	745823	1.919e+06	0	9.970e+06
Iron and steel production (tons)	51	325.5	444.2	0	2806	75	1908	5953	0	45349
Primary energy consumption*	51	7100	9968	0	62639	75	30703	100490	0	809321
World GC (Lat, Lon)	Weißwasser, Germany (51.50,14.64)					Hradec Kralove, Austro-Hungarian Empire (50.21,15.83)				

Notes: # Following the COW database, the unit is 1,000 US dollars (1,000 British Pounds) in Panels A and D (Panel C). * The unit is 1,000 of coal-ton equivalents.

Table 2: Reality Check: Geographic Relevance of Spatial Centrality

Panel A: Dep. Variable is Tdist				
	Period: 18th century		Period: 19th century	
Constant term	87212030.837***	95456240.911***	1.054e+08***	1.168e+08***
	(845,514.069)	(1682650.484)	(536,585.529)	(1822809.178)
Distance from the world GC	7,276.891***	4,864.358***	7,449.707***	4,720.678***
	(564.896)	(717.695)	(464.220)	(877.438)
Distance from the world GC^2	0.188***	0.321***	0.169***	0.409***
	(0.051)	(0.075)	(0.045)	(0.092)
Coast and island dummies	No	Yes	No	Yes
Continent FE	No	Yes	No	Yes
Observations	121	121	137	137
R-squared	0.969	0.994	0.978	0.990
	Period: early 20th century		Period: modern	
Constant term	1.088e+08***	1.187e+08***	1.088e+08***	1.187e+08***
	(1115661.126)	(1707038.555)	(1095266.681)	(1810979.989)
Distance from the world GC	7,757.427***	5,286.812***	7,823.481***	5,206.437***
	(646.753)	(808.303)	(644.294)	(818.453)
Distance from the world GC^2	0.209***	0.410***	0.205***	0.412***
	(0.061)	(0.080)	(0.061)	(0.082)
Coast and island dummies	No	Yes	No	Yes
Continent FE	No	Yes	No	Yes
Observations	174	174	162	162
R-squared	0.984	0.993	0.984	0.993
Panel B: Dep. Variable is Tdist, Modern Period+				
Constant term	1.187e+08***	1.234e+08***	1.248e+08***	1.234e+08***
	(1810979.989)	(647,497.479)	(662,080.449)	(1029453.236)
Distance from the world GC	5,206.437***	2,382.739***	-992.376	2,427.142
	(818.453)	(509.458)	(1,845.611)	(2,854.955)
Distance from the world GC^2	0.412***	0.732***	2.452**	0.063
	(0.082)	(0.160)	(0.973)	(3.050)
Distance from the world GC^3		0.000	-0.000	0.000
		(0.000)	(0.000)	(0.001)
Distance from the world GC^4		-0.000***	0.000	-0.000
		(0.000)	(0.000)	(0.000)
Distance from the world GC^5			-0.000	0.000
			(0.000)	(0.000)
Distance from the world GC^6			0.000	0.000
			(0.000)	(0.000)
Distance from the world GC^7				-0.000
				(0.000)
Distance from the world GC^8				0.000
				(0.000)
Observations	162	162	162	162
R-squared	0.981	0.997	0.997	0.997

Notes: + Panel B includes coast and island dummies and continent fixed effects in all columns (just as the second column of the modern period in Panel A). Robust standard errors in parentheses. *** p<0.01, ** p<0.05.

Reality Check 2: Economic Relevance

The spatial centrality demonstrated in Table 2 might be unsurprising. The Eurasian continent, with the largest number and longest histories of states, spreads out in an east-west direction and the Atlantic is far narrower than the Pacific. Such west-east pecuniary geography implies spatial centrality, which does not necessarily have economic significance. At the cross-state level, trade is the best indicator of economic linkage. We next estimate a gravity model, which has long been found to predict bilateral trade volumes among states with good accuracy. A standard gravity regression in the literature has the following specification:

$$\ln T(n,n') = \delta_D \ln D(n,n') + \delta_n \ln Size_n + \delta_{n'} \ln Size_{n'} + \iota' Z_{nn'} + \epsilon_{nn'} \tag{4}$$

where $T(n,n')$ is the value of imports of state n from state n', $D(n,n')$ is the distance between the two states, $Size_n$ and $Size_{n'}$ are the sizes of the two states, $Z_{nn'}$ are control variables, and $\epsilon_{nn'}$ is the error term. δ_D is expected to be negative, δ_n and $\delta_{n'}$ positive, which are extensively documented in the empirical trade literature. We add two additional regressors $\ln Dist(n)$ and $\ln Dist(n')$ to the gravity model and expect their coefficients to be negative. That is, conditional on the bilateral distance between the two states, the closer either state is to the world GC, the more it engages in trade.

Data and Results We use the 1994 CEPII data on international trade to estimate the gravity model.[7] The CEPII data provide the geographical coordinates of every state's capital city and use that to construct bilateral distances between states. This provides an opportunity to cross-check our locale-based distances. As before, we construct every state's $TDist(\cdot)$ and $Dist(\cdot)$ using those geographical coordinates of capital cities. In Panel A of Table 3, the first two columns show similar relations between $TDist(\cdot)$ and $Dist(\cdot)$ as in Table 2. The next two columns run the regressions in log terms and demonstrate a positive correlation between $\ln TDist(\cdot)$ and $\ln Dist(\cdot)$. This is a check on the reliability of $\ln Dist(\cdot)$, which will enter into the gravity model. Panel B of Table 3 reports the estimates from the gravity model. The estimated parameters are consistent with our expectation; specifically, the coefficients of the two $\ln Dist(\cdot)$ terms are both negative and statistically significant.

Regression (4) is usually referred to as the reduced-form gravity equation. It can alternatively be estimated with two state fixed effects instead of the two state-size variables. The fixed-effect specification is often termed as the structural gravity equation, where the two fixed effects have a theoretical interpretation — they capture the capacities of the two states as importers and exporters, respectively, compared to the rest of the world.[8] We hypothesize that the trade volume between any two partners is not only affected by their bilateral distance, but by their capacities compared to the rest of the world. Following this reasoning, we run regression (4) using the fixed-effect approach and extract the two fixed-effect estimates of every state, one on the export side and the other on the import side. A larger fixed effect on the export (import)

[7]The CEPII data are widely used in international trade studies. For details, see Head, Mayer, and Ries (2010) and Head and Mayer (2014).

[8]The same bilateral foreign trade cost will cause partners that are more distant from the rest of the world to substitute more towards domestic trade. For discussions on the structural gravity equation, see Anderson and van Wincoop (2004), Head and Mayer (2014) and Redding and Venables (2004).

Table 3: Reality Check: Economic Relevance of Spatial Centrality

Panel A: Cross-check of Table 2				
	Dep. Variable=Tdist		Dep. Variable=ln(Tdist)	
Constant term	1512864.086***	1492997.338***		
	(14,637.842)	(21,002.305)		
Distance from the world GC	44.787***	46.258***		
	(8.048)	(8.079)		
Distance from the world GC^2	0.003***	0.003***		
	(0.001)	(0.001)		
ln(Distance from the world GC)			0.131***	0.123***
			(0.012)	(0.011)
Coast and island dummies	No	Yes	No	Yes
Observations	155	155	155	155
R-squared	0.932	0.934	0.621	0.662
Panel B: Dep. variable is ln(Trade volume)				
	Size=population		*Size=area*	
ln(Size of exporter)	0.518***	0.499***	0.323***	0.313***
	(0.009)	(0.009)	(0.009)	(0.009)
ln(Size of importer)	0.444***	0.426***	0.260***	0.251***
	(0.009)	(0.009)	(0.009)	(0.008)
ln(Bilateral distance)	-0.466***	-0.253***	-0.404***	-0.222***
	(0.021)	(0.023)	(0.022)	(0.025)
ln(Exporter's distance from the world GC)	-0.305***	-0.331***	-0.404***	-0.408***
	(0.014)	(0.014)	(0.015)	(0.016)
ln(Importer's distance from the world GC)	-0.255***	-0.281***	-0.332***	-0.335***
	(0.014)	(0.014)	(0.016)	(0.016)
Other control variables+	No	Yes	No	Yes
Observations	18,839	18,839	19,019	19,019
Panel C: Dep. variable is estimated fixed effect in the gravity model				
		Import side		*Export side*
ln(distance from the world GC)		-0.178*		-0.230**
		(0.098)		(0.112)
Coast and island dummies		Yes		Yes
Observations		155		155

Notes: The data are for the year 1994 in all panels. + Control variables include dummies for being in the same regional trade agreement(s), sharing legal origins, sharing currency, sharing border(s), sharing official language, dummy for being a GATT member (each side), dummy for selling to colony, dummy for buying from a colony. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

side suggests a larger capacity in the exporting (importing) business. In Panel C of Table 3, we regress each of the two state-level fixed effects on $Dist(n)$ and find a negative correlation between them. That is, the farther a state is from the world GC, the smaller its capacity in international business.[9] This check establishes the economic relevance of the world GC — all else held constant, a longer distance from the world GC means less international trade.

3 The Benchmark Model

3.1 Environment

Consider a world represented by a continuum of locales, indexed by $t \in [-1, 1]$. Locales have the same size of labor. In every locale, labor is inelastically supplied to the production of a locale-specific differentiated good. Consumers in locale t consume goods made locally and elsewhere:

$$C(t) \equiv \exp\{\int_{-1}^{1} \ln c(t, s) ds\}, \tag{5}$$

where $c(t, s)$ is the quantity of the good made by locale s and consumed by locale t. We keep production as simple as possible. Technologies have the same efficiency. Wage rates and output prices are equalized across locales, and all locales have the same nominal income and expenditure (normalized as one).

Every locale is affiliated with a state, which is defined to be an interval of locales. Notationally, locale t is in state n_t. Cross-locale trade is costless if the two locales are in the same state, but incurs an iceberg cost if the two locales are in two different states. Specifically,

$$d(t, s) = \begin{cases} 1, & \text{if } s \in n_t, \\ \inf_{t \in n_t} \exp\{\tau |s - t|\}, & \text{if } s \notin n_t, \end{cases} \tag{6}$$

where the parameter $\tau > 0$ is the foreign trade cost parameter. The exponential function in equation (6) results from aggregating incremental iceberg costs as the distance between the increments tends to zero (see Allen and Arkolakis (2014)). Both zero domestic trade cost and iceberg foreign trade cost are standard assumptions in the international trade literature.[10] Zero domestic trade cost is not essential in our context. A positive domestic trade cost does not alter our findings as long as it is smaller than foreign trade cost per unit of distance.[11] Without loss of generality, we let the consumption side pay trade costs.

It follows that $c(t, s) = 1/[2d(t, s)]$, and a measure of locale t's "remoteness" to the rest of

[9] At this point, we do not attribute the explanatory power of $Dist(n)$ to any interstate institution (such as European Union or regional trade agreements), because interstate institutions build on states and our later theoretical model rationalizes how states evolve. Only when the mechanism of states are made clear, can other international institutions develop upon them.

[10] See Anderson and van Wincoop (2003) and Eaton and Kortum (2002).

[11] In that case, because locales in a state have different optimal state sizes, a domestic political regime has to be specified to generate a collective decision on the composition (scope) of the state. In order to avoid assuming specific political regimes, we assume domestic trade costs to be zero. Political regimes are discussed in Section 3.4.

the world:

$$R(t) \equiv \exp[\int_{-1}^{1} \ln d(t,s)ds]. \tag{7}$$

$R(t)$ reflects locale t's price level. As the labor supplies and wage rates are equalized across locales, we have $C(t) = 1/R(t)$. That is, a locale's aggregated consumption is decreasing in its remoteness.

3.2 Endogenous Borders

Given the settings in Section 3.1, having no borders represents the ideal configuration of the world because that would maximize consumption at every locale. Such an ideal configuration, however, is clearly counter-factual. In reality, borders are not only drawn but also enforced, dividing economic transactions into domestic ones and foreign ones. A natural question emerges as to why locales set borders to isolate themselves from the rest of the world. Before addressing that question, we introduce a few state-related notations. Borders in the world are, from the left end to the right end,

$$\{b_n\}_{-N}^{N} \equiv \{b_{-N}, ..., b_{-1}, b_{-0}, b_0, b_1, ..., b_N\}. \tag{8}$$

Take the right half for example. State n refers to the locales in $[b_{n-1}, b_n)$. The territory of state n is $S_n \equiv b_n - b_{n-1}$. Since borders reduce consumption, every locale t wants its state n_t to be as large as possible. To keep state territories limited, we follow Alesina, Spolaore, and Wacziarg (2000, 2005) to specify a constant marginal disutility h from $S(n_t)$, so that the utility function of locale t is

$$U(t) = \frac{1}{1-\gamma} C(t)^{1-\gamma} - hS(n_t), \tag{9}$$

where $\gamma > 1$.

There are several interpretations of the disutility term $hS(n_t)$. The first is to interpret it as a "cost of heterogeneity" as in Alesina et al. (2000), which arises because a larger state means that more heterogeneous people (ethnicities, races, origins) have to conform to uniform state institutions. The second is to consider equation (9) as a quasilinear utility function. In that case, there is an exogenous resource endowment in the world and every state has the same constant share. Within any state, the endowment is equally divided among locales, so that a larger state means a smaller share of the resource per locale. The third is to think of h as the cost of expanding borders for the locale per unit of distance. The cost is paid by local income tax and thus is written into the utility function of locales.

The "remoteness," as a measure of statewide price level, at locale t is now equal to

$$R(t) = \exp\{\int_{-1}^{b_{n-1}} \tau(b_{n-1} - s)ds + \int_{b_n}^{1} \tau(s - b_n)ds\} \tag{10}$$

$$= \exp\{\frac{\tau}{2}[(1 + b_{n-1})^2 + (1 - b_n)^2]\}. \tag{11}$$

where the first (second) term corresponds to the remoteness to the rest of the world on its left (right). Note that peer locales in the same state as t have the same $R(t)$, denoted by R_n, where n is the index of their state. $R(t)$ is higher (i.e., $C(t)$ is lower) if its state n_t is farther from the world GC. We define $t = 0$ as the world geometric center (GC), where remoteness is minimized and consumption is maximized. Locales close to the world GC maximize their utility by choosing optimal $b_{-0} < 0$ and $b_0 > 0$, resulting in state 0 that covers the range of locales (b_{-0}, b_0). Take the right half of the world. Locales close to the right side of b_0 solve for b_1 by maximizing the U in equation (9) with b_0 given, resulting in state 1 that covers the range of locales $[b_0, b_1)$. From there onwards, locales close to the right of b_{n-1}, $n \geq 2$, solve for b_n as the right border of state n. The same reasoning applies to the left side of the world, except that locales to the left of b_{-0} solve for b_{-1} as the left border of state -1 and so forth.

An important feature of the above "conglomerating" process is a centripetal tendency. In the right half of the world, the marginal locale excluded by state 0 wished to join state 0. From its view, the return from joining with right-side neighboring locales is less than that from joining state 0. More generally, for any state in the right half, the return from joining with right-side neighboring locales is lower than that from joining with left-side neighboring locales. It is the incumbent constituents of left-side states who oppose incorporating that marginal locale, so that the marginal locale is excluded and has to join with its right-side neighbors. The locale excluded by state 0 takes b_0 as given and chooses b_1 collectively with its right-side neighbors that it wants to internalize. In equilibrium, all locales in a state agree with their peer locales in the composition (scope) of their states. It does not make a difference if a benevolent ruler chooses S_n for them. Also, as all locales have the tendency to join states closer to the world GC, the equilibrium is unique and stable.

3.3 Analysis of the Equilibrium

The above model is stylized but provides rich comparative statics. The first-order condition for maximizing (9) is

$$\tau R_n^{\gamma-1}(1 - b_{n-1} - S_n) = h. \tag{12}$$

According to the previous indexing convention, a state with a greater n is farther from the world GC, thereby having a larger R_n and a smaller C_n. Therefore, their marginal utility from consumption is greater. Notice that when τ is very high, the left side of equation (12) is greater than the right side even for state 0, so that there is only one state in the world. That "world state" violates the definition of states in our model (i.e., sets of locales exclusive of each other). When τ lowers, states merge as sets of locales. This leads to our first major finding:

Finding 1: Unless τ reaches a very low level, states exist and those farther from the world GC have larger territories.

In other words, locales that are more distant from the world GC have to incorporate more neighboring locales to keep their price levels low. A formal proof is provided in the Appendix.

Finding 1 and its underlying mechanism provide a way to rationalize the history of modern states. When trade costs were prohibitively high in the late Pre-Columbian era, borders were not officially drawn and sovereignty was not clearly defined. The Age of Discovery was driven by the craving for foreign consumption goods, just as described by the large marginal utility of any non-local variety in equation (5). After global trade became possible, modern states started forming and a world economy emerged as a collection of statewide markets (for discussion on this transition, see for example Chapter 3 in Palmer, Colton, and Kramer (2007)). States define national markets, which are the economic foundation of nation states. As nation states are the basic units of common interests among locales, they play the role of protagonists in the alignment of regional interests, transforming inter-locale affairs to inter-state geopolitics.

Technically, Finding 1 helps to close the model. As states at the two ends of the world are the largest, we let those two "end states" absorb residual locales (if any) at the two ends, to ensure N as an integer. That is, the number of states in the world is $2N+1$, where

$$2N = \{2n : \frac{S_0}{2} + \sum_{i=1}^{n} S_i \leq 1 \text{ and } \frac{S_0}{2} + \sum_{i=1}^{n+1} S_i > 1\}. \tag{13}$$

Since the two end states have the largest territories in the world, incorporating a few residual locales has little impact on their welfare, and those marginal locales have incentives to join the end states. This connects with the reality that states far from all others usually have large core territories, together with minor dependent territories. We will provide detailed econometric evidence in Section 4.

Importantly, state 0 is not part of Finding 1. Finding 1 applies to all states except state 0, as it is concerned with states that solve their distal borders with given proximal borders. State 0 does not have to be smaller than states 1 or -1, while state 1 (respectively, state -1) is smaller than state $n > 1$ (respectively, state $n < -1$). Technically, state 0 and other states solve different optimization problems. Solving b_n with b_{n-1} held constant and solving symmetric b_n and b_{-n} correspond to different first-order conditions. Intuitively, state 0 could be large because when it sets its borders in two directions simultaneously, the disutility from extending borders spreads across the two fronts. This effect applies to none of other states. Thus, state 0 can actually be large (see the Appendix for its proof), corresponding to the empires in history. Note that in Table 1, the world GCs were in large states in three out of the four periods (Austrian Empire, Germany, and Austro-Hungarian Empire). To summarize,

Finding 2: State 0 could be larger than state $n \geq 1$ ($-n \leq -1$) in the right (left) half of the world.

International trade volume, as the major indicator of global economic integration, affects and at the same time is affected by the political integration of the world. Our model produces a gravity equation in the following form (see the Appendix for its derivation):

$$X_{m,n} = \frac{1}{2} S_m S_n \exp\{-\tau(b_n - b_m)\}, \tag{14}$$

where $X_{m,n}$ is the trade volume between two nonadjacent states m and n, $n > m$, and $(b_n - b_m)$ is the distance between the two states. With the percentage change donation $\hat{v} = dv/v$, we can decompose the impact of a τ-reduction (i.e., $d\tau < 0$) on trade volume into three effects:

$$\underbrace{\hat{X}_{m,n}^{d\tau<0}}_{\lesseqgtr 0} = \underbrace{\hat{S}_m + \hat{S}_n}_{\text{size effect}<0} \underbrace{-(b_n - b_m)d\tau}_{\text{direct effect}>0} \underbrace{-\tau d(b_n - b_m)}_{\text{location effect}>0}. \tag{15}$$

In equation (15), the size effect refers to the fact that both states shrink in size when τ lowers.[12] The direct effect is self-explanatory and is the impact of trade liberalization examined in the international trade literature. The net of these two effects has an ambiguous sign. There is also a location effect that adds to the ambiguity. The location effect is positive, because as reducing τ leads to smaller states worldwide, the shrinkage of the states between m and n brings states m and n closer to each other. In the short run, when state borders are fixed, the direct effect is the only effect of trade liberalization. In the long run, when state borders are endogenous, the size and location effects emerge and oppose each other; therefore, the total effect of τ on trade volume is ambiguous.

A rearrangement of equation (15) illustrates how a reduction in trade cost, a force that promotes economic integration, may aggravate political disintegration:

$$|b_n - b_m| d\tau = \underbrace{-\hat{X}_{m,n}}_{\text{economic integration}} + \underbrace{\hat{S}_m + \hat{S}_n}_{\text{political disintegration}} \underbrace{-\tau d(b_n - b_m)}_{\text{border reshuffling}}. \tag{16}$$

It is then clear that

Finding 3: In a long-run gravity equation, reduction in trade costs are absorbed by three effects that are exclusive of each other: (i) trade volume rises, (ii) state sizes shrink, and (iii) states become closer to each other.

It is important to note that the three effects can substitute each other in absorbing the trade cost reduction. For example, given a trade cost reduction, a larger shrinkage in state sizes would (A) reduce the magnitude of bilateral trade volume increase, or alternatively, (B) would squeeze the in-between states less. The former effect (A) can also be derived from the models featuring symmetric state sizes in Alesina, Spolaore, and Wacziarg (2000, 2005), which note that city states of Italy and the Low Countries in Europe could afford to be small because of their easy access to the world market. The latter effect (B) connects with Fazal (2007), which documents that buffer states (defined as states located between two other states engaged in a rivalry) are more likely to dissolve.

Reverting to the first-order condition (12), it also suggests that the disutility from S becomes more affordable for all locales as the trade cost parameter τ decreases. In the model, if τ lowers, h should decrease to keep borders in the world unchanged. The farther a state is from the world GC, the less such counteraction and thus less likely do borders alter. Mechanically, $dh/d\tau > 0$, and is decreasing in $|b_n|$ (see the Appendix for its proof). To summarize,

Finding 4: With borders unchanged, the impact of reducing τ and that of reducing h counteract each other. The counteraction is less for states farther from the world GC.

Finding 4 demonstrates the relation between τ, the deep parameter behind economic integration, and h, the deep parameter behind political (dis)integration. If a lower τ follows from shocks in transportation technologies and no policy intervention is undertaken on h, border changes are more likely in regions closer to the world GC. This is consistent with the aforementioned centripetal tendency in locale conglomeration. Farther locales can only join with even farther

[12] All states shrink in size when τ lowers (to demonstrate that, see equations (42) and (44) in the Appendix).

locales to form states for reducing trade costs, but the resulting trade cost reduction is smaller. In other words, these states are less bonded by the τ-versus-h tradeoff than those closer to the world GC.

Interestingly, the political (dis)integration parameter h also affects economic integration as reflected by trade volume. We can decompose the impact of an h-reduction (i.e., $dh < 0$) on trade volume into two effects:

$$\underbrace{\hat{X}_{m,n}^{dh<0}}_{\lesseqgtr 0} = \underbrace{\hat{S}_m + \hat{S}_n}_{\text{size effects}>0} \underbrace{-(b_n - b_m)d\tau}_{=0} \underbrace{-\tau d(b_n - b_m)}_{\text{location effect}<0}. \tag{17}$$

Here the size effect is positive because state sizes grow when h lowers, and the location effect is negative as m and n are farther apart owing to the expansion of states between them. The net of the two effects is ambiguous.

3.4 Remarks: Decolonization and Political Regimes

The benchmark model above is built to show the interdependence between international trade and national borders in a global economy. Its design is for rationalizing geopolitics, as done in the next section. It abstracts from decolonization and political regimes. Decolonization, as an important state-forming force, does not contradict our model.[13] Locales in colonies had joint economic interests with the rest of the world through trade. They sought independence when their gains from low-cost trade with other territories of the same controlling state (empire) were outweighed by their demand for autonomy.

Take the American Revolution, for example. The first step made by the Continental Congress towards independence was opening all colonial ports to direct trade with the rest of the world in the year 1776. Before that, all trade between American colonies and the rest of the world had to be channeled through Britain. Thomas Paine, in his seditious pamphlet *Common Sense (1776)*, manifested this rationale for independence:

> As Europe is our market for trade, we ought to form no partial connection with any part of it. It is the true interest of America to steer clear of European contentions, which she never can do, while by her dependence on Britain, she is made the make-weight in the scale on British politics.

Independence meant higher trade costs with Britain, yet the rising demand for American products in other parts of Europe still incentivized revolutionaries to seek independence. Gaining independence lowered trade costs with the rest of the world by making trade direct, and meanwhile distanced transatlantic trade from Britain's warfare with continental Europe. Both effects, as explicated by Paine, attest to a trade-autonomy tradeoff.

Our model does not specify the political institutions that operate to set borders. The institutions could rest on either democratic voting or rent-maximization ruling. The world in our model can be a mix of states under both regimes. A democratic regime is the simplest form

[13] Head, Mayer, and Ries (2010) find pronounced but gradually declining impacts of colonial history on the trade patterns of post-colonial countries (for the case of China, see Head, Ries, Sun, and Hong (2015)). Bonfatti (2014) provides a novel theoretical model on the interaction between trade and decolonization.

of the state-formation politics here, under which the median locale in a state determines the composition (scope) of the state. Apparently, in any state, the median locale is closer to the world GC and wants a smaller state than the marginal locale at the border. As a result, median locales of states farther from the world GC prefer larger states. Such a democratic regime is straightforward but is not required to reach our main findings. Under a regime where an absolute ruler sets borders, collects taxes, and defends territories, the ruler's preferences can be represented by the utility function (9). Rulers can increase tax revenues by conquering more locales, while there is a fixed cost for conquering each locale. So long as the tax revenue is concave in the number of conquered locales, rulers closer to the world GC prefer smaller states. An argument similar to the above applies if the tax is replaced by a tariff on foreign goods.

To summarize, differences in domestic political regime may lead to different departures from the equilibrium borders in our model though the mechanism in our model still holds. A general point remains regardless of political regime: gains from a larger territory increases at a decreasing rate as the territory expands. Thus, so long as the cost of extending borders is non-decreasing, states closer to the world GC have relatively less incentive to extend their borders.

4 Geopolitics in Light of the Benchmark Model

4.1 Territorial Area

In this section, we derive five geopolitical implications from the benchmark model and test them empirically. The geopolitical *implications* discussed in this section have no direct linkage with the *findings* on trade and borders discussed in Section 3. The only exception is Implication 1, which follows immediately from Finding 1 and can be tested with the GIS data described in Section 2:

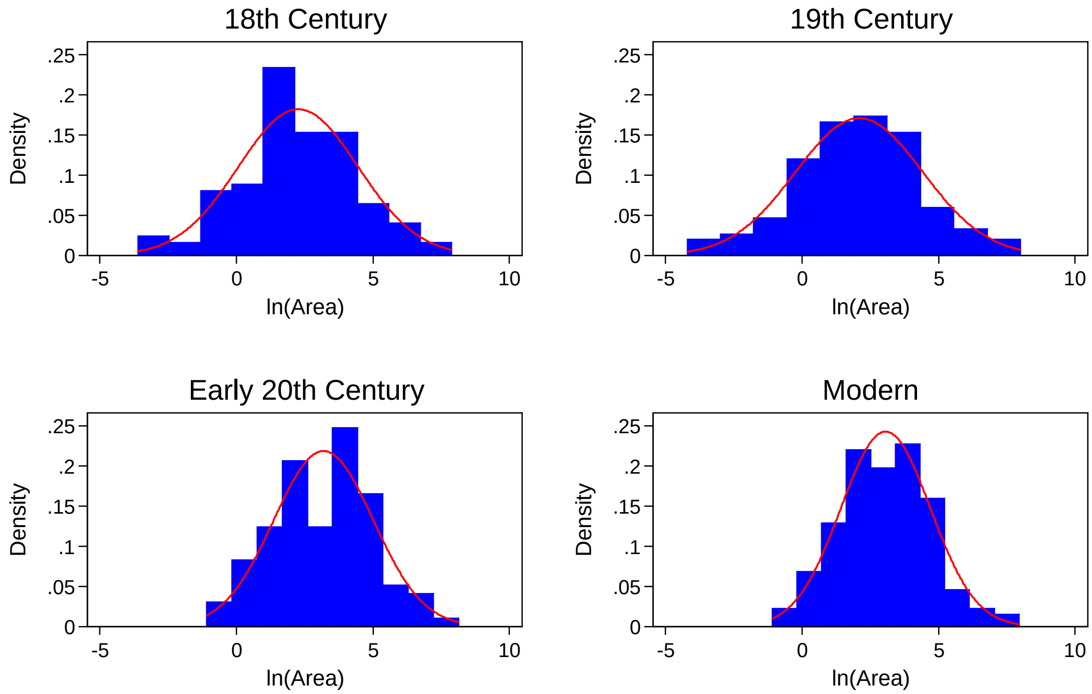
Implication 1: States farther from the world GC set their borders farther apart, leading to larger territories.

Below, we start with a simple regression of $\ln Area(n)$ on $\ln Dist(n)$. Figure 2 demonstrates histograms of $\ln Area(n)$ in every period. Over time, as states rise in number, the dispersion of $\ln Area(n)$ shrinks.

1. Baseline Results The regression results are reported in Table 4, where a positive and statistically significant correlation between $\ln Area(n)$ and $\ln Dist(n)$ is widely found. We include continent fixed effects in all regressions. In Panel A, we limit control variables to geographical characteristic: a coast dummy and an island dummy. Column (1) of Panel A corresponds to the modern period. Since $Dist(n)$ is a state's average distance across its locales, we experiment with weighting regressions using numbers of locales at the state level to address potential heteroskedasticity. The results turn out to be similar. We minimize the use of control variables in Panel A to maximize sample sizes. In column (1) of Panel B, we control for military expenses, iron and steel production, and primary energy consumption. These variables are correlated with national powers, which may affect territorial areas. Their data are from the National Material

Capabilities dataset of the Correlates of War (COW) Project (http://correlatesofwar.org/), the coverage of which started from the year 1815, though not every state is covered in every period. With national powers controlled for, our sample size slightly shrinks (from 162 to 156). The coefficient of $\ln Dist(n)$ remains positive and statistically significant, either unweighted or weighted. In later tables, we report only unweighted results to save space.[14]

Figure 2: Dispersion of State Territories



Columns (2)-(4) in both panels of Table 4 correspond to historical periods. There are two motivations for testing Implication 1 using historical data. First, state-level variations are confounded by cross-sectional idiosyncrasies in any given period, and thus checking every period helps to mitigate the identification problem. Specifically, the variations in $Dist(n)$ in any single historical period are different from those in the modern period at three separate margins. To demonstrate the differences, equations (1)-(2) can be rewritten, for a period in history, as

$$Dist(n^0) \equiv \frac{1}{N_{n^0}} \sum_{t \in n^0} Dist(t, GC^0), \tag{18}$$

where

$$GC^0 = \arg\min_t \sum_{t' \in W^0} Dist(t, t'). \tag{19}$$

where n^0 is a state in history, GC^0 is its contemporary world GC, and W^0 is the set of its con-

[14] Weighted results are available upon request. We are in favor of the unweighted specification because the application of weighted regressions to non-survey data is controversial. Weighting regressions may aggravate rather than mitigate heteroskedasticity (Solon, Haider, and Wooldridge, 2015).

Table 4: Baseline Results (Implication 1)

Dependent variable is ln(Area)	(1)	(2)	(3)	(4)
	Modern	18th century	19th century	Early 20th century
Panel A: Full sample				
ln(Distance from the world GC)	0.628***	0.760***	0.651***	0.383***
	(0.196)	(0.204)	(0.122)	(0.130)
Coast dummy	1.745**	-0.116	0.704***	0.456*
	(0.703)	(0.359)	(0.266)	(0.275)
Island dummy	-2.089***	-1.038**	-1.439***	-1.376***
	(0.598)	(0.401)	(0.467)	(0.371)
If weights are used:#				
ln(Distance from the world GC)	0.607***	0.701***	0.628***	0.639***
	(0.153)	(0.234)	(0.196)	(0.102)
Continent FE	Yes	Yes	Yes	Yes
Observations	162	121	137	174
Panel B: With national power controls				
ln(Distance from the world GC)	0.522***		1.937***	0.850***
	(0.110)		(0.643)	(0.248)
Coast dummy	-0.400*		0.939**	0.012
	(0.223)		(0.406)	(0.452)
Island dummy	-1.025***		-2.474*	-1.006***
	(0.328)		(1.273)	(0.349)
ln(Military expenses)	0.003		-0.068	0.037
	(0.130)		(0.290)	(0.127)
ln(Iron & steel production)	0.027		0.449*	0.001
	(0.056)		(0.254)	(0.099)
ln(Primary energy consumption)	0.487***		-0.116	0.255***
	(0.103)		(0.206)	(0.068)
If weights are used:#				
ln(Distance from the world GC)	0.774***		2.239***	1.511***
	(0.129)		(0.768)	(0.254)
Continent FE	Yes		Yes	Yes
Observations	156		51	75

Notes: # In both panels, regressions are rerun under the same specification but with weights (number of locales), with only the coefficient of ln(Distance from the world GC) reported as a separate row (other coefficients available upon request). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

temporary states. The first margin of difference stems from the birth and death of states. That is, not every n^0 has a modern counterpart n, and not every modern state n has a counterpart n^0 in history. For a state that exists both now and in the historical period, $Dist(n)$ and $Dist(n^0)$ are usually different, because its two compositions $\{t \in n\}$ and $\{t \in n^0\}$ are rarely identical (the second margin) and the location of the world GC changes as well (the third margin).[15] These three margins are exclusive of each other, producing three sets of additional variations. Second, influential events in one period, such as large-scale wars and (de)colonization, may drive the results in a single period. By applying the same specification to three other periods, we mitigate their impacts. Again, we experiment with adding control variables related to military powers (unavailable for the 18th century) and weights. The findings from historical periods are similar to those from the modern period.

2. Eurasia vs. Non-Eurasia World geography in the benchmark model is a continuous landmass, whereas the landmass of the earth is divided by oceans into different continents. Among all continents, the geography of Eurasia fits our theoretical construct best. We rerun the regressions in Table 4 using the subsamples of Eurasian and Non-Eurasian states in each period. The results are reported in Table 5A. To keep the largest number of observations, we do not include national power control variables in this table. Both subsamples display patterns consistent with Implication 1.[16]

3. Landscapes We next check states with different landscapes. We rerun the regressions in Table 4 using the subsamples of (i) landlocked states, (ii) coastal states, and (iii) continental (i.e., non-island) states. The results are reported in Table 5B. Note that all island states have access to coastlines so that they are counted as coastal states. Therefore, we add an island dummy to the coastal state regressions, and a coastal dummy to the continental state regressions. The findings are consistent with what we found earlier, except when sample size is smaller than 20 (i.e., landlocked states in the 19th century and early 20th century).

4. Numerical Distance vs. Ranking We also experiment with using the rank value of $Dist(n)$ instead of $\ln Dist(n)$ as the main explanatory variable. The merit of using the rank value is that it reduces potential mechanical correlation between $\ln Area(n)$ and $\ln Dist(n)$. Consider a state close to the world GC, which has a perfect round shape and contains a uniform distribution of locales. Its $\ln Area(n) = \ln \pi + 2 \ln r$ is mechanically correlated with its $\ln Dist(n) = \ln r$, where r is its radius. Such a possibility is limited to states near the world GC. We define the rank as a normalized value between 0 (nearest to the world GC) and 1 (farthest from the world GC) within a period. In Table 6, the rank value is used instead of $\ln Dist(n)$ and the specifications are otherwise the same as in Table 4. It shows results that highly resemble those in Table 4. The shortcoming of the rank value is its lack of cardinal meaning. Its variation is ordinal and thus the numerical differences among values are ambiguous. We use the rank value

[15] The world GC changes in location over time because uninhabited regions in earlier periods enter into the estimation of world GCs in later periods.

[16] Since the density of locales has a large variation across continents, regressions are weighted for the non-Eurasian sample.

Table 5A: Eurasia and non-Eurasia

Dependent variable is ln(Area)	(1)	(2)	(3)	(4)
	Modern	18th century	19th century	Early 20th century
Panel A: The Eurasian subsample				
ln(Distance from the world GC)	0.410***	0.868***	0.620***	0.356**
	(0.135)	(0.229)	(0.132)	(0.136)
Island and coast dummies	Yes	Yes	Yes	Yes
Observations	82	67	81	90
Panel B: The Non-Eurasian subsample				
ln(Distance from the world GC)	1.033**	1.554***	1.673***	1.027**
	(0.427)	(0.451)	(0.270)	(0.445)
Island and coast dummies	Yes	Yes	Yes	Yes
Continent fixed effects	Yes	Yes	Yes	Yes
Observations	80	54	56	84

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05.

Table 5B: Subsamples Corresponding to Different Landscapes

Dependent variable is ln(Area)	(1)	(2)	(3)
	Modern	19th century	Early 20th century
Panel A: Landlocked states			
ln(Distance from the world GC)	0.570*	-0.326	1.000
	(0.293)	(0.239)	(0.536)
National power countrols	Yes	Yes	Yes
Observations	39	19	9
Panel B: Coastal states			
ln(Distance from the world GC)	0.421***	2.900***	0.809***
	(0.132)	(0.609)	(0.274)
Island dummy	Yes	Yes	Yes
National power countrols	Yes	Yes	Yes
Observations	117	32	66
Panel C: Continental states			
ln(Distance from the world GC)	0.575***	1.396*	0.806***
	(0.125)	(0.740)	(0.277)
Coast dummy	Yes	Yes	Yes
National power countrols	Yes	Yes	Yes
Observations	137	48	66

Notes: Robust standard errors in parentheses. *** $p<0.01$, * $p<0.1$

here only as a robustness check, and in later testing of Implication 3b where $\ln Dist(n)$ is the dependent variable to be explained.

5. Continental GCs vs. World GC The discontinuity of landmass on the earth causes noise in locating the world GC. The equation (1) used to locate the world GC does not consider the possibility of having multiple GCs. Suppose that it is every continent's own GC that affects state territories on that continent, and these continental GCs happen to be close to the single world GC we located for each period, then there would be a spurious positive correlation between state territories and distance from the single world GC. To address this, we construct a local geometric center (LC) for each continent using a variant of equation (1):

$$LC \equiv \arg\min_{t \in C} \sum_{t' \in V} D(t, t'), \tag{20}$$

where V represents a continent. The estimated locations of LCs are reported in Panel A of Table 7. We next construct the average distance of every state with its LC:

$$LDist(n) \equiv \frac{1}{N_n} \sum_{t \in n} D(t, LC(n)), \tag{21}$$

where $LC(n)$ is the LC of the continent where state n is located. In Panel B of Table 7, for each period, we regress $\ln Area(n)$ first on $LDist(n)$ alone, and then include $Dist(n)$ as well. Interestingly, when included alone, $LDist(n)$ has a positive and marginally significant coefficient in three out of four periods, though the marginal significance disappears when $Dist(n)$ is also included in the regression.

The on-and-off significance of $LDist(n)$ in Table 7 has two implications. On the one hand, proximity to the center of a continent tends to reduce a state's territory. This pattern is consistent with our benchmark model when the model is applied to an individual continent. On the other hand, the marginal significance of $LDist(n)$ is possibly owing to its shared variation with $Dist(n)$. Notice that recent LCs of all continents are moderately close to the world GC, at least in comparison with other states on their continents.[17] Therefore, the roles of LCs are not distinguishable from the role of GCs in determining territorial sizes.

6. Centroid-based Results In previous subsections, we use data on locales in the GeoName database as the empirical counterpart of t in equations (1)-(2) to estimate world GC and $Dist(n)$. The rationale behind that is that the topography of locales represents primary human habitats, so that using their locations helps us exclude uninhabited regions in the estimation of world GC and $Dist(n)$. We now take an alternative approach. We treat the centroid of each state (i.e., the arithmetic mean position of all the points in the state as a polygon) as the state's geometric center. Accordingly, we treat the centroid of the world as a collection of polygons as the world GC. Based on these, we recalculate $Dist(n)$ and rerun our study for the modern period.

This approach can be easily implemented using GIS software. We find the centroid of the

[17] In the case of Africa, it should be noted that the Sahara accounts for the major distance between the Central African Republic and Eastern Europe (where the world GC is located).

Table 6: Robustness: Rank Instead of Distance

Dependent variable is ln(Area)	(1)	(2)	(3)	(4)
	Modern	18th century	19th century	Early 20th century
Panel A: Full sample				
Rank (Distance from the world GC)	0.007**	0.021***	0.017***	0.007**
	(0.003)	(0.005)	(0.004)	(0.003)
Coast dummy	0.202	-0.205	0.709**	0.528*
	(0.254)	(0.364)	(0.281)	(0.276)
Island dummy	-1.355***	-1.067***	-1.401***	-1.383***
	(0.371)	(0.403)	(0.458)	(0.356)
Continent FE	Yes	Yes	Yes	Yes
Observations	162	121	137	174
Panel B: With national power controls				
Rank (Distance from the world GC)	0.008***		0.058***	0.014**
	(0.003)		(0.018)	(0.005)
Coast dummy	-0.342		1.155***	0.192
	(0.230)		(0.427)	(0.483)
Island dummy	-0.965***		-2.403*	-0.885**
	(0.328)		(1.316)	(0.371)
ln(Military expenses)	0.022		-0.025	0.044
	(0.133)		(0.288)	(0.137)
ln(Iron & steel production)	-0.014		0.463	-0.038
	(0.054)		(0.297)	(0.098)
ln(Primary energy consumption)	0.512***		-0.235	0.267***
	(0.105)		(0.253)	(0.074)
Continent FE	Yes		Yes	Yes
Observations	156		51	75

Notes: This table is a robustness check for Table 4. All specifications here are the same as those in Table 4, except that Rank (Distance from the world GC) instead of ln(Distance from the world GC) is used as the main regressor. Rank 0 (respectively, 1) means the shortest (longest) distance from the world GC. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: LCs in the World

Panel A: List of LCs

Continents	Period+	Center	Lat, Lon
Eurasia	18th century	Surovikino, Russia	48.61, 42.85
	19th century	Surovikino, Russia	48.61, 42.85
	Early 20th century	Surovikino, Russia	48.61, 42.85
	modern	Surovikino, Russia	48.61, 42.85
America	18th century	Barranquilla, Viceroyalty of Peru	10.97,-74.78
	19th century	Tampa, Florida, United States	27.95,-82.46
	Early 20th century	Tampa, Florida, United States	27.95,-82.46
	modern	Tampa, Florida, United States	27.95,-82.46
Africa	18th century	N'guigmi, Bornu-Kanem	10.11,14.45
	19th century	N'guigmi, Bornu-Kanem	14.25,13.11
	Early 20th century	Paoua, Kamerun	7.24,16.44
	modern	Paoua, Central African Republic	7.24,16.44

Panel B: Dep. variable is ln(Area) ++

	Period: 18th century		Period: 19th century	
ln(Dist from LCs)	0.561	-0.197	0.525*	-0.288
	(0.350)	(0.452)	(0.312)	(0.383)
ln(Dist from the world GC)		0.850***		0.739***
		(0.304)		(0.174)
	N=118		N=134	
	Period: early 20th century		Period: modern	
ln(Dist from LCs)	0.343*	0.074	0.368*	0.169
	(0.197)	(0.246)	(0.196)	(0.225)
ln(Dist from the world GC)		0.352**		0.313**
		(0.164)		(0.151)
	N=171		N=159	

Notes: (+) the four periods refer to those defined in Section 2. (++) Island dummy, coast dummy, and continent fixed effects are included in all regessions. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Robustness: Results based on Centroids

Dependent variable is ln(Area)		
	(1)	(2)
ln(Distance from the world centroid)	0.554**	0.411**
	(0.236)	(0.172)
Coast dummy	0.226	-0.365
	(0.284)	(0.257)
Island dummy	-1.674***	-1.127***
	(0.448)	(0.407)
ln(Military expenses)		0.047
		(0.152)
ln(Iron & steel production)		-0.052
		(0.064)
ln(Primary energy consumption)		0.580***
		(0.127)
Observations	162	156

Notes: The data is based on the 1994 world map. The set of states is the same as in column (1) of Table 4. Robust standard errors in parentheses. *** p<0.01, ** p<0.05.

modern world to be at (40.52N, 34.34E), located in Yarımca, Uğurludağ, Çorum, Turkey. The centroid-based results are reported in Table 8, which follows the specifications used in Table 4. We maintain the same set of modern states between Tables 4 and 8. As in Table 4, a positive and statistically significant correlation is found between $\ln Area(n)$ and $\ln Dist(n)$.

We do not adopt the centroid approach in our earlier benchmark findings but use it only as a robustness check. It has the merit of easy implementation and is useful when locale-level data are unavailable. It overstates the importance of territories with low population density. Take the US for example. Figure 1 illustrates the difference between the centroid-based approach and our previous locale-based approach. The centroid of the mainland US is in Kansas (38.88N, 99.33W) while the locale-based center is in Missouri (37.71N, 92.16W). Their latitudes are similar, whereas their longitudes are different owing to the relatively unpopulated Rocky Mountain area in the Western US.

7. Within-state Studies The earth is the only planet that hosts humans, economies, and states. A fundamental challenge to the empirical findings above is that they might capture an "earth fixed effect." That is, the earth, owing to its topographical, vegetative, and climatic features or other unknown peculiarities, can only accommodate small economies in its middle regions. This possibility is unfalsifiable and thus cannot be investigated directly. We propose a partial solution below using variations within states.

In states that use a federal system, every constituent unit, under the name of region, province, constituent state and so on, enjoys autonomy to a certain extent from the state. In other words, federalism divides powers between the state and its constituent political units. The division of political powers between the two layers is state-specific, though one of them is typically granted all residual political powers left by the other. Therefore, it is a reasonable assumption to consider each constituent unit within a state as a semi-state. Then constituent units closer to the *world* GC are expected to be smaller in size. Theoretically, if all semi-states in the world are in the same global federal system, the world should alternatively be seen as a collection of semi-states rather than a collection of states.

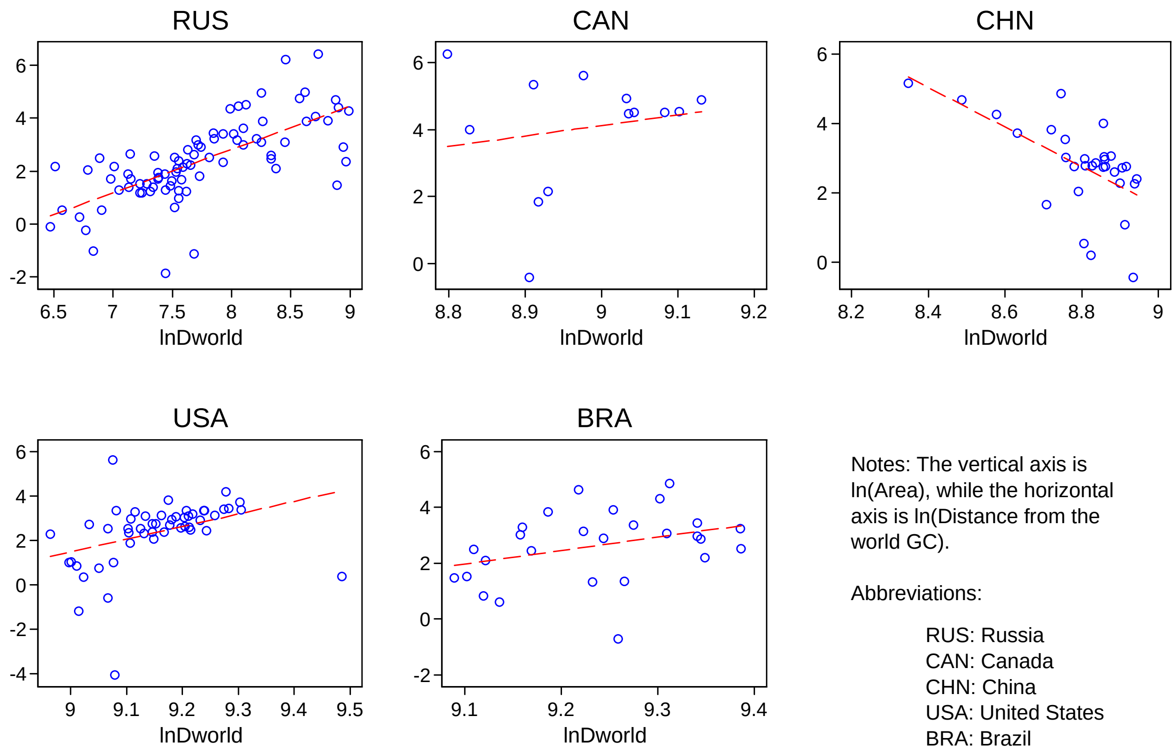
A practical concern here is the different sizes of states. Small states may be as small as constituent units in large states. It would thus be problematic if constituent units of small states are pooled with those of large states, not to mention other concerns such as data unavailability and state idiosyncrasy. To address that, we consider only the five states with the largest territorial areas in the modern period — Russia, Canada, China, United States, and Brazil — and we utilize only their within-state variations. We use their GIS maps to calculate the areas of their individual constituent units.[18] Since some constituent units are small in size and thus have no locales that have populations of 15,000 or more, we use the centroid approach to pinpoint the locations of constituent units. We calculate each constituent unit's distance from the world GC and rerun the regression of $\ln Area(n)$ on $\ln Dist(n)$ within each of the five states, where n now indexes domestic constituent units.[19]

The regression results are reported in Table 9, and a graphical demonstration of the correlation is presented in Figure 3. In four out of the five states, a positive correlation is found. The

[18]Their GIS maps are available at www.gadm.org.
[19]Using the centroid of the world instead does not alter our findings.

positive correlation is statistically significant in three of them. The insignificant case of Canada is likely caused by its small number of provinces, as the positive correlation is evidently present in the panel for Canada (CAN) in Figure 3. In other words, within every one of those states, constituent units that are closer to the world GC are smaller. This offers further support of our theory at the semi-state level, especially considering that the four states have dissimilar cultural traditions, political histories, types of representative democracies, and legal origins.

Figure 3: Within-State Correlations



Among the five states, the only exception, China, is the only state that uses a unitary system rather than a federal system. The province-level division of China's territory derived from the *Xingsheng* system of the Mongol dynasty (1271-1368), when China was part of the Mongol Empire. Later dynasties and the current central government of China (established in 1949) kept revising the division. Over those eight centuries, provinces and province-level constituent units were for the purposes of administration rather than for regional autonomy.[20] Since Chinese provinces are by no means semi-states, the absence of a correlation between province area and distance from the world GC is not surprising.

[20]The 1946 Constitution of China specified regional autonomy, though it was not implemented because of the Second Civil War (1945-1949) and the resulting political regime change (1949).

Table 9: Within-state Correlation in Five Largest States (by Terr. Size)

Dependent variable is ln(Area of domestic constituent unit)					
	(1)	(2)	(3)	(4)	(5)
State	Russia	Canada	China	US	Brazil
ln(Distance from the world GC)¶	1.637***	3.132	-5.678***	5.689*	4.811**
	(0.216)	(5.057)	(0.865)	(3.203)	(1.751)
Observations	83#	13	31&	51+	27
R-squared	0.478	0.032	0.367	0.139	0.120

Notes: ¶ ln(Distance from the world GC) is now the distance between a domestic continuent unit in a given state (labeled in each column) and the world GC. # There were 89 federal units in Russia in 1993, when the Constitution of Russia became effective; the number decreased to 83 owing to several mergers. & Two administrative regions Hong Kong and Macau are ex-colonies and currently autonomous territories; they are excluded but adding them does not alter the result. +District of Columbia is treated as a state, but excluding it does not affect the results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.2 Island States

The above empirical testing of Implication 1 includes island states in the sample and controls for their peculiarity with island dummy variables. We now extend the benchmark model by incorporating island states explicitly. This extension offers additional insight on how natural geography and political geography interact with each other. We would like to note two issues before proceeding. First, island states are small in number in our sample.[21] The following analysis does not negate the benchmark model but elaborates on islands as a special case. Second, islands are different from each other in physical sizes, densities, and distances from continents. To rationalize them, we consider each island as a locale and assume island locales to be near each other but far from continents. That is, an island state is a set of islands, and islands (locales) decide with which neighbors to join, just as previous continental locales.

Suppose that two straits separate a group of islands from continents. The straits are atomless, but crossing straits causes the foreign trade cost τ to rise to τ'. By assumption, the island group is so small that the additional "strait cost" affects only the price level on islands but not on continents. Through τ', we introduce islands without sinking landmasses or expanding the length of the world. Put differently, we keep the length of the linear world unchanged, and let the width of straits be absorbed by the difference $\tau' - \tau$.

Without loss of generality, suppose the island is in the right half of the world. Following the previous indexing convention, state n is the n-th closest state to the world GC. To differentiate it from a continental state, we denote its territory by S_n^l, with borders b_{n-1}^l and b_n^l, where the superscript l reminds us that it is an island state. By equation (12), we have (see the Appendix

[21] See Section 2 for a discussion on the sample.

for the derivation)

$$\left.\frac{\partial S_n^l}{\partial b_{n-1}^l}\right|_{b_{n-1}^l=b_{n-1},b_n^l=b_n} > \frac{\partial S_n}{\partial b_{n-1}} > 0. \tag{22}$$

That is,

Implication 2 (Theoretical): Island states are larger than comparable continental states.

Intuitively, island states need larger territories than continental states that have the same distance from the world GC, in order to compensate for additional trade costs.

The term *comparable* in Implication 2 is pivotal. An island state close to the Eurasian continent cannot be compared with a continental state in America, because (b_{n-1}^l, b_n^l) and (b_{n-1}, b_n) are so different in that case. Therefore, we empirically compare Eurasian island states with Eurasian continental states, and non-Eurasian island states with non-Eurasian continental states. Then another issue emerges. Eurasian island states are farther from the world GC (around Czech Republic) than Eurasian continental ones, while the opposite applies to non-Eurasian island states and continental states. Starting from the world GC towards either direction, observations are generally presented in the order of Eurasian continental states, then Eurasian island states, then non-Eurasian island states, and lastly non-Eurasian continental states. As a result, within the Eurasian subsample, island states are larger owing to an intercept effect — their locations are the farthest from the world GC in the subsample. Meanwhile, within the non-Eurasian subsample, island states are larger owing to a slope effect — their locations are the nearest to the world GC in the subsample.

To summarize,

Implication 2 (Empirical): Between proximal (Eurasian) continent and island states, island states are *interceptly* larger. Between distal (non-Eurasian) continent and island states, island states are *slopely* larger.

One may wonder whether there is also a slope (respectively, intercept) effect in the Eurasian (respectively, non-Eurasian) subsample. Generally speaking, no. Within the Eurasian subsample, islands are on average larger but this does not necessarily mean that they are larger per unit of distance from the world GC. Their distance from the world GC is right-truncated. To the contrary, within the non-Eurasian subsample, islands are on average larger per unit of distance, but they are not necessarily larger than continental ones, because non-Eurasian continental states are the farthest in the world from the world GC and thus may be even larger.

Importantly, when the two subsamples are merged, we revert to Implication 1, and the regressions in Tables 4-9 are not misspecified. This is because Eurasian island states are *interceptly* larger but *slopely* smaller than non-Eurasian island states, and at the same time are nearer than non-Eurasian island states to the world GC. So the positive association between territorial size and distance from world GC remains to hold for the full sample.

To test the empirical version of Implication 2, we use the modern sample and specify the regression as[22]

$$\ln(Area_n) = \theta_0 + \theta_D \ln(Dist_n) + \theta_I Island_n + \theta_{DI} \ln(Dist_n) \times Island_n + \delta' X_n + \epsilon_n, \quad (23)$$

where n is the state index, $Island_n$ is an island dummy variable, and X_n is as before a vector of control variables for national power. The testable hypothesis is that $\theta_I > 0$ for the Eurasian subsample and $\theta_{DI} > 0$ for the non-Eurasian subsample. The empirical results are reported in Table 10, which are in line with the predictions. Notably, the coefficients without predicted signs, namely θ_{DI} for the Eurasian subsample and θ_I for the non-Eurasian subsample, are both small in magnitude.

Before concluding this extension, we would like to emphasize the theoretical version of Implication 2, relative to its empirical version. The empirical version helps to demonstrate the empirical relevance of the theoretical version, though islands in the theoretical version are not limited to geographical islands. The two straits that sandwich the islands in the extended model are just trade-cost boosters for some locales but not for others. Any bloc of locales that are isolated from the rest of the world, politically, economically, or culturally, can be thought of as such disadvantaged islands. The theoretical version delivers a general point — isolation of a bloc aggravates within-bloc imbalance. This is because the locales that are relatively less disadvantaged as a result of isolation can group with more neighboring locales in the bloc, and thus they jointly outpower others in the bloc more than in the case where all locales are equally disadvantaged. Such within-bloc imbalance may be either constructive (e.g., regional trade agreements initiated by a powerful few) or destructive (e.g., annexation of others). We do not pursue those possibilities in this study.

Table 10: Island States in Comparison with Continental States

	(1)	(2)
ln(Distance from the world GC) × Island dummy	-0.832***	2.700**
	(0.256)	(1.319)
Island dummy	6.088***	-25.766**
	(2.000)	(12.182)
ln(Distance from the world GC)	0.659***	-0.189
	(0.144)	(0.262)
ln(Military expenses)	-0.278**	0.329**
	(0.136)	(0.151)
ln(Iron & steel production)	0.090	-0.117*
	(0.072)	(0.066)
ln(Primary energy consumption)	0.582***	0.410***
	(0.159)	(0.103)

Notes: The sample is for the year 1994 (as in column (1) of Table 4). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[22] The modern sample has the largest number of island states.

4.3 "Heartland"

Our estimation of the world GC is located in Eastern and Central Europe (ECE). Geopolitical theorists in the early 20th century were usually strong advocates of the strategic location of ECE. For example, Mackinder (1904, 1919) emphasized the strategic importance of East European states in his famous dictum

> Who rules Eastern Europe commands the Heartland;
> who rules the Heartland commands the World-Island;
> who rules the World-Island commands the world.

Mackinder's view was revised by Spykman (1944) to incorporate peripheral regions ("rimland") into the heartland. On one hand, such "heartland" theories captured some of the complex political and military power interactions at that time, as attested to by the two following world wars and the Cold War. On the other hand, those prophetic arguments are clearly oversimplistic and overreaching, if not outright erroneous.

The valid observation represented in their theories is that territories are indeed connected with the rest of the world to different extents. In a globalized world, states closer to the world GC have a stronger association with the political geography of the whole world, as illustrated by our benchmark model. Consider the right half of the world for example. A simple manipulation of equation (12) shows

$$\frac{\partial b_n}{\partial b_{n-1}} = \frac{\partial(b_{n-1} + S_n)}{\partial b_{n-1}} = 1 + \frac{\partial S_n}{\partial b_{n-1}} > 0, \tag{24}$$

where $\frac{\partial S_n}{\partial b_{n-1}} > 0$ stems from Finding 1.

Equation (24) has two implications. The first is on S_n. Equation (24) implies

$$\frac{\partial b_n}{\partial b_0} = \prod_{i=0}^{n-1} \frac{\partial b_{n-i}}{\partial b_{n-i-1}} > 0, \tag{25}$$

for any $n \geq 1$, and thus

$$\frac{\partial S_n}{\partial b_0} = \frac{\partial S_n}{\partial b_{n-1}} \frac{\partial b_{n-1}}{\partial b_0} > 0. \tag{26}$$

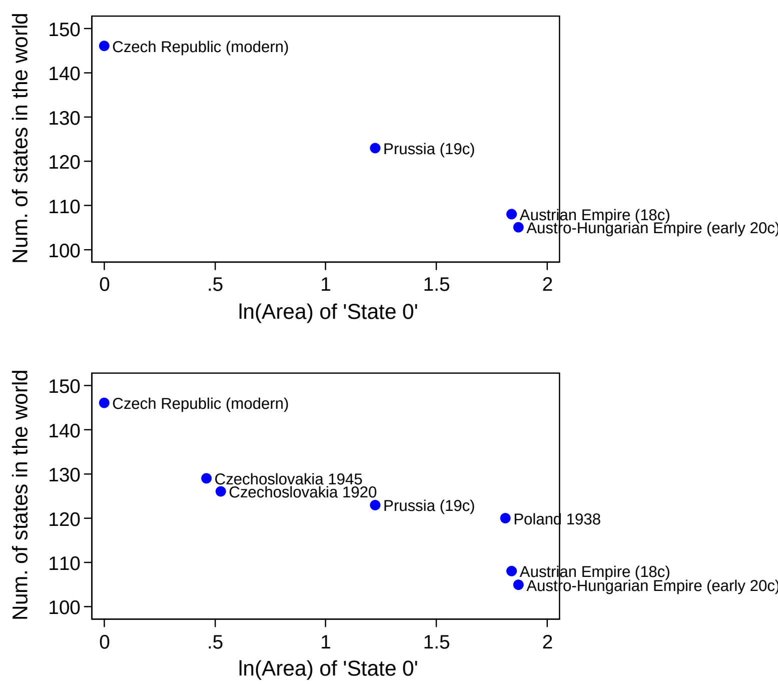
That is, a larger state 0 is associated with larger territories of all states in the world. Or,

Implication 3a: Number of states is smaller when "state 0" is larger, given the same total habitable area on the earth.

Note that the total inhabitable area on the earth increases over time, though that works against finding a negative correlation between the two variables.

Figure 4 demonstrates the correlation between state 0's territory (the so-called "heartland") and the number of states in the world over different time periods. A negative association between the two variables is evident. In the modern period, the number of states reaches its maximum and the current state 0, the Czech Republic, has the smallest size in comparison with its historical counterparts. In contrast, in the 18th century, when the number of states was small, the state 0 at that time, the Austrian Empire, had quite a large territory. In the lower panel, we add a post-war observation (Czechoslovakia in 1920), an interwar observation (Poland in 1938), and another post-war observation (Czechoslovakia in 1945). The negative correlation remains and actually becomes more pronounced.

Figure 4: Number of States and 'State 0'



Notes: c is the abbreviation of century. The lower panel includes three additional observations related to the two world wars, which are excluded by the upper panel. Czech Republic (modern) has the smallest area among all state 0's. We normalize it to one (zero in log). For all other periods, the ln(Area) of state 0 refers to the difference between actual ln(Area) and the ln(Area) of Czech Republic (modern). This normalization is in order to keep the horizontal axis short.

There are two concerns regarding Figure 4. First, it has too few observations. After all, each period can contribute at most one observation. Second, it is confounded by the fact that all states (including state 0) in a world with a greater number of states are expected to be smaller. If the world's area is randomly cut into states, a smaller state 0 might simply be driven by "finer cuts" of the earth's surface. Historically, there were fewer states in "the Age of Empires."

The second implication of equation (24) is on states' distances from the world GC. Equation (25), derived from equation (24), also implies (see the Appendix for its derivation)

$$\frac{\partial^2 b_n}{\partial b_{n-1} \partial b_0} > 0. \tag{27}$$

Recall that state n, the n-th nearest state to the world GC, has borders b_{n-1} and b_n. Equation (27) implies that in a period with a larger state 0, every rank value n refers to a farther state. Specifically, when n rises, b_{n-1} increases so that b_n rises, an effect that has been shown in equation (24). In a period with a larger state 0, for any small or moderate n, the state to which n refers is larger, an effect that has been shown in equation (25). This state-0 effect also applies to all states between state 0 and state n. Therefore, as a result of a larger state 0, every small or moderate n refers to a state farther from the world GC. Put differently, an increase in n is associated with a greater increase in $Dist(n)$. Intuitively, an expansion of state 0 "pushes" all other states outward more than proportionally — the farther a state is from the world GC, the more it has to move outward, since it has to gain a greater number of worse locales to compensate for the better locations lost. Notice that we require that n be small or moderate, to make sure it is not so distant from the world GC that it does not exist in some periods. To summarize,

Implication 3b: Every small or moderate rank value n refers to a farther state in a period when the contemporary state 0 is larger.

Implication 3b is the only implication in this paper that involves cross-period comparison. The cross-period variation is highly limited, as shown in Figure 4, where state 0 has only four distinct values, corresponding to four different periods. Interacting that variation with rank values considerably increases the total variation that we can use. Implication 3b informs a difference-in-differences specification:

$$\ln(Dist_{nr}) = \psi_0 \times Rank_n + \psi_1 \times State0Area_r + \psi_2 \times Rank_n \times State0Area_r + \delta' X_{nr} + \epsilon_{nr}, \quad (28)$$

where $Rank_n$ is the normalized rank value of state n. The value is 0 (respectively, 1) if state n is the state that is nearest to (farthest from) the world GC. Its coefficient ψ_0 is expected to be positive. We limit n to 1-30, 1-50, and 1-70, respectively, to ensure that n is not too large. $State0Area_r$ is the area of state 0 in period r, and X_{nr} is a vector of control variables. ψ_1, expected to be positive, captures the mechanical fact that a larger state 0 causes all other states to be farther from the world GC. What interests us is ψ_2, which is expected to be positive as predicted in Implication 3b. As an alternative to including $State0Area_t$ in the regression, we can use a more inclusive period fixed effect to absorb its variation.

The regression results are reported in Table 11. The sample used in Panel A is states 1-30 in each of the four periods, so that the full sample size is 120. We use $State0Area_t$ in columns (1) and (2) and use period fixed effects instead in columns (3) and (4). We include no national power control variables in columns (1) and (3), so that their numbers of observations are both 120. In columns (2) and (4), we include national power control variables, which are unavailable for all states in the 18th century and for some states in later periods. Therefore, the sample size shrinks to 78 in these two columns. The coefficient of the interaction term, namely $\hat{\psi}_2$, is positive and statistically significant in all columns. The specifications in Panels B and C are the same as in Panel A, except that their samples include states 1-50 and states 1-70, respectively. Very similar findings are obtained.

The results in Figure 4 and Table 11 enrich the spatial distribution of states we discuss in Section 3: states farther from the world GC are not only larger, but also increasingly larger.

Table 11: State 0 and Rest of the World

Dependent variable is ln(Distance from the (contemporary) world GC)				
	(1)	(2)	(3)	(4)
Panel A: 30 Nearest States to the World GC				
Rank (Distance from the world GC)¶	4.052***	4.940***	3.573***	5.025***
	(0.852)	(0.886)	(0.554)	(0.887)
Size of State 0	-0.382	1.363**		
	(0.486)	(0.532)		
Rank (Distance from the world GC)	12.458***	9.034**	15.163***	9.420***
× Size of State 0	(3.413)	(3.449)	(2.722)	(3.516)
Period FE	No	No	Yes	Yes
National power countrols¥	No	Yes	No	Yes
Island and cost dummies, and continent FE	Yes	Yes	Yes	Yes
Observations	120	78	120	78
Panel B: 50 Nearest States to the World GC				
Rank (Distance from the world GC)¶	4.361***	5.263***	4.254***	5.297***
	(0.402)	(0.471)	(0.270)	(0.475)
Size of State 0	0.049	1.552***		
	(0.346)	(0.380)		
Rank (Distance from the world GC)	8.295***	5.694***	9.124***	6.078***
× Size of State 0	(1.408)	(1.725)	(1.193)	(1.742)
Period Fixed Effect	No	No	Yes	Yes
National power countrols¥	No	Yes	No	Yes
Island and cost dummies, and continent FE	Yes	Yes	Yes	Yes
Observations	200	121	200	121
Panel C: 70 Nearest States to the World GC				
Rank (Distance from the world GC)¶	5.220***	5.322***	5.082***	5.363***
	(0.203)	(0.418)	(0.215)	(0.419)
Size of State 0	0.706**	1.757***		
	(0.274)	(0.358)		
Rank (Distance from the world GC)	3.538***	3.333**	4.006***	3.508**
× Size of State 0	(0.826)	(1.501)	(0.803)	(1.516)
Period Fixed Effect	No	No	Yes	Yes
National power countrols¥	No	Yes	No	Yes
Island and cost dummies, and continent FE	Yes	Yes	Yes	Yes
Observations	280	151	280	151

Notes: ¶ Rank (Distance from the world GC) is the standardized ranking of states in "Distances from world GC" in their own periods. 0 (respectively, 1) means the shortest (longest) distance to the world GC. ¥ National power controls include military expenses, iron & steel production, and primary energy consumption (all in log terms). Robust standard errors in parentheses. *** p<0.01, ** p<0.05.

Admittedly, both the first- and second-order effects, presented as comparative statics, establish correlations rather than causality. Simply tampering with established borders does not lead to ruling the world, and may instead cause border tensions. This is why the early heartland theories are oversimplistic and largely erroneous. We examine border tensions and military disputes in the next subsection.

4.4 Military Disputes

We now extend the benchmark model to rationalize military disputes observed in recent history. Military disputes have three major dimensions: cause (tension), probability of occurrence (escalation), and scale. Thus, we need three additional assumptions to introduce military disputes into the benchmark model:

(i) Every border has a constant probability $0 < q < 1$ of being revised by the states on its two sides ($q/2$ on each side). That is, $\Pr(RE|b_n) = q$ for any b_n, where RE denotes revision.

(ii) Conditional on revision, border b_n is more likely to cause a military dispute if $|b_n|$ is smaller. That is, $\Pr(MD|RE, b_n)$ is decreasing in $|b_n|$, where MD denotes military dispute.

(iii) Conditional on occurrence, a military dispute has a random scale.

Assumption (i) is a technical assumption for introducing border tensions. Assumption (ii) is based on the benchmark model. For a given state S_n in the right half of the world, being closer to the world GC means its left border has a larger impact on its welfare in percentage:[23]

$$-\frac{\partial R_n/\partial S_n}{R_n} = \tau(1 - b_{n-1} - S_n). \tag{29}$$

As shown, as b_{n-1} decreases, its price index is increasingly affected by territory in percentage. For this reason, Assumption (ii) claims that all borders are not created equal — borders closer to the world GC are more sensitive politically. These two assumptions together comprise one simple postulation: states may have various solutions to resolving border tensions, but are more likely to use violence when the interests at stake are larger.[24] In summary, the probability for a military dispute, denoted by

$$p(b_n) \equiv \Pr(MD|RE, b_n) \times \Pr(RE|b_n) = q \Pr(MD|b_n), \tag{30}$$

is assumed to be decreasing in $|b_n|$. Assumption (iii) will be detailed later. In a nutshell, we treat cause and scale of military disputes as exogenous, and concentrate on the role of borders in influencing the probability of military disputes.

State Numbers The first question we address is the number of states involved in a military dispute with a given scale m. Suppose that the location of the military dispute is c^*. Its geographical range is $[c^* - m/2, c^* + m/2]$. A state with either border or any locale in this range is involved in the dispute. As involved states have different distances from the world GC, we

[23] Equation (29) is derived from rearranging equation (37) in the Appendix.
[24] This follows the rationalist view of war. Assigning a probability to military disputes is the common practice in the literature. See, e.g., Alesina and Spolaore (2006), Martin, Mayer, and Thoenig (2008b) and references therein.

denote the distal border of the j-th closest state by b^*_{mj}. Consider the right half of the world. The leftmost involved state's right border is b^*_{m1}, which is less than or equal to $c^* - m/2$. There are $Q \geq 2$ involved states in the dispute, and the value of Q is our research interest. Note that the right border of the rightmost involved state is b^*_{mQ}, which is greater than or equal to $c^* + m/2$.

A unique state number Q can be implicitly solved for any m. Specifically, the probability for Q to be M is

$$\begin{aligned}\Pr(Q = M|m) &= p(b^*_{m1}) + p(b^*_{m2}) + ... + p(b^*_{mM-1}) \\ &= \Pr(b^*_{m1} < c^* + m/2) + \Pr(b^*_{m2} < c^* + m/2) + ... + \Pr(b^*_{mM-1} < c^* + m/2).\end{aligned} \tag{31}$$

Two observations are in order. First, a military dispute occurs only if at least two states become involved. In equation (31), if $b^*_{m1} > c^* + m/2$, then $Q = 1$ and no cross-state military dispute occurs. Second, with m held constant, the Q of a military dispute is more likely to be large if the military dispute is closer to be world GC (i.e., c^* is smaller). This association has two channels, as shown in equation (31), one through b^*_{mj} for any given j and the other through the count of $\{j\}$. For a smaller c^*, the range $[c^* - m/2, c^* + m/2]$ covers borders that are more contentious (smaller b^*_{mj} for any given j), an effect that stems from Assumptions (i) and (ii). Meanwhile, with m held constant, a military dispute with a smaller c^* is more likely to cover more state j's, an effect that stems from Finding 1. In other words, as c^* decreases, there is a location effect that raises each $\Pr(\cdot)$ and a density effect that lets more $\Pr(\cdot)$'s be added up. To summarize,

Implication 4: Conditional on scale m, military disputes farther from the world GC involve fewer states.

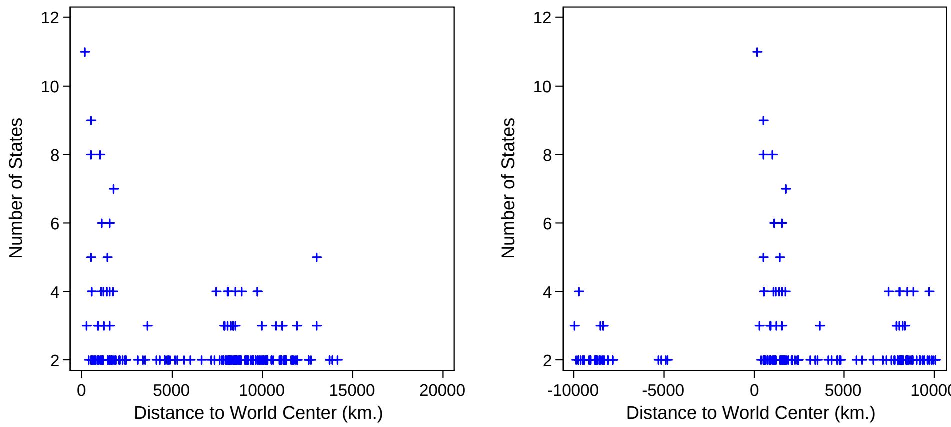
The data source for testing Implication 4 and Implication 5 is also the aforementioned COW project. Now we use its MID (version 4.1) and MIDLOC (version 1.1) datasets. The MID dataset provides data on military disputes in the world, including their involved states, originators, fatalities, and reciprocality (explained later). The MIDLOC dataset provides geographical coordinates of military disputes. Both datasets cover the years 1816-2001. We divided this coverage into three periods, 1816-1900, 1900-1945, and 1994-2001, corresponding to the three periods in our data. Summary statistics of our working dataset are provided in the Appendix.

To test Implication 4, we calculated the distance between each military dispute and its contemporary world GC. Figure 5 combines six data plots, in which each row is linked to one period and the left (right) column does not (does) distinguish westward from eastward distances on the horizontal axis. As shown, the number of involved states is decreasing in the military dispute's distance from the world GC.

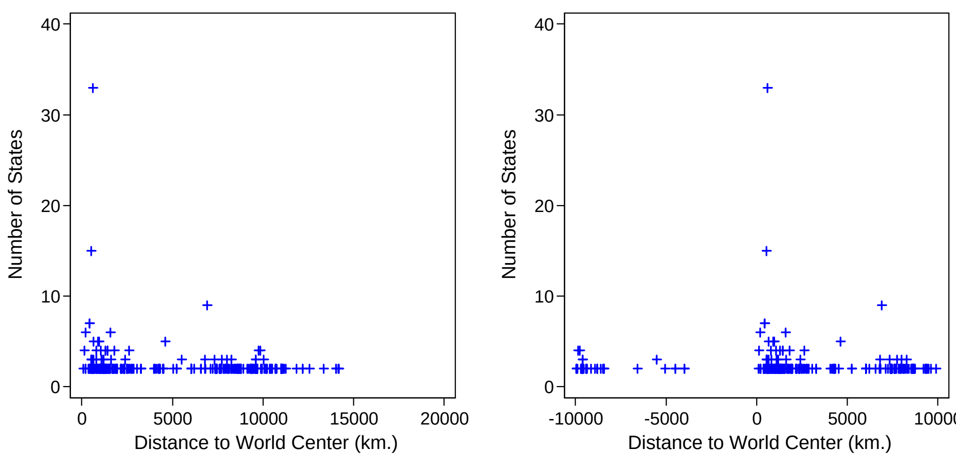
A limitation of Figure 5 is that the scale of military disputes is not held constant. To address that, we next conduct a regression analysis. Table 12 reports regression results for Implication 4. The dependent variables are various measures of Q, including the probability of having more than two involved states, the total number of states, and the number of states on each side. The MID dataset categorizes involved states in every military dispute into two sides: A (the

Figure 5: Number of Involved States and Locations of Military Disputes

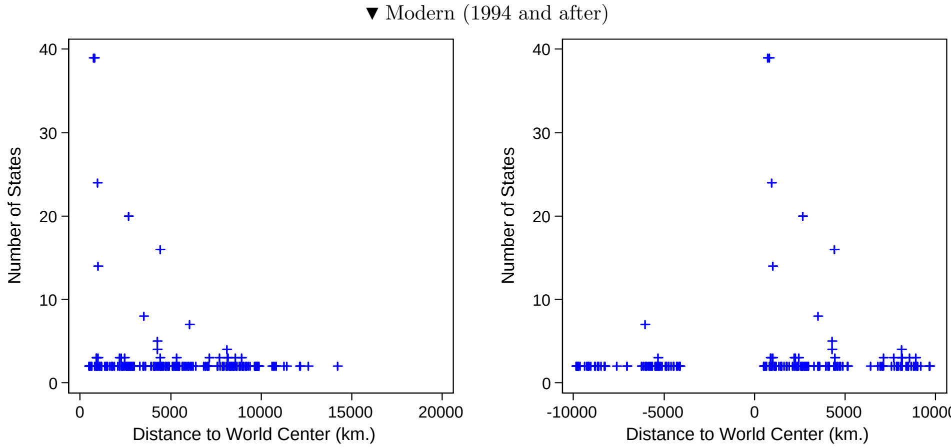
▼ The 19th century



▼ Early 20th century



▼ Modern (1994 and after)



originator side) and B (the target side). We proxy for the scale of a military dispute using its fatality scale index. In the MID data, fatality level is measured by a 0-to-9 scale index (0 means no death). Note that the areas of battlefields in military disputes are not reported in the MID dataset, and scale m in the extended model is in spirit similar to fatality. Fatality is a commonly used criterion for gauging the scale of military disputes.[25] A reciprocated dispute is defined as one in which at least one state on side B takes a military action against side A. All else being equal, reciprocated disputes involve more fatalities, so that we include a reciprocated dummy along with the fatality index.

As predicted, in Table 12, fewer states are involved in military disputes farther from the world GC. This association holds for all three periods and both sides of military disputes. It also holds regardless of how multi-state participation is measured, qualitatively (as a 0-1 indicator) or quantitatively (as a count). The qualitative measure is less driven by influential large counts.

A possible concern over Table 12 is that, although the pattern of correlation supports our model, it remains unclear whether the correlation is driven by the mechanism we suggest. For example, the correlation in Table 12 might be completely driven by the large density of proximal states around the world GC. This political geography pattern is predicted by our model, though it does not specifically support the mechanism in our model. An examination of the revisionist pattern, which we undertake next, helps to address this concern and is also interesting in its own right.

Revisionism The second question that interests us is which side, proximal or distal, in a given military dispute is more likely to be the side that wants to change the status quo (i.e., be a revisionist). Recall that, following Assumptions (i) and (ii), every state border b_n has a probability $p(b_n)$ of causing a military dispute (see equation (30)). Since each state has two borders, the probability for state n, in the right half of the world, to be in a military dispute is

$$\Pr(MD|n) \equiv \Pr(MD|b_n) + \Pr(MD|b_{n-1}), \tag{32}$$

where b_{n-1} and b_n are its left and right borders, respectively.

Given involvement in a military dispute, the probability of state n being a revisionist is

$$\Pr(RE|MD, n) = q/2 \times \frac{\Pr(MD|RE, b_n) + \Pr(MD|RE, b_{n-1})}{\Pr(MD|b_n) + \Pr(MD|b_{n-1})}, \tag{33}$$

where the denominator is equation (32). Note that

$$\frac{\Pr(MD|RE, b_n)}{\Pr(MD|b_n)} < \frac{\Pr(MD|RE, b_{n-1})}{\Pr(MD|b_{n-1})}, \tag{34}$$

and by Assumption (ii), both of them are decreasing in b_n. As a mathematical fact,

$$\frac{\Pr(MD|RE, b_n)}{\Pr(MD|b_n)} < \Pr(RE|MD, n) < \frac{\Pr(MD|RE, b_{n-1})}{\Pr(MD|b_{n-1})}, \tag{35}$$

and therefore $\Pr(RE|MD, n)$ is decreasing in b_n. That is,

[25] See Buhaug and Lujala (2005) for discussion on the difficulties in estimating scales of conflicts. For the use of fatality to measure scale, see for example Harrison and Wolf (2012).

Table 12: Number of Involved States in Military Disputes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob. of having more than two states	Total num. of states	Num. of states on Side A	Num. of states on Side B	Total num. of states	Num. of states on Side A	Num. of states on Side B
Panel A: 19th century							
ln(Distance from the world GC)#	-0.094***	-0.176***	-0.235***	-0.104***	-0.129***	-0.188***	-0.057**
	(0.031)	(0.050)	(0.070)	(0.040)	(0.039)	(0.059)	(0.028)
Scale (fatality scale index)¶					0.073***	0.076**	0.070***
					(0.019)	(0.030)	(0.020)
Reciprocated (or not) dummy+					-0.000	-0.039	0.044
					(0.064)	(0.116)	(0.039)
Observations	192	192	192	192	192	192	192
Panel B: Early 20th century							
ln(Distance from the world GC)#	-0.057***	-0.120**	-0.123*	-0.117**	-0.135***	-0.141**	-0.131***
	(0.019)	(0.049)	(0.065)	(0.047)	(0.042)	(0.058)	(0.047)
Scale (fatality scale index)¶					0.132***	0.158***	0.104**
					(0.042)	(0.054)	(0.042)
Reciprocated (or not) dummy+					-0.006	-0.094	0.084
					(0.045)	(0.062)	(0.055)
Observations	343	343	343	343	343	343	343
Panel C: Modern							
ln(Distance from the world GC)#	-0.058*	-0.401***	-0.432**	-0.381*	-0.402***	-0.407**	-0.374*
	(0.030)	(0.135)	(0.197)	(0.212)	(0.138)	(0.182)	(0.203)
Scale (fatality scale index)¶					0.195***	0.256***	0.050
					(0.062)	(0.095)	(0.070)
Reciprocated (or not) dummy+					0.173	0.445	-0.085
					(0.185)	(0.282)	(0.095)
Observations	229	229	229	229	229	229	229

Notes: Column (1) uses linear probability regressions. Using probit or logit regressions instead does not change our findings. Columns (2)-(7) use negative binomial regressions. # Distance to the world GC is calculated using the geographical coordinates provided in the MIDLOC dataset (v1.1) and Table 1. We use its natural log to ensure that its coefficient can be interpreted as an effect with a percentage magnitude on the mean of the dependent count variable when negative binomial regressions are used. ¶ In the MID data, fatality level is measured by a 0-to-9 scale index (0 means no death). +Reciprocated (or not) dummy: it equals to one if at least one country on side B takes a military action against at least one state on side A. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Implication 5: In an observed military dispute, the side farther from the world GC is less likely to be a revisionist.

Before testing Implication 5 empirically, we would like to make three notes. First, Implication 5 follows from Assumptions (i) and (ii). This is different from Implication 4, which has two channels, one through Assumptions (i) and (ii) and the other through Finding 1. Second, Implication 5 does not negate causes of military disputes other than border tensions. Third, a military dispute may involve more than two states. Recall the scale parameter m earlier. With a larger m, more states are involved in the military dispute. Either side may have more than one state. If more than one state are on one side, its distance from the world GC refers to the average distance across states on that side.

We test Implication 5 with the MID dataset, and specify regressions in the following form:

$$\Pr(RE_{n,md} = 1) = \chi_0 + \chi_1 \ln(Dist_n) + \delta' X_{n,md} + \nu_{md} + \epsilon_{n,md} \tag{36}$$

where md indexes military disputes, $RE_{n,md}$ equals 1 if state n in military dispute md is a revisionist, and $X_{n,md}$ is a vector of control variables. The revisionist variable is reported in the MID dataset as an indicator variable, denoting whether a state in a given military dispute is dissatisfied with the existing status quo prior to the onset of the military dispute. If both sides are dissatisfied with the status quo, the state that openly attempts to challenge the pre-dispute condition is coded as the revisionist.[26] Regression (36) may include military-dispute fixed effects ν_{md}. When they are included, the regression uses only within-dispute variations, and the earlier dispute-specific scale m is automatically held constant.

Regression results are reported in Table 13, where a negative and statistically significant $\hat{\chi}_1$ is found, indicating that involved states farther from the world GC are less likely to be revisionists.[27] We use the linear probability model, though using probit or logit instead does not change our findings.[28] In Panel A, columns (1)-(3) use military-dispute fixed effects, while columns (4)-(5) are without military-dispute fixed effects. Column (5) uses time-period fixed effects.[29] All columns lead to similar results, and $\hat{\chi}_1$ with dispute fixed effects are larger in magnitude.

We have distinguished revisionism from originating military disputes. A revisionist state does not have to originate a military dispute, and a state that originates a military dispute may do so to retaliate for a foreign state's passive revisionist actions (e.g., sponsoring separatist movements in the originator's state). To address this, we have controlled for a dummy variable for "being the (military-dispute) originator" in Panel A. The coefficient of this dummy variable is positive, suggesting that the propensity of being an originator is positively correlated with that of being a revisionist. This, however, does not alter the sign or the significance of $\hat{\chi}_1$. Furthermore, we conduct a counter-check of regression (36), with its dependent variable replaced by the probability of state n being an originator in military dispute md. The results are reported in Panel B of Table 13, where no significant correlation between the dependent variable and the distance from the world GC is found when within-dispute variations are used. There is a significant but positive correlation between the two variables when the variations are not limited to those within disputes, suggesting that the dispute fixed effects difference out distance-related idiosyncrasy.

The results in Panel B of Table 13 have several additional implications. First, within disputes, there is no statistically significant association between the distance from the world GC and being an originator of a dispute. This forms a contrast with the within-dispute positive correlation

[26] There are cases where all involved states are coded as revisionists, meaning that they all have open attempts. Those cases are excluded from our sample because there is no within-dispute variation in them.

[27] Inequality (35) is in a "sandwich" form, suggesting heteroskedasticity. Robust standard errors have been used to address potential heteroskedasticity.

[28] Using probit or logit instead is less convenient computationally because of the large number of fixed effects used in regression (36).

[29] We do not call them year fixed effects because only years with military disputes have those fixed effects.

between the distance from the world GC and being a revisionist in a military dispute, as reported in Panel A. Second, revisionists are more likely to be originators of military disputes. This is not a prediction of the extended model, though it does not contradict the extended model. It is in line with our expectation on the association between the two variables. Third, when dispute fixed effects are not used, the weak association between the distance from the world GC and the probability of originating a dispute is positive rather than negative. That is, all else being equal, states farther from the world GC are more likely to originate military disputes. Recall that in the benchmark model, locales actually want to join *any* proximal state unless declined by them. In other words, proximal states do not voluntarily accept unwanted distal locales and thus military forces may be used by distal states to break into proximal ones.

5 Concluding Remarks

Is the surface of the earth linear? Clearly not. But a model based on a linear geography of the world can still help us understand global political geography, because in the long run, territories are influenced by trade, and states close to (far from) the rest of the world are in advantageous (disadvantageous) locations for trade. Modeling (dis)advantageous locations tractably is the unique merit of a linear-geography model. We are fully aware of the benefits and costs of "linearizing the world." It proves useful in rationalizing geopolitics, which are highly complex but popular in international political and economic narratives.

Our model consolidates the economic substance at the locale level and the political borders at the state level. Endogenous state borders bridge locales with the foreign world in the model, and create an intersection between international economics and international politics. The mechanism in our model is robust to time. Over centuries, the contents of international trade alter and the domestic operations of states evolve, though the trade linkage between locales, states, and the world captured by our model remains unchanged. Borders discourage trade, though proximity to the rest of the world allows setting borders less apart. Our model is also versatile. Borders interact with each other, with natural geography, and with military disputes. All these interactions shape the geopolitics to which international political and economic narratives refer.

The limitations of this study are threefold, each providing a practical avenue for future research. First, on the theoretical front, the downside of a linear world geography is the absence of interplay between states with the same distance from the world geometric center. A two-dimensional geography, such as a unit-disk continent, helps to introduce such interplay. Advancements in this direction would entail differential geometry. Second, on the empirical front, we did not find worldwide bilateral trade data dating back to the 18th and 19th centuries. If found, such data would be valuable for evaluating how trade volumes and nation states influence each other over time. Such data are scarce, although they have started to become accessible for certain regions, such as Western Europe and East Asia. Third, as noted at the end of Section 3, our model does not explicitly model domestic political regimes. It would be interesting to explore how states under different political regimes engage in geopolitics in a global economy.

Table 13: Revisionism in Military Disputes

	(1)	(2)	(3)	(4)	(5)
Panel A: Dep. Variable is Indicator of Revisionist					
ln(Distance from the world GC)#	-0.135***	-0.133***	-0.048**	-0.035***	-0.057***
	(0.024)	(0.024)	(0.023)	(0.012)	(0.013)
Indicator of originator		0.332***	0.360***	0.255***	0.262***
		(0.076)	(0.080)	(0.050)	(0.049)
ln(Military expenses)			0.095***	0.025***	
			(0.008)	(0.004)	
Other control variables¶	No	No	No	Yes	Yes
Military dispute FE	Yes	Yes	Yes	No	No
Period FE	No	No	No	No	Yes
Observations	1,376	1,376	1,330	1,330	1,376
Panel B: (Counter-Check) Dep. Variable is Indicator of Originator					
ln(Distance from the world GC)#	-0.004	0.003	-0.004	0.013*	0.015**
	(0.013)	(0.013)	(0.014)	(0.007)	(0.007)
Indicator of revisionist		0.054***	0.069***	0.063***	0.062***
		(0.014)	(0.016)	(0.014)	(0.013)
ln(Military expenses)			-0.006	0.001	
			(0.005)	(0.002)	
Other control variables¶	No	No	No	Yes	Yes
Military dispute FE	Yes	Yes	Yes	No	No
Period FE	No	No	No	No	Yes
Observations	1,376	1,376	1,330	1,330	1,376

Notes: All columns use linear probability regressions. Using probit or logit regressions instead does not change our findings. Panels A and B use the same sample, in which only one side has revisionist claims. ¶ Other control variables refer to fatality scale index (as in Table 12), reciprocated (or not) dummy (as in Table 12), and number of states in the dispute. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

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Appendix

A1.Proofs and Derivations

A1.1. Finding 1

Since $R_n = \exp\{\frac{1}{2}\tau[(1+b_{n-1})^2 + (1-b_{n-1}-S_n)^2]\}$, we have

$$\frac{\partial R_n}{\partial S_n} = -\tau(1-b_{n-1}-S_n)R_n, \tag{37}$$

$$\frac{\partial R_n}{\partial b_{n-1}} = \tau(2b_{n-1}+S_n)R_n, \tag{38}$$

$$\frac{\partial R_n}{\partial \tau} = \frac{1}{2}[(1+b_{n-1})^2 + (1-b_{n-1}-S_n)^2]R_n. \tag{39}$$

Equation (12) is equivalent to

$$F \equiv \tau R_n^{\gamma-1}(1-b_{n-1}-S_n) - h = 0, \tag{40}$$

which implies the following partial derivatives:

$$F_h = -1 < 0, \tag{41}$$

$$F_S = -(\gamma-1)R_n^{\gamma-1}\tau^2(1-b_n)^2 - \tau R_n^{\gamma-1} < 0, \tag{42}$$

$$F_{b_{n-1}} = (\gamma-1)R_n^{\gamma-1}\tau^2(2b_{n-1}+S_n)(1-b_{n-1}-S_n) - \tau R_n^{\gamma-1}, \tag{43}$$

$$F_\tau = R_n^{\gamma-1}(1-b_n)\{1+\tau(\gamma-1)\frac{1}{2}[(1+b_{n-1})^2 + (1-b_n)^2]\} > 0. \tag{44}$$

By equation (43), $F_{b_{n-1}} > 0$ if

$$\tau > \frac{1}{(\gamma-1)(b_0(1-b_0))}. \tag{45}$$

By total differentiation, $\frac{\partial S_n}{\partial b_{n-1}} = -\frac{F_{b_{n-1}}}{F_S}$. Recall $F_S < 0$ in equation (42). Thus, $\frac{\partial S_n}{\partial b_{n-1}} > 0$ so long as inequality (45) holds.

A1.2. Finding 2

The first-order condition for state 0 is

$$\tau R_0^{\gamma-1}(1 - \frac{S_0}{2}) = h. \tag{46}$$

The first-order condition for state 1 is

$$\tau R_1^{\gamma-1}(1 - \frac{S_0}{2} - S_1) = h. \tag{47}$$

Recall $R_0 < R_1$ and $\gamma > 1$. The only requirement on the relative sizes of S_0 and S_1 is that $1 - \frac{S_0}{2}$ must be greater than $1 - \frac{S_0}{2} - S_1$. That always holds. So, S_0 could be greater than, less than, or equal to S_1. Similarly, the first-order condition for state n is

$$\tau R_n^{\gamma-1}(1 - [\frac{S_0}{2} + \sum_{k=1}^{n-1} S_k] - S_n) = h. \tag{48}$$

If n is very large, $\sum_{k=1}^{n-1} S_k + S_n$ would be so large that equations (46) and (48) do not hold simultaneously. Otherwise, state 0 could be larger than state n. The possibility for state 0 to be smaller than state n is obvious.

A1.3. Derivation of Equation (14)

The trade volume between two non-adjacent states m and n is

$$\begin{aligned} X_{m,n} &= S_m \int_{b_{n-1}}^{b_n} c(s, b_m) ds = \frac{S_m}{2} \int_{b_{n-1}}^{b_n} d(s, b_m)^{-1} ds \\ &= \frac{1}{2\tau} S_m [\exp\{-\tau(b_{n-1} - b_m)\} - \exp\{-\tau(b_n - b_m)\}]. \\ &= \frac{1}{2\tau} S_m \exp\{-\tau(b_n - b_m)\} \times (\exp\{\tau S_n\} - 1). \end{aligned}$$

where state m (n) is the exporter (importer). Since states sizes are small compared with 1 (the total size of all states is 1 on both sides), $\exp\{\tau S_n\} - 1 = \tau S_n$. So, $X_{m,n} = \frac{1}{2} S_m S_n \exp\{-\tau(b_n - b_m)\}$.

A1.4. Finding 4

By total differentiation, equations (42) and (44) imply $dh/d\tau > 0$. With b_{n-1} given, F_h is constant while F_τ is decreasing in b_n in the right half of the world, so $dh/d\tau > 0$ is decreasing in b_n.

A1.5. Equation (22)

As in Section A1.1,

$$\frac{\partial S_n}{\partial b_{n-1}} = -\frac{F_b}{F_S} = \frac{(\gamma-1)\tau(2b_{n-1}+S_n)(1-b_n)-1}{(\gamma-1)\tau(1-b_n)^2+1} > 0, \tag{49}$$

given that τ is not too small (i.e., inequality (45) holds). Now, define $\Delta(b_{n-1}, b_n) \equiv (b_{n-1} + b_n)(1-b_n)^{-1}$, and $\Xi(b_{n-1}, b_n, \tau) \equiv (\gamma-1)\tau(1-b_n)^2$. $\Delta(b_{n-1}, b_n)$ does not depend on τ, while $\Xi(b_{n-1}, b_n, \tau)$ is increasing in τ. Now, equation (49) becomes

$$\frac{\partial S_n}{\partial b_{n-1}} = \Delta(b_{n-1}, b_n) - \frac{\Delta(b_{n-1}, b_n)+1}{\Xi(b_{n-1}, b_n, \tau)+1}. \tag{50}$$

Now consider a continental state n in the right half of the world, with territory $[b_{n-1}, b_n)$. Suppose it becomes an island state (i.e., τ rises to τ') but with unchanged borders. In equation (50), only one term $\Xi(b_{n-1}, b_n, \tau)$ changes (rises). So,

$$\left.\frac{\partial S_n^l}{\partial b_{n-1}^l}\right|_{b_{n-1}^l = b_{n-1}, b_n^l = b_n} > \frac{\partial S_n}{\partial b_{n-1}} > 0.$$

A1.6. Implication 3b (Inequality (27))

Since $\frac{\partial^2 b_n}{\partial b_{n-1}\partial b_0} = \frac{\partial^2 S_n}{\partial b_{n-1}\partial b_0}$, we can show $\frac{\partial^2 S_n}{\partial b_{n-1}\partial b_0} > 0$ instead. Recall equation (26):

$$\frac{\partial S_n}{\partial b_0} = \frac{\partial S_n}{\partial b_{n-1}} \frac{\partial b_{n-1}}{\partial b_0} > 0.$$

$\frac{\partial S_n}{\partial b_{n-1}}$ is increasing in b_{n-1} because $S_n = b_{n-1} + b_n$. As for $\frac{\partial b_{n-1}}{\partial b_0}$, notice that by equation (25), $\frac{\partial b_{n-1}}{\partial b_0} = \prod_{i=1}^{n-1} \frac{\partial b_{n-i}}{\partial b_{n-i-1}}$. $\frac{\partial b_{n-i}}{\partial b_{n-i-1}} > 1$ for every i. So $\frac{\partial b_{n-1}}{\partial b_0}$ is increasing in b_{n-1}. So, $\frac{\partial^2 S_n}{\partial b_{n-1}\partial b_0} > 0$.

A2. Tables (next page)

Appendix B: Summary Statistics Related to Military Disputes (Section 4.4)

Variable	Obs	Mean	STD	Min	Max
Panel A: Number of involved states (corresponding to Table 12)					
A1. 19th Century					
Total num. of states	192	2.46875	1.265351	2	11
Num. of states on Side A	192	1.333333	1.055196	1	8
Num. of states on Side B	192	1.135417	0.4933016	1	5
Fatality scale index	192	0.8489583	2.034544	0	6
Reciprocated (or not) dummy	192	0.4375	0.4973753	0	1
Distance from the world GC	192	5635.049	3547.611	168.4559	10084.53
A2. Early 20th Century					
Total num. of states	343	2.355685	1.960581	2	33
Num. of states on Side A	343	1.215743	1.359432	1	23
Num. of states on Side B	343	1.139942	0.8329522	1	11
Fatality scale index	343	0.6326531	1.65762	0	6
Reciprocated (or not) dummy	343	0.3556851	0.4794198	0	1
Distance from the world GC	343	4129.122	3368.796	98.16036	9942.989
A3. Modern					
Total num. of states	229	2.751092	4.10862	2	39
Num. of states on Side A	229	1.458515	3.228747	1	38
Num. of states on Side B	229	1.292576	2.586569	1	38
Fatality scale index	229	0.3231441	1.021882	0	6
Reciprocated (or not) dummy	229	0.3799127	0.4864281	0	1
Distance from the world GC	229	5362.322	3016.856	491.6061	9869.512
Panel B: Revisionism (corresponding to Table 13)					
Indicator of revisionist	1376	0.4789244	0.4997372	0	1
Indicator of originator	1376	0.8888081	0.3144839	0	1
Distance from the world GC	1376	4546.508	3651.731	52.12795	18007.49