

War, Wealth and the Formation of States ¹

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The number and size of sovereign states across the world has varied substantially over time. Up until the late 18th century, and at least since the Middle Ages, the number of independent nations experienced a massive reduction. In Europe alone, Tilly estimates that in 1450 there were around 200 states, principalities and city-states, averaging 9,500 square miles (the size of Vermont) and about 350,000 inhabitants.¹ Yet by 1830 that number had declined substantially – to about 25.² After the unification of Germany and Italy, the number of European states bottomed at its lowest level ever, 17 states, in the early 1870s. That process of consolidation stopped and then reversed in the 19th century with the spread of the idea of self-determination and the access of new nationalities to independence. The independence of Latin America from Spain in the first half of that century resulted in the creation of about 15 new countries. Several nations in the Balkans, three former British colonies (Canada, New Zealand and Australia) and Norway followed in the decades before World War I. Finally, the collapse of the German, Austrian and Russian empires in 1918 pushed the number of states up to 70 by the mid 1920s. After a decline during World War II resulting from the German occupation of almost all continental Europe, the process of decolonization across the globe doubled that figure. The breakdown of the Soviet Union ushered another wave of secessions and put the number close to 200 sovereign units.

Besides fluctuating in numbers, countries have differed (and continue to differ) in terms of their size. Figure 1 reports the evolution of the median and average size of countries as well as the maximum and minimum countries from 1815 to 1998. Dispersion is considerable. Most countries, however, are small. A fourth of all countries had a territory below 40,000 square miles – and in fact

¹ According to Carneiro (1978), there were about 600,000 independent political communities on the Earth in the year 1000 B.C.

² This figure assumes all Swiss cantons to be part of one confederation, takes the Papal states as just one political unit and only includes mid-sized German territories. Otherwise, the number would be closer to 80.

the size of the lowest quartile has declined to below 20,000 square miles in the last two decades. Fifty percent of all states have less of 100,000 square miles and only 25 percent have a territory over 350,000 square miles.

The current scholarly literature that has developed to explain why and how the size and number of states varied over time falls into two categories. The thrust of the current research on the size of countries has been written within the tradition of macrohistorical sociology. At the turn of the twentieth century, Hintze (1975) was the first to point to war as the generator and creator of states. Tilly (1975, 1990) then traced the varying territorial size of states to the pressures of warfare conditional on the extent to which ‘capital’ or ‘coercion’ were employed to organize and fund warfare machines. Spruyt (1994) related the ‘type’ of state to the underlying social coalitions that sustained it. More recently, a few scholars, mostly employing the tools of microeconomics, have developed several analytical models to predict the size of countries as a consequence of both the degree of trade integration and the preferences of citizens over the level of redistribution and public good provision (Alesina 2002, Alesina and Spolaore 1997, Bolton and Roland 1997).³

Although both the economic and sociological approaches provide invaluable insights on the formation of countries, they are ultimately limited by their respective methodological and substantive choices. The macrohistorical literature provides the theoretically most convincing building blocks (war, the technological shock of new and increasingly more expensive weapons, and the need of states to survive) to develop an empirically sound story of the evolution of the size and number of states. Still, its logical foundations are sketchy and the concepts it employs (such as ‘capital’ and ‘coercion’) imprecise (for example, ‘coercion’ is not a resource – akin to money – to be employed by the ruler to build a state, as Tilly suggests, but rather a mechanism to muster compliance). Moreover,

³ See a recent summary of the literature on state formation by Spruyt (2007).

its structuralist explanations are devoid of agency and hence mostly correlational in nature.

In turn, the economics literature on state formation is attractive in the way it develops an analytical model and it is (relatively) careful in its treatment of how agents choose their political strategies. Its theoretical approach, which is based on the assumption that rulers (or citizens, in democratic polities) choose borders through some joint welfare maximization process given how the size of the state affects taxes and public goods provision, presents, however, two problems. On the one hand, it minimizes or simply disregards the role of security concerns and war in the formation of states. Trade, the creation of economies of scale and the choice of policies that maximize economic efficiency are indeed important concerns among policymakers. But, in the context of anarchy that characterizes the international system, security and military considerations play the most crucial role in explaining state behavior and state outcomes. Most, if not all, state rulers maximize their welfare through non-economic mechanisms, that is, through military expansion (exclusively or in conjunction with purely economic means). And even when they do not contemplate military action to increase their wealth and power (for reasons we discuss and model later), they still need to prepare militarily and even take preemptive action against potential aggressors. Given that other states may simply prefer to increase their wealth through military raids, even trading (and hence “peaceful” or peace-prone) states need to amass enough military power to secure the protection of their citizens’ property rights against any external bandits. In short, security constitutes a central goal of states and war technology plays a key role in determining state borders. In fact, almost all the instances leading to the creation of unified nations or to the fragmentation of existing empires are related to military defeat (directly or after a protracted cold war): from the declaration of an independent United States to the collapse of Austria-Hungary and the split of the Soviet Union. There are very few cases in which nations have become independent through a peaceful process, completely unrelated to the

military defeat or military exhaustion of the dominant state: Norway and Iceland seem to be the only two cases. It is also true that world trade may have facilitated the emergence of regionalist demands within nation-states but it seems only distantly related to the number of countries. The search for a unified trade space may have spurred the national unifications of Germany and Italy – but both events eventually required fighting several military campaigns. Even the creation of a common market in Europe may have been the result of security concerns (Rosato 2006). In short, a truly successful model of state formation must necessarily include violence as the central mechanism through which countries are created and reshaped.

On the other hand, current economic models of state formation are inherently static in nature. They posit a fixed number of agents that make decisions, generally in the context of a game-theoretic structure or a joint welfare maximization decision, on the “optimal” size of states. Yet the history of state and nation formation is an inherently dynamic one. The number of agents that had competed with each other has changed over time. The outcome of war in the first period alters the outcome of the following periods, since the winners of the first round of conflict can now count on newly acquired resources to launch a new wave of attacks (or defensive actions). In the mean while, war technologies and the economic techniques employed to generate income vary over time, affecting the number and payoffs of actors in unexpected manners. Finally, the structure of preferences of rulers and rules (e.g. in terms of their national identity) shift, often in direct relation to the outcomes in each round of the war game. All these transformations can be hardly modeled using closed game forms.

To examine the process of state formation (more specifically, the process of change in the territorial size of the state), we take a (partially) different theoretical and methodological approach. From a theoretical point of view, we go back to the notion of war as the main driving force of state formation, while at the same time formalizing with more precise analytical foundations the general

insights of the macrohistorical literature.⁴

More precisely, we envisage an anarchical world in which there is no single authority capable of adjudicating among different rulers. All sovereign rulers are intent on the maximization of their wealth – which may be achieved mainly, but not exclusively, through military expansion and the taxation of the conquered territory. Under those two conditions of anarchy and wealth maximization, states are potentially in military competition with each other. Concerned about their security and ultimate survival, states are necessarily compelled to accumulate power. Since power is a function, at least in the long run, of the country's population and productivity (Mearsheimer 2001), states both nurture their domestic economy and consider expanding their territories. This in turn exacerbates the cycle of interstate competition even more.

Notice, however, that even though gaining an advantage over all other states may be desirable in principle, following a strategy of military expansion is never an unconstrained activity. The decision to wage wars to expand and conquer new territories is determined by, on the one hand, the costs of fighting external competitors and controlling the population of the territory to be occupied, and, on the other hand, the benefits or revenue that can be extracted from that new area. The costs of war and occupation vary with changes in the technologies used to produce violence and with the willingness of the occupied population to accept the new ruler. The benefits of expansion are a function of the distribution of the population, the latter's production technology, the administrative capacity of the state to tax its citizens and finally the types of economic activities (and assets) that states control (or could control). For example, any wealth that can be easily taxed (such as land and mineral wealth) will be much more sought after than any assets (such as trading or financial activities) whose control may be much harder to achieve. Accordingly, territorial expansion and the use of war

⁴ As it should be apparent shortly, we can also integrate economic considerations into the general model of war and territorial expansion we develop here.

will be differently distributed (across the world and over time) depending on the type of economy in place (at home and abroad).

To put it in different words, we postulate a model that starts from realist assumptions – an anarchical environment in which states as the only actors and where they interact in the context of a security dilemma. But we then proceed to endow our states with a set of rational calculations that derive from domestic and external conditions affecting the benefits and costs of war amounts: This second step allows us to move beyond the inherent theoretical poverty of realism.⁵

Methodologically, we examine the validity and empirical purchase of our theoretical assumptions by engaging in agent-based simulations (and comparing them to the evolution of the international state system). That is, once we formally model the ways in which states make decisions about their preferred borders, we create a strategic environment populated with a number of states that, behaving according to a set of theoretically-derived decision rules, interact over a given time period. The analysis of states' interactions in an agent-based world rather than in a closed game set-up has several advantages. First, it allows us to construct a model based on assumptions that approximate the empirical world quite closely – that is, we need to make fewer sacrifices to build the model than we would have to if we used the tools and solution concepts of standard game theory. Second, it enables us to track the dynamic structure of the game thoroughly – that is, over all the steps that lead from the starting moment of the world we create to a particular point in time (that we select or that seems to exhibit some robust equilibrium).⁶

Simulation modeling in political science already includes some notable contributions, that spawn from the analysis of voting decisions to Axelrod's work on the emergence of cooperation in

⁵ Our closest predecessor is therefore Gilpin (1981).

⁶ For similar considerations, see Cederman (1997).

the context of a prisoner's dilemma game (Axelrod 1984).⁷ In the field of international politics, war and the determination of political borders was first modeled through a simulation game by Benson (1961) and then Bremer and Mihalka (1977). The latter modeled the environment as an hexagonal grid in which countries are allotted some resources and information and then engage in decisions about war and conquest. This model was further extended by Cusack and Stoll (1990) and then explored and improved by Cederman (1997, 2003). Here we follow the same tradition of building an agent-based model to explore the process of state formation. Nonetheless, we depart from the existing work in various regards – mostly in characterizing different types of states in terms of their domestic or internal conditions (political regime, population densities, economic profiles, nature of assets). It is this richness in the economic and political parameters of our units that allows us to explain the causes of the different distributions of states that have emerged spatially and temporally in the world (and, in particular, in Europe).

The paper is organized as follows. The first part presents a stylized model in which a single ruler (or a small ruling elite) chooses the size of the state to maximize his (its) welfare conditional on the available military technology and the neighbors' strategies and resources. The second part moves from this characterization of the environment and its agents into the agent-based model. In particular, the second part explores how changes in war technologies, population, economic technology, taxes and types of assets affect the number of states. It also compares the simulation results with the evolution in the number of states over time and, particularly, in Europe in the last 1000 years. The paper concludes by sketching those elements we plan to add to make the model closer to the real world.

⁷ See a general review of the literature of simulation in political science in Johnson (1999) and a critical assessment of simulation as a method of inquiry in international relations in Pepinsky (2005).

MODELING THE BEHAVIOR OF RULERS

To understand the mechanisms that explain the variation in the size of countries over time (and in fact, across the world at any point in time), let us consider an environment in which there are states each one governed by a ruler called Leviathan (L) who wants to maximize his welfare, or, more exactly, his net income. To maximize net income so, L will maximize the difference between the revenues R he will raise in the territory under his control and the costs C he will have to incur to maintain the monopoly of violence over a certain territory (and hence domestic and external peace).

The goal of income maximization can be interpreted in strict “economic” terms – that is, we can think of the ruler as being simply interested in increasing his purse and therefore his consumption. However, as noted above, it also embeds the goal of securing the survival of the ruler. In the absence of a central authority and of general, enforceable rules at the international level, all sovereign rulers are uncertain about their neighbors’ behavior and therefore about their own survival. In this context of anarchy, in which all states compete (or may compete) with each other, each ruler maximizes its resources and wealth to have enough power to overcome any challenge to his sovereignty. There are several strategies to maximize income, ranging from generating a more productive economy to expanding and capturing new territories and subjects. Here we will focus on wealth maximization through territorial expansion. As we will see, we do not disregard nonmilitary means to generate wealth. Our model endows countries with varying levels of technology, different population growth rates, and so on. But methodologically we treat them as fixed, that is, as exogenous to the choices of the policymakers.

Consider the structure of costs and revenues sequentially.

Costs of Violence

To establish a state, L has to incur some costs to maintain a minimal domestic police, an army to fight other states and an administrative structure (to raise revenue, monitor the police and the army, and to adjudicate any disputes among the inhabitants of the territory under control).

These costs can be distinguished into two types. On the one hand, the ruler has to pay some ‘fixed costs’, that is, some start-up costs that are independent of the territory and population L controls – for example, the costs of sustaining the central government and the central command of the army. On the other hand, the ruler must meet some ‘variable costs’ or, in other words, costs that are not fixed and that vary with the territory under control. Soldiers, who can be easily hired or laid off, as a function of the territory being defended, are variable costs. In between fixed and variable costs, there are quasi-fixed costs such as most weapons: although in the long run they can be adjusted to the size of the state, states normally have to spend heavily in guns to start with and they can only amortize that expenditure once they have expanded substantially.⁸

The structure of costs can be displayed graphically. In Figure 2 the horizontal axis represents the territory controlled by L , from 0 in the left to all the world at the right -- so that the segment $[0, S_1]$ is smaller than $[0, S_2]$. For the time being, assume that population is uniformly distributed along the territory. The vertical axis captures total costs faced by L and associated to each level of S .

Figure 2 assumes that fixed costs are at C_f . In turn, variable costs increase with territory at an increasing rate. This may happen for three different reasons. First, the central government has a harder time controlling the population in the periphery (the area away from 0) than in the center (the point close to 0) for purely ‘technical’ reasons. L ’s army has to march for longer periods of time to reach the bordering populations. Communications become more sporadic, therefore weakening the

⁸ In the long run, there are no fixed costs since all costs can be adjusted to controlled territory. However, we will assume throughout the discussion that we are discussing the short-run evolution of the state. Naturally, the threshold between short and long run is in a sense arbitrary.

effectiveness of the state. Second, the cost of control is shaped by ‘political’ domestic reasons. Assume that, as one moves away from the center, populations become increasingly different from the inhabitants at the core of the polity: they exhibit distinctive traits and preferences, making particular demands, and hence putting renewed pressures on the ruler. The costs of control should increase accordingly. Finally, control becomes harder for external political reasons. As the country becomes larger, it clashes more directly with other states and political and military competition becomes more acute. Since the enemies’ armies may have some advantage due to proximity to their center of decision or to the loyalty of a population that is more similar to them in preferences, L has to step up military expenditure at a faster pace than before.⁹

State Revenues

Consider now the structure of state revenues. To simplify our analysis, assume for the time being that all the territory exhibits the same productivity: each geographical segment produces the same quantity of product y . Thus, the total production in the territory S_N is Y_n or, generally, $Y = Y(S)$.

The state or ruler exacts the same proportional amount τ from each individual. This quantity $y\tau$ may be extracted through taxes, confiscation, personal services, etc. The exact way through the extraction is achieved should not concern us now. For the sake of simplicity, we will refer to it as a tax.

Given that τ is a linear tax or charge, and given the assumptions about the uniform

⁹ Similarly, average costs per territorial unit can be broken down into average fixed costs, or fixed costs per territorial unit ($AC_f = C_f/S$), average variable costs, or variable costs per territorial unit ($AC_v = C_v/S$). Average costs will be $AC = [C_f + C_v]/S$. The average fixed costs are infinite for $S=0$ and then decline as the state grows in size. In turn, the average variable costs remain flat (or even decline) and then grow at an increasing rate in the periphery. The average cost curve is the sum of the previous two curves – it declines (as average fixed costs fall) and then increases (with average variable costs). Marginal costs, MC , that is, the increase in costs that result from adding a unit of territory to the state, may be denoted in terms of variable costs since fixed costs do not change with territory: $MC = \Delta C_v(S) / \Delta S$.

productivity of the territory, total state revenues R grow linearly with the territory, $R=\tau Y(S)$, in the manner represented in Figure 4.

Optimal Behavior and Size of the State

We can now put together the two dimensions of state ruling -- revenue extraction and the provision of certain goods such as military protection -- to explore how the size of the state evolves. As pointed out above, the Leviathan will choose to expand to the point where net revenues are maximized. The graphic solution is represented in Figure 4. Given a tax rate τ^* (determined according to parameters we examine later), L decides to expand to the point S^{MAX} , where net income, that is, total revenue minus total cost, reaches its maximum.¹⁰

Notice, however, that in this simplified theory of state size each ruler Leviathan seems, so far, to choose its optimal area independently from what others do. Thus up to here we are modeling through a straightforward decision-theory set-up a situation that actually resembles a strategic game (where the solution derives from what an individual does in response or in anticipation to what other actors or states do). That is, the size of the state depends both on the costs and revenues the ruler faces and on the costs and revenues other rulers have.

It is true that, to some extent, the model encompasses in an implicit manner what other rulers or states may do. The model takes into account the actions (and resources) of other states as follows. On the one hand, it contains the effect of other states' strategies through the level of fixed costs: for example, as new technologies leading to more sophisticated weaponry are adopted by other states, all rulers have to modernize their stock of guns – otherwise they face extinction. On the other hand, the structure of the variable cost function, and its steepness, incorporates too the behavior of other states

¹⁰ Maximizing with respect to S shows that the ruler will choose S where marginal revenue (the increase in revenue resulting from an additional unit of territory) equal marginal cost (the increase in cost resulting

and the choices L makes. While L has hardly any opponents or his enemies are weak, the variable cost curve remains relatively flat, even for very distant peripheries. L has then a strong incentive to expand and imperial structures should be common. Conversely, a prince that faces very powerful states has a rapidly increasing variable cost function -- unless L has little information about other states' resources (a case in which he may be prone to expand only to find himself entangled in wars and probably in defeats), he would rather constrain himself to a relatively circumscribed area.

Still, to understand how countries evolve and what may be the weight of each parameter of interest, we need to examine the strategic interaction of several rulers over time. As pointed in the introduction, we do so through the examination of how several rulers behave in a simulated environment given the rules we just laid out.

EVOLUTION OF THE SIZE OF COUNTRIES

The environment in which agents act consists of a two-dimensional space of 50 x 50 squares populated by a maximum of 49 states (with contiguous borders). Each state is endowed with some initial population, determined by its area and a national density parameter. The density parameter, which is set up by the researcher (randomly or directly), varies according to the type of terrain in place -- either mountainous, hilly or flat. Population grows at a given rate, also to be determined by the researcher. In addition to the demographic parameters, countries have some production technology, which, jointly with total population, determines total wealth. State rulers tax wealth according to two parameters: a tax rate, which represents the taxation capacity of the state, and a mobility parameter, which defines the extent to which national assets are more or less non-specific or mobile. As asset mobility or non-specificity increases, the share of wealth the ruler may tax declines.

from an additional unit of territory).

In addition to these social and economic parameters, the model posits a military cost function. This cost function is identical for all countries – under the assumption that successful war technology is quickly copied by all states – and includes both a fixed cost component and a variable cost component that grows with distance from the state capital. The cost function may be specified to change over time tracking particular technological shocks in war waging. Given the demographic and economic structure of each country and the military cost function, rulers make decisions, under some informational uncertainty, about whether to challenge their neighbors or not. The war outcome is then determined by the resources of each side and the losses they bear. A detailed description of the decision rules of the states is given in the appendix to this paper.

Consider now what are the implications of the model to explain the evolution of the size (and number) of states. We first explore the effects of a shift in the cost function. We then examine what happens when the revenue schedule changes. Finally, we consider the joint interaction of changing costs and revenues.

Shifting Costs

The size of states varies, in the first place, as the schedule of costs shifts. The cost function may vary as a result of two changes -- a shift in fixed costs or a change in variable costs -- with different consequences. A shift in the level of fixed costs, which affects the intercept of the cost function, changes the minimal size any state has to meet to survive: we may call this level the ‘survival threshold’. This effect is captured in Figure 5. As the cost function shifts upwards, from C_1 to C_2 , the size of the state has to be, by definition, bigger: the threshold moves leftward from S_1 to S_2 . Any modification of variable costs and, therefore, of the slope of the cost function, alters S^{MAX} , that is, the state size desired by the ruler. Figure 5 also depicts this possibility through the cost function C_3 , in which an increase in variable costs shifts the ideal size of the state leftwards.

Although Figure 5 distinguishes the shift in fixed and variable costs as two separate events,

both changes often take place simultaneously – broadly speaking, rising (declining) fixed costs are substituted for declining (rising) variable costs. Consider, for example, the case in which a technological shock leads to the invention of new, more sophisticated weapons – such as the invention of the cannon in Europe during the 15th century. Before the introduction of guns, that is, in the pre-cannon world, the provision of military power was labor-intensive. Soldiers carried at most spears and swords. Their capacity to control a given territory and its population was low or, to put it differently, the ratio of soldiers to population was high, especially in the periphery of the state. Thus, fixed and quasi-fixed costs were low. By contrast, variable costs were high and rose quickly with territory. The extension of fire weapons had two effects. In the first place, fixed and quasi-fixed effects went up. As a result, the survival threshold shifted to the left for each state – states need to be of a larger size just to be viable. In the second place, variable costs declined: with the help of guns, the ratio of soldiers to population declined and so the ‘optimal size’ of the state increased. State rulers had an additional incentive to enlarge their territories.

Let us now turn to the analysis of state behavior and the general outcome at the level of the international level through the agent-based model. Figures 6 and 7 summarize the results of simulating the behavior of states as both fixed and variable costs change over time (4,000 units of time each). In Figure 6 fixed costs are very low (in fact 0) while variable costs vary from high to very low (again, variable costs decline as the distance parameter declines in the model). In Figure 7 fixed costs are set at high levels while variable costs also vary from high to very low. Both figures show that the number of states decline over time (as the resources in population and wealth increase and make conquest more attractive).¹¹ But the decline is strongly determined by variable costs. When the latter are high, that is, when the cost function has a steep function, the number of states hardly changes. However, when they fall, states have a much higher incentive to expand (remember that S^{MAX} shifts rightward in Figure 5) and over time the number of states converges to a minimum of 1.

¹¹ Population is set to increase at some rate in the simulation.

The pace of unification varies, however, considerably with variable costs. For high variable costs, the world remains extremely fragmented even at time 4,000. With very low variable costs, the process of unification is extremely fast – in our simulations there are less than five states at time 600. By itself, the rate of change has interesting implications to explain the pace at which unification happens.

The impact of variable costs is also interesting in a different sense, that is, in interaction with other factors. Assume that there are some parameters (e.g. capital mobility) that, when taking some values, reduce the incentives to conquer new territories. Assume, further, that these values or thresholds occur at a given point in time – and not at the initial moment of the simulation. If variable costs become low very early in the simulation, before the other parameter reaches a threshold blocking unification, unification (through war and conquest) happens. By contrast, if variable costs decline very slowly so that hardly any state consolidation has occurred by the time the other parameter kicks in and reduces the incentives to engage in war, then the pressures to unify decline and the world remains relatively fragmented even as variable military costs continue to decline.

The simulations summarized in Figures 6 and 7 match the broad patterns of transformation affecting the world. At the dawn of mankind military control over the territory was very fragmented. As we shall shortly see this was in part related to population density (and wealth). But it had much to do with war technology. Fighting the enemy was such a labor intensive activity that any predator easily encountered very tough resistance from similarly equipped men as soon as he moved away from his home base. Once variable costs fell, however, conquest and control became possible, wars multiplied and the number of states (or political organizations with exclusive or near exclusive control a certain territory) declined.

For a period closer to us, these patterns also fit relatively well the evolution of the European state system since the Middle Ages to the 19th century. In the early Middle Ages (circa 1000 AD), political control was extremely fragmented and in the hands of several hundred feudal princes and magnates, cities and micro-states. This level of fragmentation matched the type of military structure

in place. Armies were mostly composed of horsemen, organized in small bands, and had relatively primitive weapons. The costs of equipping a knight were probably high for those eminently agrarian territories and so only a few could serve on a permanent basis as combatants. Still, their output/input ratio (i.e. the number of killings and dominated populations per warrior) was low – the number of peasants a horseman could defend and control was rather limited. Across Europe, kings and upper-level nobles such as dukes and counts could only exercise nominal control over their territories. They relied on a hierarchical structure of barons and other low-level noblemen who, in turn, exercised direct de facto control over minute areas. In that configuration of power, monarchs acted as brokers, adjudicating disputes between their subordinates, thus in fact minimizing the possibility of a constant state of war between smallish bandits. The barons and feudal lords in turn pledged their loyalty to the crown – but their obligations were rather limited or ill-defined.

Over the following centuries, some European monarchs gradually asserted their preeminence over that feudal structure with varying rates of success. Still, it was not till fire weapons, and particularly the cannon, were introduced that the size of the state changed dramatically. Having fire power altered the nature of war permanently. At the beginning of the 15th century, it took Henry the Fifth of England ten years to conquer the French region of Normandy. Thirty years later, the French monarch, now in possession of artillery pieces, conquered it back in one year, at the pace of one fortress per week. The feudal cavalry, which had dominated military action in the past, collapsed. States had to engage in a race to amass strong, well-disciplined armies to survive other foreign powers engaged in the same dynamics of international competition. In the late 15th century, France, Spain and England had been able to organize permanent armies in the order of 20,000 to 25,000 men – this was a significant departure from the medieval ages, in which battles were fought by a few thousand men at most. During the following centuries, however, the size of permanent troops spiraled to unprecedented levels. By 1530 Spain had a standing army of 130,000 men. In 1600 the number had risen to 200,000 and in 1630 to 230,000. Its more direct rival, France, had to engage in the same

policy of general mobilization. French troops went up from 65,000 soldiers in the Italian campaign of 1498 to 155,000 around 1635 and then to about 279,000 in 1679.¹²

The upward shift in the costs of war led to the territorial expansion (and consolidation) of the existing states. The French monarch occupied Brittany, absorbed a good part of the former kingdom of Bourgogne and then invaded Italy at the turn of the century. In response, the previously independent kingdoms of Aragon-Catalonia and Castile joined, through a marriage contract, to form Spain in 1479. The Spanish kings replicated the same strategy by marrying their offspring with other European dynasties. By the second quarter of the 16th century Spain had succeeded in building a tight territorial ‘cordon sanitaire’ around France: its king held direct control over the Low Provinces (contemporary Belgium and Netherlands), several territories along the Rhine and Milan in Northern Italy, and had been elected emperor of Holy German Empire.

Still, notice that the evolution of downward trend in military costs only explains part of the phenomena we are interested in describing. It does not account for the considerable variation that we observe in the size of countries (e.g. France versus all the Italian city-states) even as the costs of war were forcing many countries to reconfigure their borders (and internal apparatus) to survive. It does not explain the growing number of countries since 1900. We now turn to changes in the revenue function to explain the first problem: the variance in territorial size across the world.

Shifting Revenues

The revenue schedule shifts as a result of, first, changes in the productivity of the territory, and, second, changes in the response of the economic agents to the effects of the tax rate (which we will refer to as tax elasticity of income).

The revenue function changes, in the first place, with the productivity rate of the territory. The productivity rate is the level of output Y produced per units of input employed in the production

¹² Data come from Finer (1975).

process. In each unit of land, production increases with an increase in population and/or with an increase in capital (both in the sense of having more tools per person or in a more efficient use of the same tools by the existing population). A higher productivity of the territory increases the incentive of states to expand. Figure 8 captures this fact. An upward shift in total output (with an unchanged tax rate) changes the desired state size from S^{MAX-1} to S^{MAX-2} : states have a stronger incentive to expand.

As already pointed out before, rulers do not maximize output but rather (net) revenue. How much revenue can be collected will depend on the tax rate imposed by the state. In a world where there are only autocratic rulers intent on maximizing, they will tax constrained by two factors. The first factor is the tax capacity of the state – tax collection will increase with the organization of the state. The second factor is the distortionary impact that taxes may have on the economic decisions taken by individuals and therefore on the final size of the economy or Y .

The relationship between total output and the tax rate can be expressed as $Y = Y(\tau)$, where $\partial Y/\partial \tau < 0$. Given this function and the tax elasticity of income, L will choose a certain τ^* to maximize public revenue. As total production becomes more sensitive to taxes, that is, L is increasingly constrained to set a relatively low tax rate, the slope of R flattens and the optimal size of the state declines.

Although the tax elasticity of Y is a function of several factors, the type of assets (both in terms of their mobility and the easiness with which states can monitor them) are central among them, altering the size of the state as follows. In areas with more mobile types of assets (such as money or skilled people), which can escape high taxes easily, states would be smaller in size than in regions with fixed assets (land, mines, etc.), which can be heavily taxed by the ruler. Or, to put it differently, the level of aggressiveness of states will decline with asset mobility. Historically, asset mobility is correlated with the abundance of capital (and the relative scarcity of land) (Boix 2003). For that reason capital availability should lead to smaller states – just the opposite result of what we found by

assuming that capital is more productive than land. To paraphrase Barrington Moore, no bourgeoisie, no peace: a world of industrialists and financial entrepreneurs may be (on average) a more peaceful world than an aristocratic one.

Consider again the results of our simulations. Figure 9 reproduces the evolution of the number of states over time under the same military cost function, unchanged technology and tax rates yet changing population levels. With no population growth, and given a very low initial density, no ruler has any incentive to expand. The number and size of states remains unaltered. With population growing at 0.05 percent every time period, wealth increases progressively and by time (or year) 2,000, when population density has multiplied by 20,000, the number of states has declined to 35. Two thousand years later the number of states has declined to 26. At a higher (and unrealistic pace of 1 percent annually), the world has become completely unified. Figure 10 shows similar results when we vary the technology parameter (that is, the parameter that transforms population into some income). With a very primitive technology, and hence little wealth creation, the number of states hardly changes (naturally, this outcome is a function as well of the level of military costs). As the technological capacity of countries changes, however, wealth multiplies and competition increases, leading again to a process of unification.

Figures 11 and 12 examine the impact of taxation on the number of states. Higher tax capacity makes conquest more profitable and accelerates the process of unification. In Figure 11, the number of states at year 2,000 varies from over 45 for a low tax rate (20 percent) to 16 under a high tax rate (70 percent). Capital mobility has an even stronger effect on war. With complete asset immobility, an even for low taxation levels, the number of states falls rather quickly. Yet, once capital becomes mobile and has an option to escape from the control of the conqueror, the incentive to invade declines rather quickly. Capital mobility can be understood in a broader sense that goes beyond mobility in a strict sense – for example, as the capacity to hide assets from the state or as having assets that cannot be exploited by the conqueror once part of the conquered population has

been killed or wounded (something that may be unavoidable in a war).

Notice that population and technology affect both the incentive to attack and the capabilities the attacker has to win the war. By contrast, the type of asset mostly acts as a factor affecting the incentive to attack. This parameter captures and formalizes Tilly's insight that the evolution of the size of states may have been affected by the type of wealth they controlled. In land-abundant, capital-poor areas, all monarchs formed large, unified territories, such as Russia, Prussia and Spain, which were located at the periphery of the European continent. If they failed to do so, they disappeared: the Teutonic states or Poland stand as good examples of that fate. By contrast, unification was much slower in commercial regions – in part because they were rich enough to sustain strong armies but in part because their direct control must have been inherently hard to the potential invaders.

Table 1 shows the estimated number of independent political territories from 1000 to 1870 in the Iberian Peninsula, Italy, France and Britain. With the exception of Italy, by 1600 those areas had experienced a process of consolidation. The French number is deceiving because it includes a set of small cities close to the German border – by the end of the 17th century France could be considered practically unified. Italy was a territory rich in commercial capital and its states were small. This was also the case of other medieval and modern city-states in central Europe such as Hamburg or the Dutch Provinces.

All these city-states were able to survive as small independent states until a new technological change made war too expensive (and shifted the 'survival threshold' upward): this shift happened with the French and Napoleonic wars, which mobilized massive infantry armies. This eventually led to the processes of German and Italian unification in the second third of the 19th century.

A Heterogeneous World

So far we have examined the impact that a change in several parameters may have on the

evolution of states. However, we have treated each one of those parameters (population, technology, taxes and capital mobility) as identical across all countries. Let us now consider the effect of cross-country differences in the underlying parameters. Naturally, differences in wealth (due to population and technology) are somewhat trivial: richer countries have an advantage and use it to expand and defeat their enemies.

Following the discussion in the previous subsection, it is more interesting to simulate the evolution of the world when countries vary in terms of their type of wealth – with some having mobile assets and others being rich on fixed wealth. Figure 13.A depicts a world (of 49 states) with two types of states: the states in the core and the states in the periphery. In Figure 13.B we characterize the core as having perfectly mobile assets and the periphery as having fully immobile wealth. We then run the simulation for 10,000 time periods and reproduce the results at times 500, 1,500, 5,000 and 10,000.¹³ By year 500 there are 19 countries left. The unification has taken place in the periphery although it is still incomplete. By year 1,500, there are two larger countries controlling the NW and SE of the world and the core is mostly intact. New expansions take place no much later and by 2,500 a single country (A) surrounds the core from all sides but one. One of the core countries (q) has expanded toward the NE but it is rich and its average wealth mobile enough that A has no incentive to attack. No military changes take place and the world looks identical throughout the end of the exercise.

In Figure 13.C the core has the more realistic trait of having medium levels of asset specificity (the parameter is set at 0.6). Unification also starts in the periphery and proceeds quickly. In the core states fight each other and consolidate in three. After 2,500 no change occurs either. The world is mainly unified but there is still some fragmentation.

Finally, in Figure 13.D we go back, for the sake of comparison, to a situation in which asset specificity is complete across the world. Unification takes place very fast, without respecting the

¹³ The remaining parameters are: initial density=5, population growth=0.001, technology=3, inference error=10, no fixed military costs and low variable costs ($s=0.1$).

pattern of fragmentation at the core that we observed before. By 2400 the simulated world looks like China after the period of warring states.

War Costs and World Government

The model on war and Leviathan's choice of territorial can encompass a wide variety of outcomes. Take a case in which there is a technology with extraordinary initial costs – such as a massive missile and space shield system – and zero or minimal additional costs (per unit of territory controlled). Assume as well as only one state can garner the revenue to pay its costs – in fact its technology base is so productive that a tax on the production on its core area is enough to pay for that military technology. That scenario should lead to a one-state government with the whole world (W*) under its control.

As a matter of fact, our model and simulation reveals how implausible the event of a world state is: the revenue schedule is not increasing on territory across the world. Roughly speaking, the globe contains three types of regions: a core of industrialized, highly productive countries (the North Atlantic and North Pacific basins), a few mineral-rich regions, and vast impoverished areas, riven from the core by mountains and deserts, and systematically lacerated by malaria, floods and famines. Any imperial power would establish its 'limes' just outside that latter, that is, what we want to call the sub-periphery. This is the outcome we get in Figure 14. Here the periphery is just a very sparsely population, technologically underdeveloped area, located in the northern fringes of the space. The states in the core end up not expanding there, even after we run the simulation for 5,000 years or time units.

CONCLUSIONS

This paper offers a simple model to account for the variation in territorial size and hence total number of states over time. States, that is, organizations that have the stable monopoly of violence

over a given territory and population, decide over their optimal geographical area to maximize the welfare of their rulers. That decision is constrained by the costs involved in securing the control over that territory. After developing the model, the paper uses an agent-based simulation to probe its insights.

The main insights of the paper are as follows:

1. The size of states increases (and their number decreases) as war technologies become capital-intensive. This explains the fundamental downward trend in numbers that we have witnessed from the emergence of states until our times.

2. In addition to war technology, wealth is also a central factor driving state formation and expansion. In scarcely populated, technologically underdeveloped areas the number of states remains high. Rulers have little incentive to expand and unification does not happen.

3. To explain variance in state size we need to consider the type of wealth of each country. Countries are smaller (larger) in capital-rich (capital-poor) economies. Rulers take into account the type of assets they may acquire. If wealth is difficult to tax, either because the state apparatus is inefficient or because its owners can hide it or move it abroad, then the incentive to conquer is much lower. As a result, war is less frequent and fragmentation much more common. To put it more broadly, bourgeois economies are more peaceful than land-based, mineral-based economies.

4. Relatedly, world government may become possible in the future (given the evolution of military technology) yet only with a very low probability (given the distribution of economic activities throughout the globe).

These stylized findings fit well the historical evolution of Europe and most of the territorial dynamics of state formation over time, at least until the 19th century.

In general terms, our paper represents a step toward developing a more sophisticated theory of international politics in two ways. First, it calls for endogenizing the number of states that operate in the international system. So far, most international relations theorists take the number of states or

the so-called structure of the state system as given. They then make predictions about the behavior of states depending on the environment (unipolar, bipolar, etc.) they live in. We instead reflect on the ways in which the very anarchical environment in which they interact shapes the number and strength of the actors. This line of research follows previous work, by Gilpin, Cederman, Tilly and Alesina, interested in thinking about the causes of state size and formation. Still, we offer what we think is a broader framework in which war acts as the main (although not exclusive) cause of state formation and in which more realistic assumptions about state behavior (than what previous analytical models use) are combined with methodologically powerful tools to investigate shifts in the structure of state systems (and in the relative frequency of wars).

Second, we pay attention to the domestic conditions (demographic and economic) that motivate state behavior. These “second image” turn has important implications. It allows us to explain, in a systematic manner, certain systemic patterns that remain unaccounted for in traditional international theory, such as the presence of geographical clusters of peace-keeping nations or the fact that war and constant expansion does not exist in some areas (for example, along the US-Canada border). Using wealth maximization as the general goal of states allows us to still keep survival and security as central components directing state action. But the level of security threats (and the corresponding foreign strategy of states) becomes conditional on the behavior and incentives of surrounding states. If all states in a given region maximize wealth through non-aggressive mechanisms, peace and border stability may become possible. (In the simulation we tentatively characterize wealth-maximizing states that do not choose expansion through the parameter of high capital mobility.) States are not less directed by self-interest in that case. Their goals are simply different than pure expansion through war and, given how others behave, they can pursue their most preferred pattern of action in an unconstrained manner. Naturally, whenever their neighbors act aggressively, war becomes unavoidable and borders and states change as a consequence. All these different, conditional or strategic, types of behavior can be encompassed in the model we have

written and are captured by the simulations we have run. The general product consists of a much richer set of outcomes, closer to how the real world looks like.

This paper is still work in progress. For the sake of simplicity and given the technical difficulties of implementing the agent-based model, we have not considered some central traits of state behavior. We plan, however, to include them in our model. First, we will examine how different types of government, either democracy or autocracy, may affect the likelihood of any state to expand or not. Second, we will include a set of rules according to which states can form alliances against aggressors. Third, we plan to model the possibility of self-determination or secession among regions. Finally, we will consider the ways in which trade flows or potential trade flows may affect the size of states.

APPENDIX

In the model, the parameters (that can be specified individually for each country) are: initial population density; rate of population increase; tax rate (from 0 to 1); a parameter indicating which percentage of error one country can incur when evaluating if it is convenient to attack another country; technology; and mobility (measuring how much of one country's belongings are transferred to another country in case the first one is attacked and defeated).

Initial moment

Given a certain initial density and the type of territory (plain, hill, mountain), the initial population is calculated as:

Population_t = (density * number of plain cells) + (density * number of hilly cells * 0.75) + (density * number of mountainous cells * 0.25).

In turn, savings of each state are calculated as:

Savings_t = (population * technology * taxation).

Evolution of parameters

At each step, data is updated following the function:

1/ Population_{t+1} = Population_t * (1 + (Population increase /1,000)) -- in peace times. (Population increase is set by the simulator).

2/ Military Costs = K + m * D^S; where K is a fixed cost, m is a multiplier, D is the distance from the region to the capital. S approximates a function that modifies the cost of distance. The total military cost is computed by adding the military costs for each of its regions m * D^S.

3/ Income_{t+1} = Population_t * Technology * Taxation

4/ Net Revenues_{t+1} = Income_{t+1} - Military costs_{t+1}

5/ Savings_{t+1} = Savings_t + Net Revenues_t

Decision to attack

A country evaluates the possibility to attack a neighbor randomly, every about 10 steps, unless there are already two ongoing attacks.

In this environment, any country A decides to attack D if the following conditions take place: (1) D is A's neighbor; (2) Savings of A > perturbation * Savings of D, the "perturbation" parameter equals 1 ± intelligence (as set by simulator, to capture uncertainty in information)

The attack lasts a random number of steps (between 10 and 30 steps).

End of war

Both countries involved suffer a loss of 10% of population and accumulated wealth.

At the end, if the attacking country has mistakenly evaluated the strength of its victim, the roles are reversed.

If the strength of the two countries differs by less than 5% nothing happens. If the difference is between 5% and 20%, the winner conquers a portion of the loser's regions. If the difference is larger than 20% or if the partial annexation involves the loser's capital, the winner absorbs completely the loser's region.

Depending on the mobility parameter, a fraction of the loser's accumulated wealth is transferred to the winner or it is lost.

BIBLIOGRAPHY

- Alesina, Alberto. 2002. "The Size of Countries: Does It Matter?" Harvard University. Unpublished manuscript.
- Alesina, Alberto, Enrico Spolaore and Romain Wacziarg. 2000. Economic Integration and Political Disintegration, *American Economic Review* 90 (December): 1276-96.
- Alesina, Alberto and Enrico Spolaore. 1997. On the Number and Size of Nations, *Quarterly Journal of Economics* 112 (November): 1027-56.
- Axelrod, R. 1984. *The Evolution of Cooperation*. New York: Basic Books.
- Benson, O. 1961. "A Simple Diplomatic Game." In J. N. Rosenau, ed. *International Politics and Foreign Policy: A Reader in Research and Theory*. Glencoe, IL: Free Press.
- Bremer, S. A. and M. Mihalka. 1977. "Machievelli in Machina: Or Politics Among Hexagons". In K.W. Deutsch, B. Fritsch, H. Jaquaribe and A. S. Markovits, eds. *Problems in World Modeling: Political and Social Implications*. Cambridge: Ballinger.
- Boix, Carles. 2003. *Democracy and Redistribution*. New York: Cambridge University Press.
- Bolton, Patrick and Gerard Roland. 1997. "The Breakup of Nations: A Political Economy Analysis," *Quarterly Journal of Economics* 112 (November): 1057-90.
- Cederman, Lars-Erik. 1997. *Emergent Actors in World Politics: How States and Nations Develop and Dissolve*. Princeton, NJ: Princeton University Press.
- Cederman, Lars-Erik. 2003. "Modeling the Size of Wars: From Billiard Balls to Sandpiles," *American Political Science Review* 97 (February): 135-150.
- Cusack, Thomas R. and R. J. Stoll. 1990. *Exploring Realpolitik: Probing International Relations Theory with Computer Simulation*. Boulder, Co.: Lynne Reiner.
- Gilpin, Robert. 1981. *War and Change in World Politics*. Cambridge: Cambridge University Press.
- Hintze, Otto. 1975. *The Historical Essays of Otto Hintze*. Edited by Felix Gilbert, with the assistance of Robert M. Berdahl. New York: Oxford University Press.
- Johnson, Paul E. 1999. "Simulation Modeling in Political Science," *American Behavioral Scientist* 42 (August): 1509-30.
- Mearsheimer, John J. 2001. *The Tragedy of Great Power Politics*. New York: Norton.
- Pepinsky, Thomas B. 2005. "From Agents to Outcomes: Simulation in International Relations," *European Journal of International Relations* 11 (3): 367-394.

Rosato, Sebastian. 2006. "The Strategic Logic of European Integration." Unpublished manuscript. The University of Chicago.

Spruyt, Hendrik. 1994. *The Sovereign State and Its Competitors*. Princeton: Princeton University Press.

Spruyt, Hendrik. 2007. "War, Trade, and State Formation." In Carles Boix and Susan Stokes, eds. *Oxford Handbook of Comparative Politics*. New York: Oxford University Press. Forthcoming.

Tilly, Charles, ed. 1975. *The Formation of National States in Western Europe*. Princeton: Princeton University Press.

Tilly, Charles. 1990. *Coercion, Capital, and European States, AD 990-1990*. Cambridge, Mass.: Blackwell. 1990.

TABLE 1. APPROXIMATE NUMBER OF INDEPENDENT POLITICAL UNITS IN SEVERAL EUROPEAN AREAS, 1000-1870

	France	Iberian Peninsula	Italy	Britain
Year				
1000	>10	about 13	>20	3
1300	>10	6		3
1400	>10	5		2
1500	5-10	3	17	2
1600	5-10	1		2
1700	about 5	2	about 12	1
1815	1	2	9	1
1870	1	2	1	1

Figure 1. Evolution of Size of Country, 1815-1998

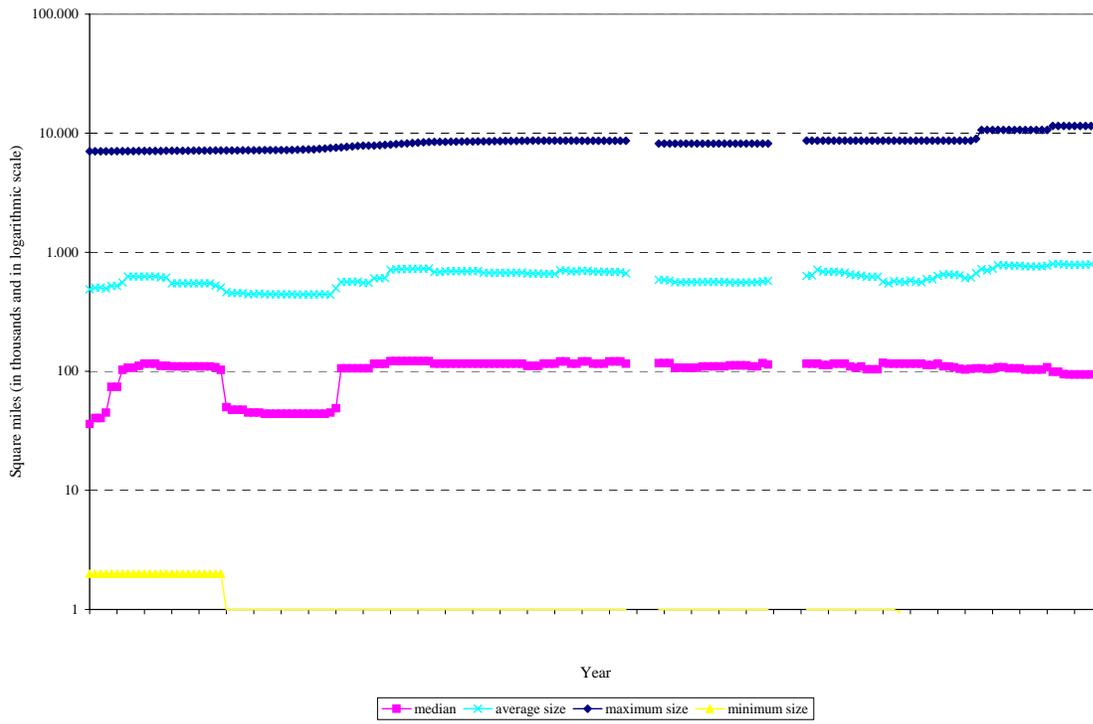


Figure 2. State Territory and Total Cost Schedule

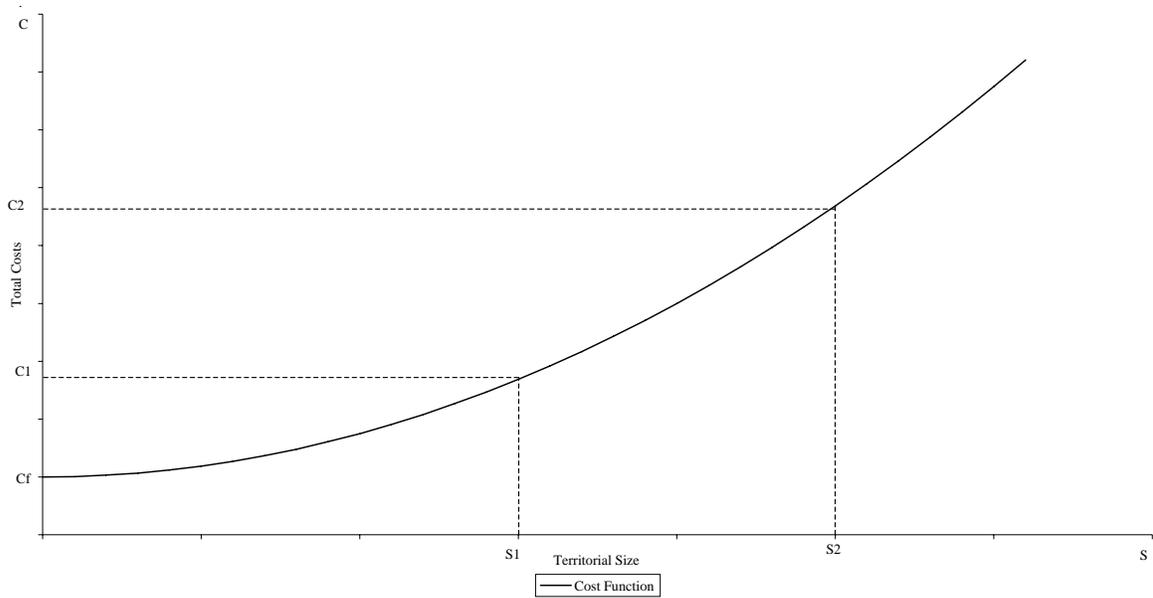


Figure 3. State Territory and Total Revenue Schedule

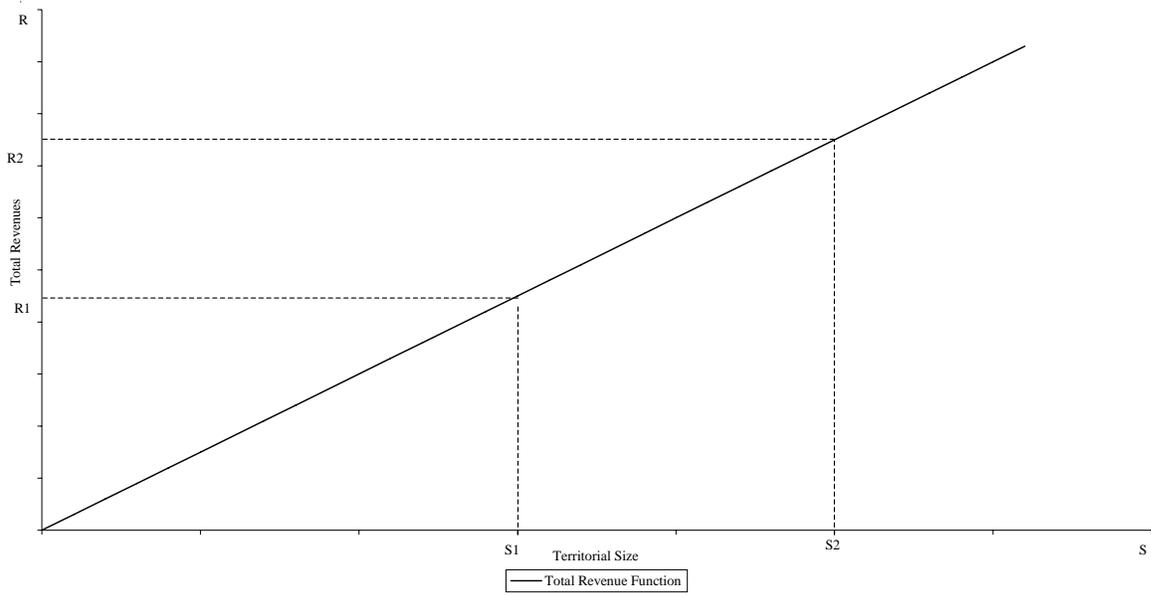


Figure 4. Size of the State

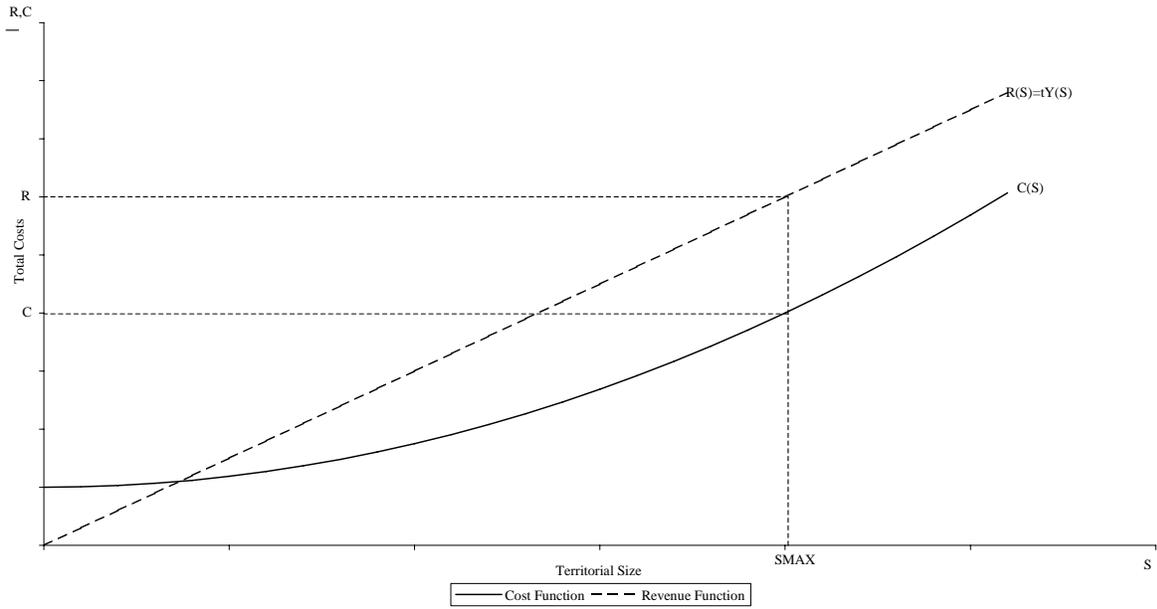


Figure 5. A. Shift in Fixed Costs

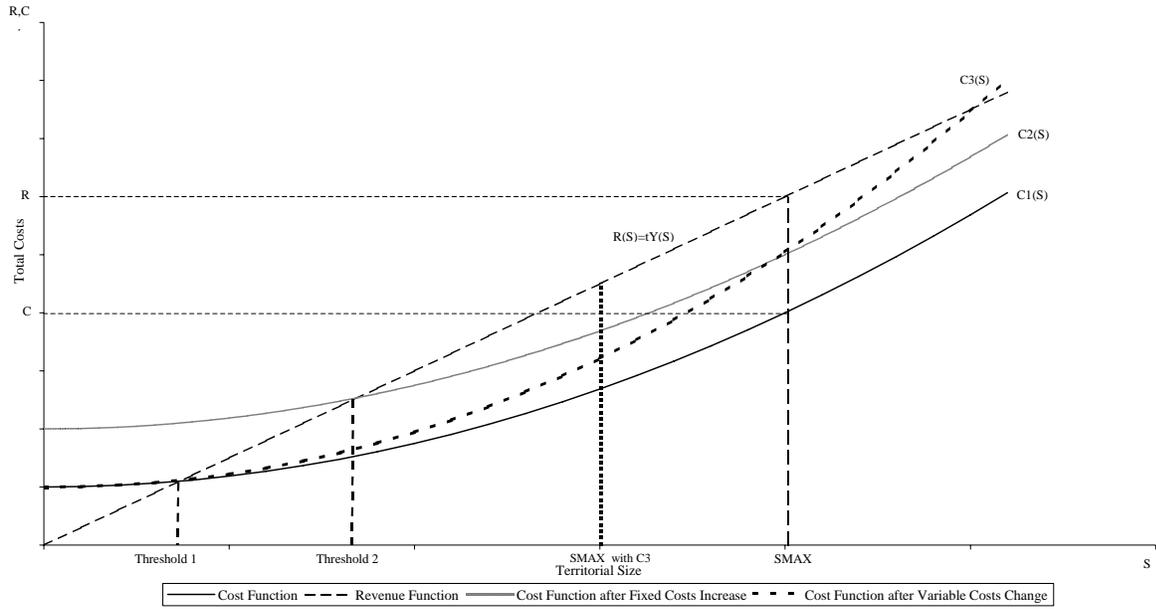


Figure 6. Number of States for Low Fixed Costs (k) and Different Levels of Variable Costs (s)

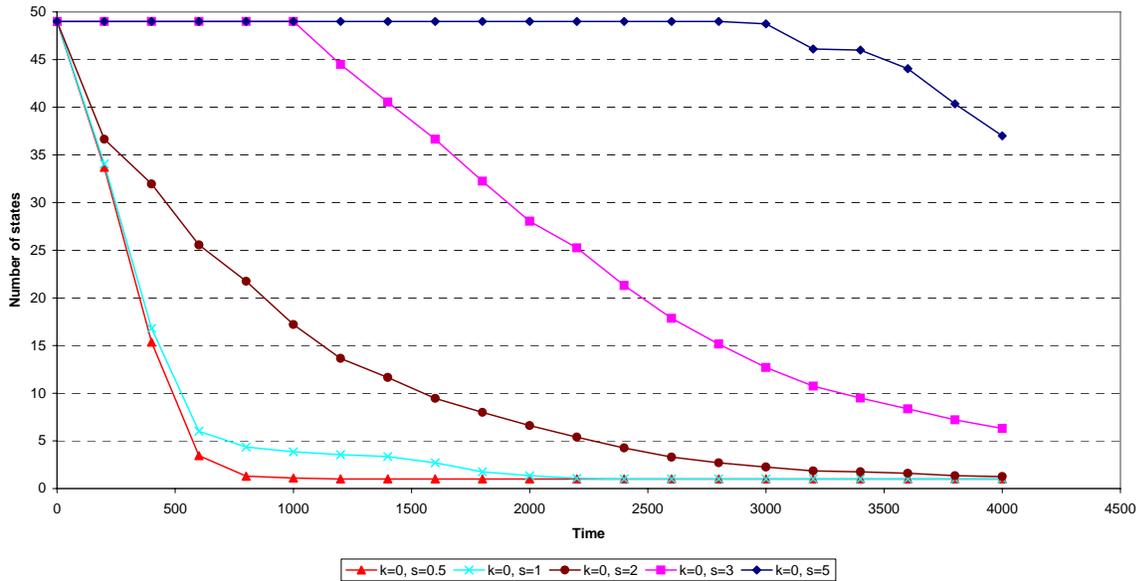


Figure 7. Number of States for High Fixed Costs (k) and Different Levels of Variable Costs (s)

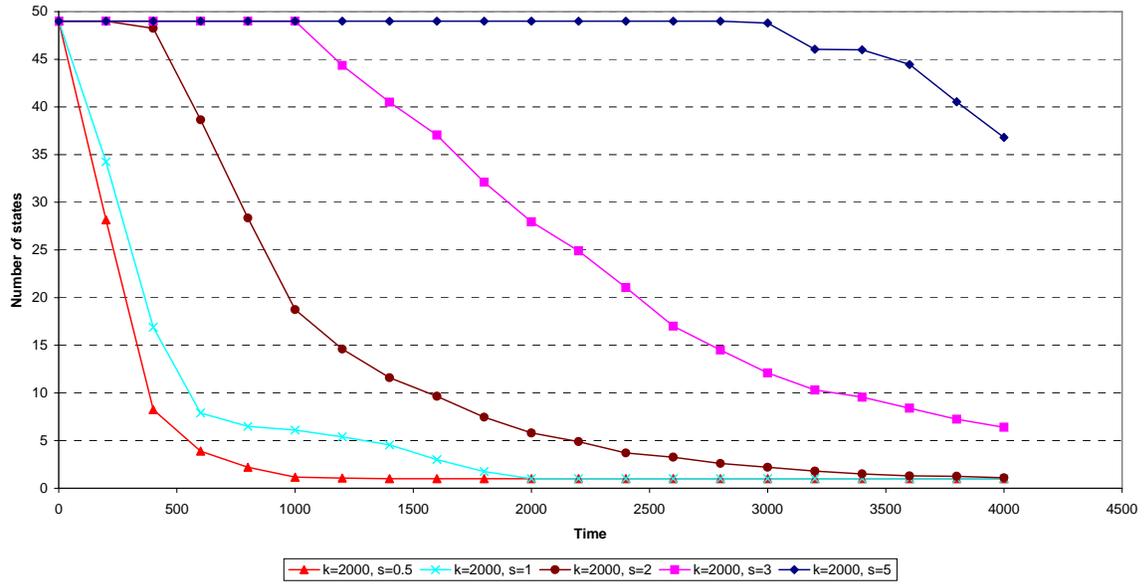


Figure 8. Shift in Output

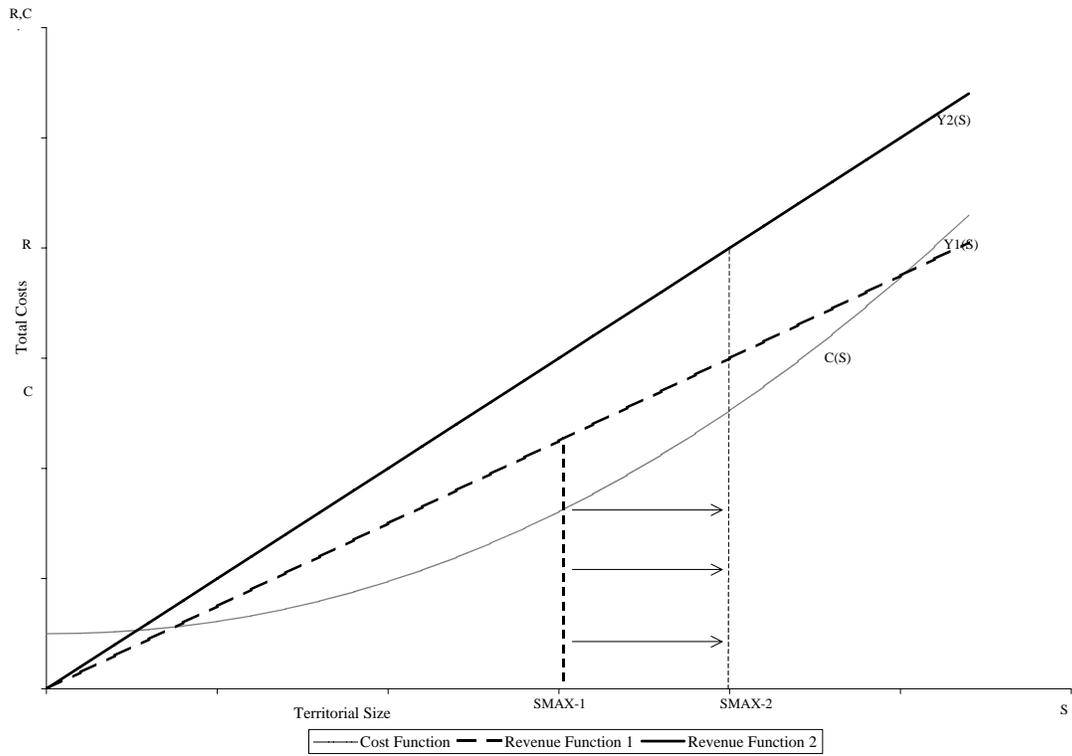


Figure 9. Number of States with Varying Population

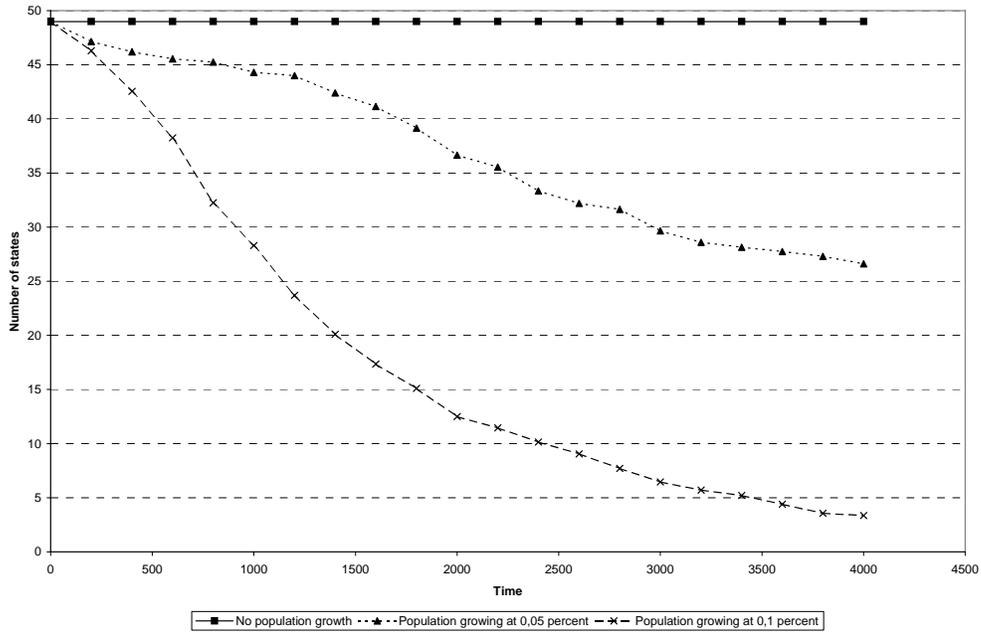


Figure 10. Number of States with Different Levels of Economic Technology

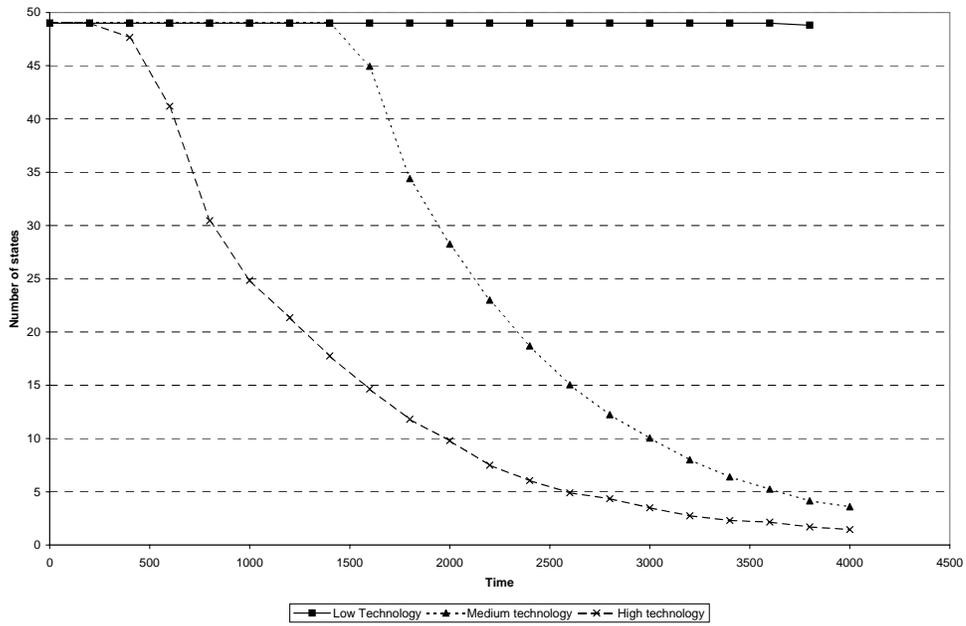


Figure 11. Number of States with Different Tax Rates

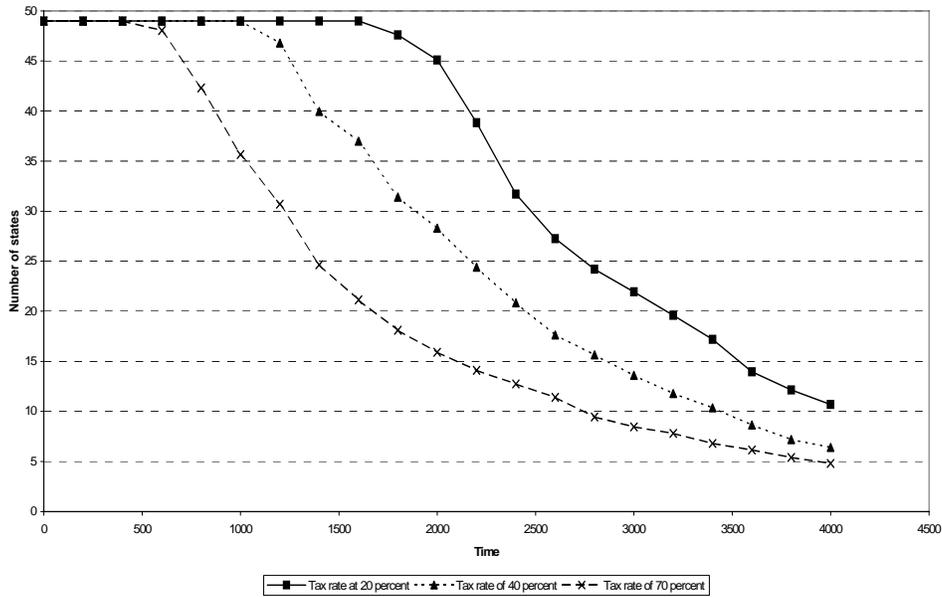


Figure 12. Number of States with Different Levels of Capital Mobility (Tax rate of 25 percent)

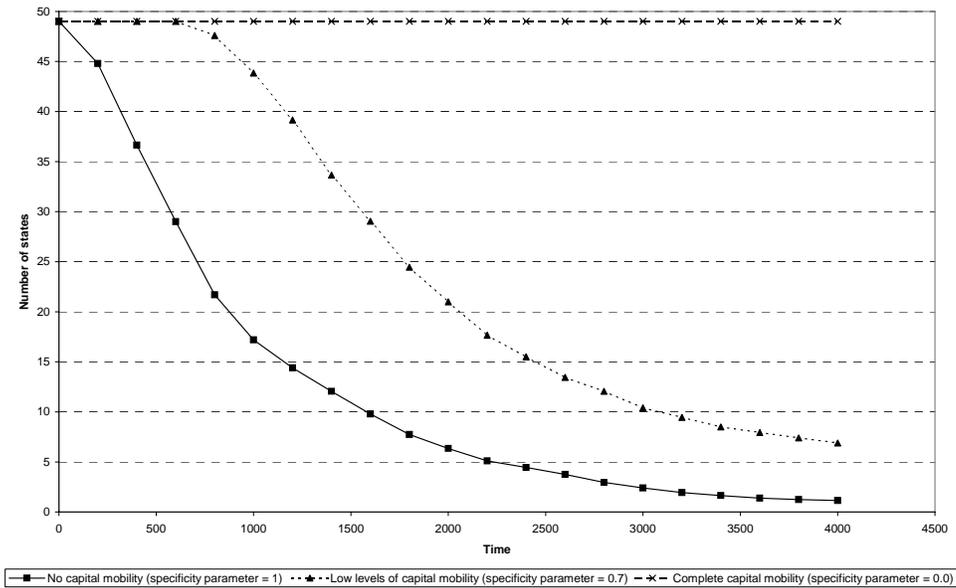


Figure 13. A. Simulated world with core and periphery

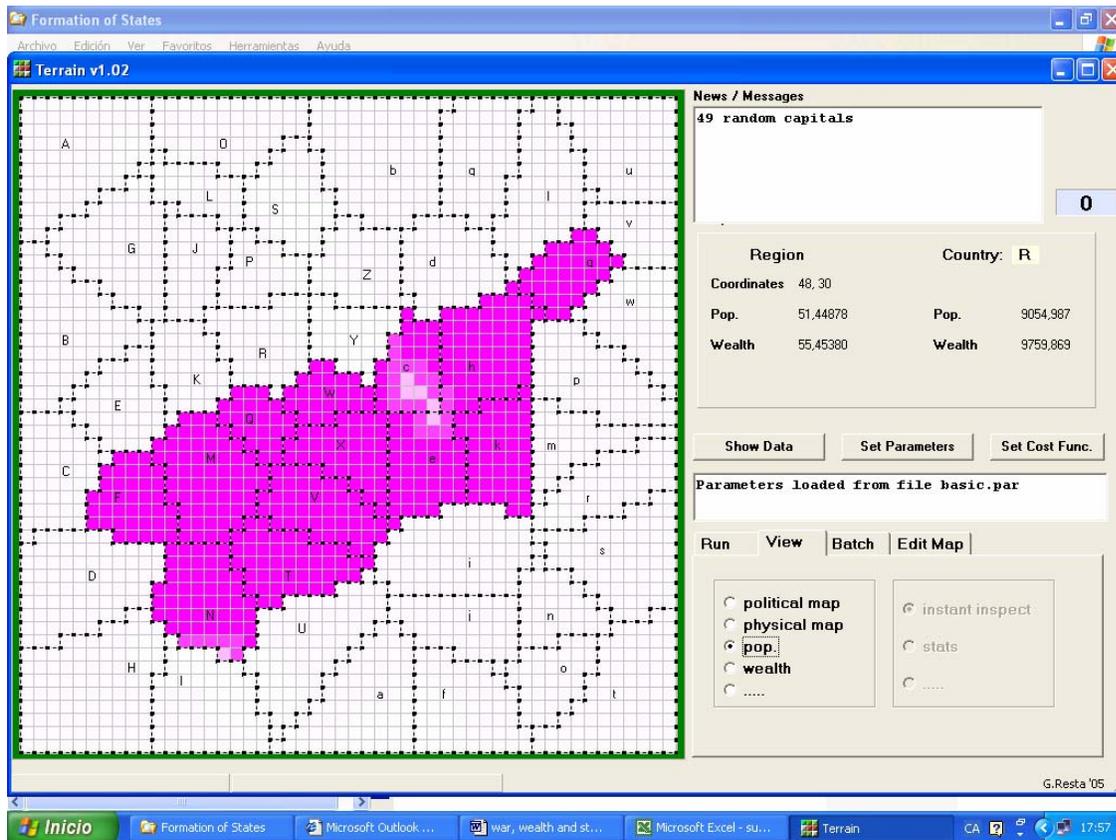


Figure 13.B. Complete capital mobility in the core

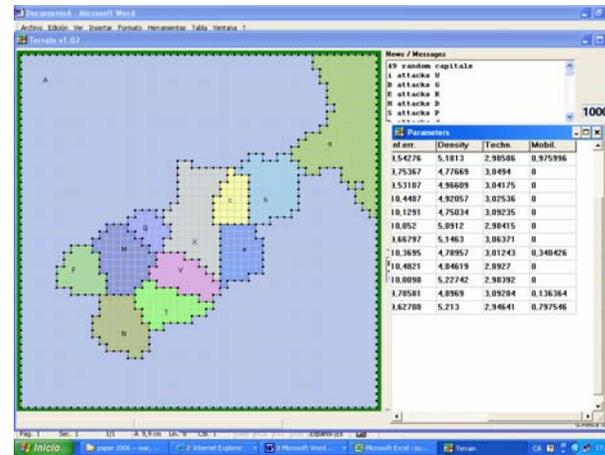
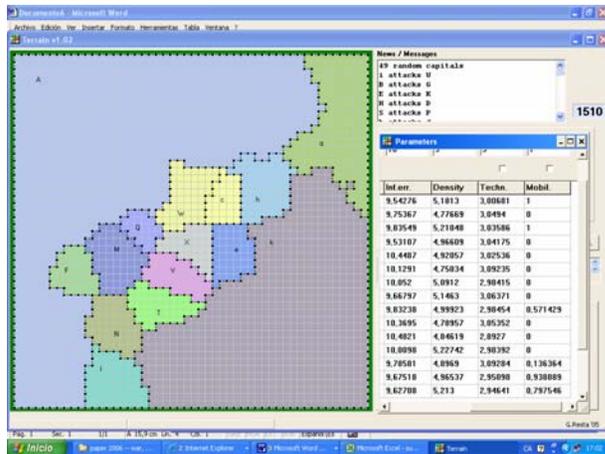
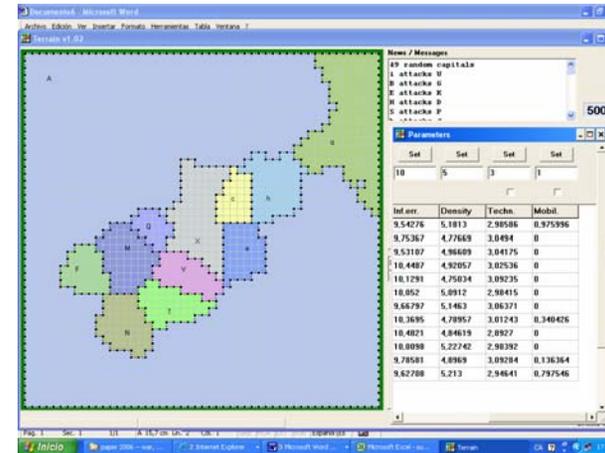
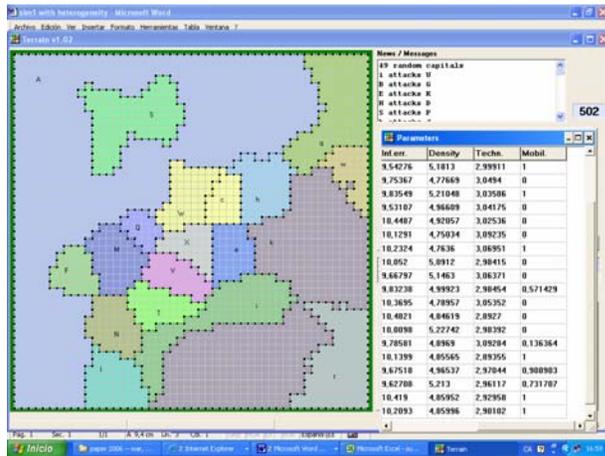


Figure 13.C. Medium heterogeneity in the core

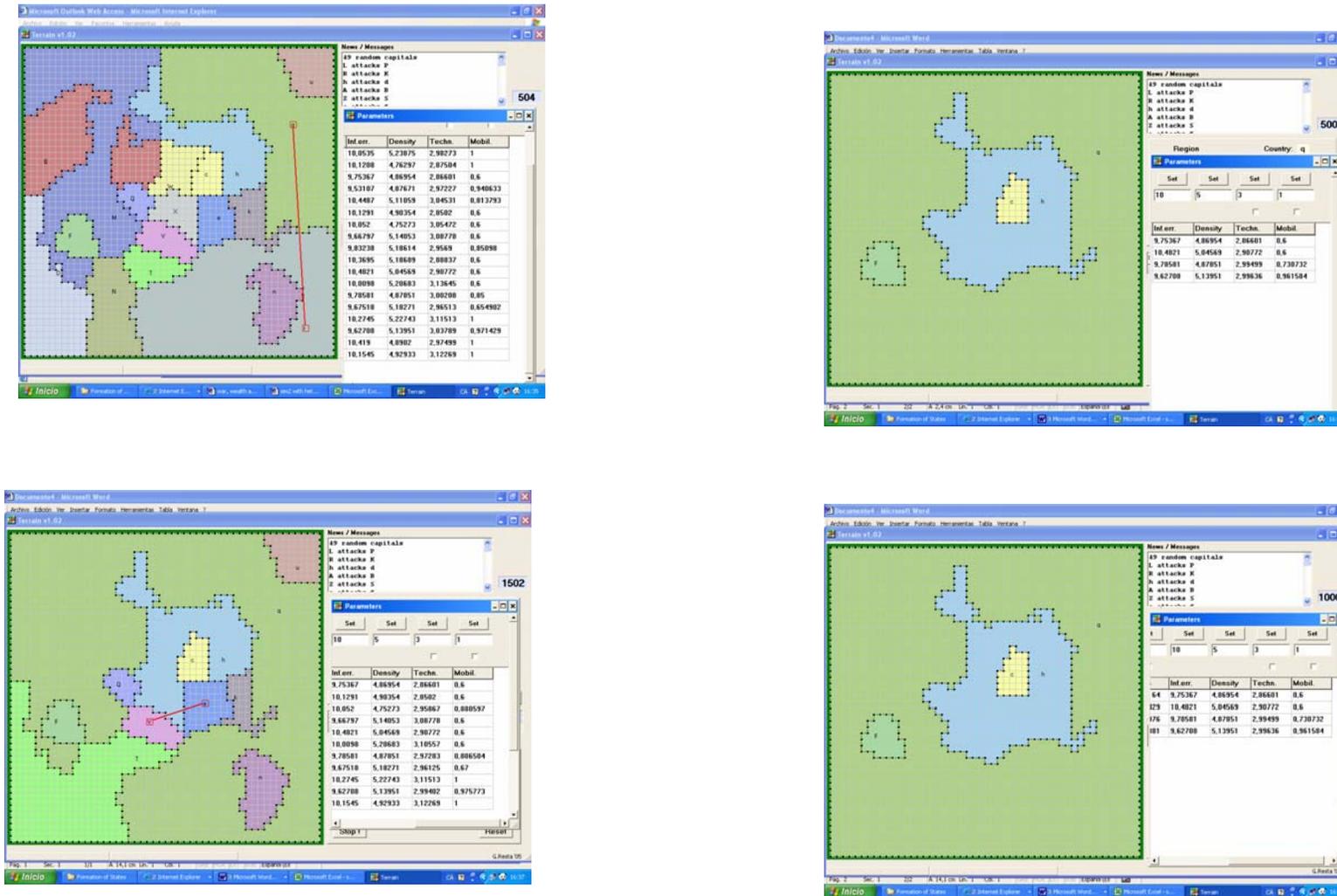


Figure 13.D. No capital mobility

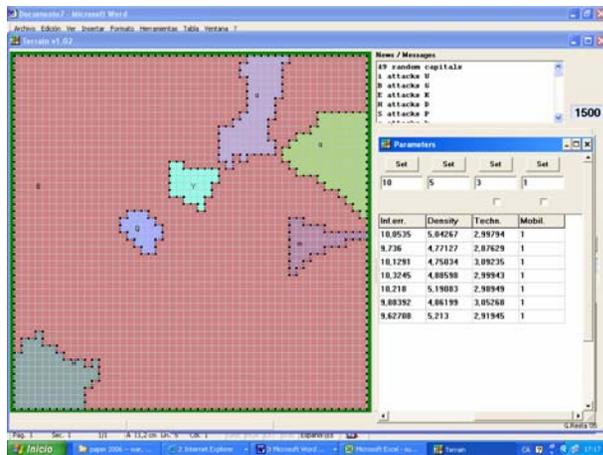
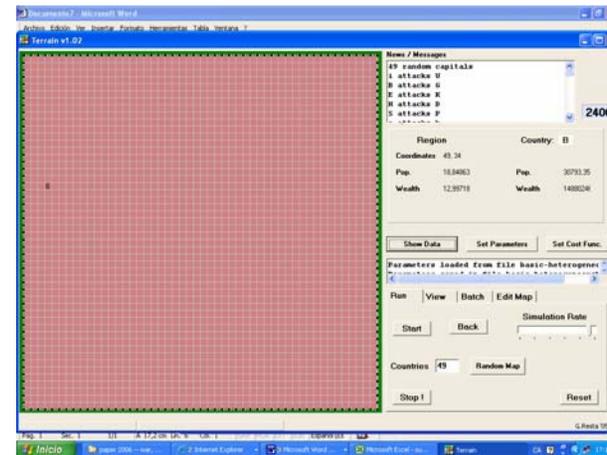
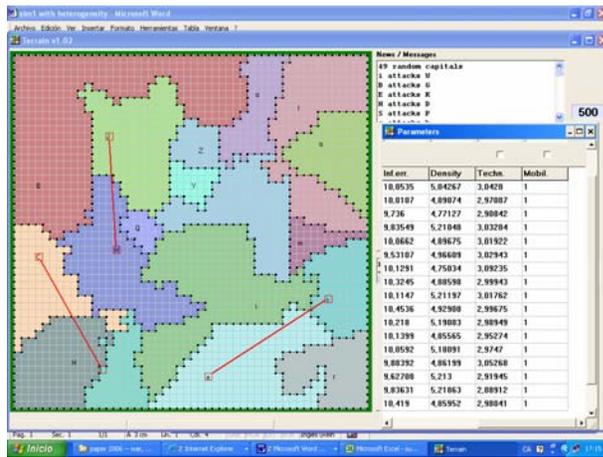
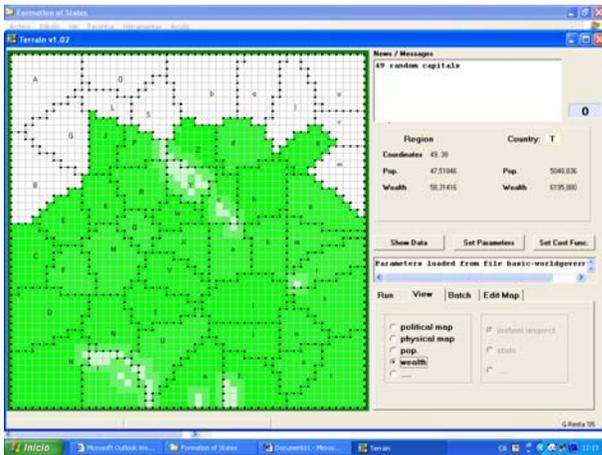


Figure 14. World Government and Periphery.



Countries in blank have sparse population and low technology.

