

# How many subdivisions?\*

MAXIMILIAN AUFFHAMMER

*University of California, Berkeley*

RICHARD T. CARSON

*University of California, San Diego*

Draft: August 22<sup>nd</sup> 2003

## Abstract

This paper studies what factors determine the number of first order administrative subdivisions across 179 countries. In the paper we estimate the impact of population heterogeneity and cost of local public goods provisions on the number of subdivisions of a country. Estimation results from a Zero Inflated Poisson model suggest that measures of religious and lingual heterogeneity as well as physical characteristics of countries have a statistically significant impact on the number of subdivisions. Economic factors do not seem to matter statistically.

## 1 Introduction

There are dozens if not hundreds of papers using countries' first order political subdivisions as the unit of observation. Recently, the macroeconomic growth literature on convergence of per capita incomes has spurred interest in the behavior of sub-national economies and political subdivisions. Economists typically treat the exogeneity of a country's primary subdivisions as an unquestioned assumption, which raises the question of whether the number and size of these divisions is indeed exogenously determined. The empirical literature on how these political subdivisions form is small and mostly concerned with historical occurrences. In this paper we estimate an empirical model explaining differences in the number of political subdivisions across countries.

---

\*Rough Draft: Do not cite without the authors' permission. Send correspondences to Maximilian Auffhammer, Department of Agricultural and Resource Economics, 207 Giannini Hall, University of California, Berkeley, CA 94720-3310, USA, Phone: (510) 643-5472, Fax: (510) 643-8911, E-Mail: auffham@are.berkeley.edu. Without implicating them, we thank Roger Gordon, Barry Naughton, James Rauch and Jeffrey Vincent for many helpful comments. All remaining errors are the authors'.

The quest to exert control over territory has always been a central human characteristic. Land and some form of command over it have been necessary for survival, and thus territorial conflict has been a persistent feature throughout history. To counteract this threat, countries compete for power over certain areas, which provide different bundles of natural, or human resources, desirable boundaries, or an improved communication structure. In the shires of feudal Europe, as in present times, countries waged war for these territorial bundles, since maintaining satisfactory resource levels was integral to sustaining territorial borders. In order to efficiently govern larger empires, the land area was broken up into smaller subdivisions (shires, states, cantons, etc.). The governmental units in these small areas could more efficiently collect taxes, supervise agricultural production as well as (in later days) provide government services such as education, health care and other benefits. Historically, the manipulation of state boundaries to influence the outcome of security matters was largely centered on controlling land, people, and resources within those very limits.

Economists have recently become interested in the what the optimal size and number of countries are. Alesina & Spolaore (2003) provide an excellent and comprehensive treatment of this literature. The current state of theoretical and empirical research on the optimal number and size of countries follows Alesina & Spolaore (1997), who provide a political economy model looking at the tradeoff between heterogeneity of groups and the cost of providing public goods in determining the optimal size of countries. Their theoretical model implies that there are heterogeneity costs to individuals sharing the same public good. Thus the more heterogenous the overall population the greater the number of implied jurisdictions. Alesina & Spolaore (2003) show that in a world of no transactions costs and economies of scale, there would be a "maze" of overlapping jurisdictions, each providing a specific public good. They argue that political subdivisions result from a tradeoff between the overlapping jurisdictions model and the centralized "one government does it all" model. The tradeoff between the cost of public goods provision and population heterogeneity allows for the determination of an optimal size of a country.

There is a fairly extensive literature on the efficient provision of local public goods, largely following the classic work by Tiebout (1956). Most of these studies assume that the number of subdivisions in a country is fixed and that individuals migrate across borders to self select into a jurisdiction with the desired combination of local public goods and tax structure.

The relevant empirical literature dealing with subdivisions at the highest level of aggregation deals with the observed size of countries, such as Alesina & Wacziarg (1997). In the industrial organization literature, there is a number of papers dealing with the optimal number and size of firms in a market based on classic papers by Coase (1937) and Lucas (1978). The recent focus in this literature has been on deviations from the optimal number of firms in a market power context (Berry &

Waldfoegel, 1999). At a lower level of aggregation, there are a few papers looking at the number of plants for a multiplant firm (*e.g.*, Chambers (1998)). In the public finance literature Alesina, Hoxby & Baqir (2000) provide the first application of the Alesina & Wacziarg (1997) model to a subnational level of jurisdiction. They extend the basic model by including economies of scale in the provision of a local public good. The empirical section of their paper shows a significant tradeoff between these economies of scale and racial heterogeneity in the determination of the number of school districts across US counties. In the paper the authors argue that this model can be applied to determine the number of subnational jurisdictions, such as states, counties and, as in their case, school district. Alesina, Baqir & Easterly (1999) provide a paper looking at the provision of local public goods within cities and again find significant evidence of the tradeoff between heterogeneity of the population and cost of public goods provision.

In summary, these papers address the number of subdivisions at the largest (countries and firms) and the smallest (school districts, cities and plants) of aggregation. The current paper provides the first empirical study of the "missing middle", namely the optimal number of first order political subdivisions across countries. The firm equivalent level of aggregation would be dividing firms into divisions, supervising production at groups of plants.

In the developed and developing world one can observe that different levels of government provide different sets of public goods. In the United States for example, the legal system and national defense are provided by the central government, while the prison system and secondary education are largely provided by state governments. At an even lower level of aggregation, police protection and primary schooling are provided by counties. The empirical evidence suggesting strong evidence of a tradeoff between heterogeneity costs and costs of public goods provision largely stems from the smallest level of aggregation, namely schooling across counties (Alesina et al., 2000) and roads sewers and trash pickup for counties and cities (Alesina et al., 1999).

Casually observed spatial sorting along cultural, ethnic, religious and wealth lines is generally observed at the smallest level of aggregation, namely neighborhoods of cities or counties of states. People often migrate within cities to send their children to a better school district, without changing many other aspects of their lives such as their job and social environment. This sorting is much closer to behavior suggested by Tiebout (1956) than what is observed across states. Citizens at the margin may move to a state with a favorable tax structure or - as an extreme example - prison system. Changing states is much more likely to result in a drastic change in lifestyle, such as a new job and social environment compared to moving within a city. The state level of aggregation therefore provides an interesting level of aggregation to test the Alesina & Spolaore (2003) model.

In this paper we attempt to add to the empirical literature by explaining the

variability in the number of political subdivisions across countries. We use the model of decentralized public good provision by Alesina & Spolaore (2003) as a basis for testing whether the tradeoff between heterogeneity in preferences and economies of scale in local public good provision explains variability in the observed number of such divisions. The next chapter provides the stylized theoretical model and a discussion of its applicability and testable hypotheses in this context. The following section addresses estimation issues and results from the count data estimation. Section 4 provides some concluding remarks and extensions for future research.

## 2 Model

Below we provide a stylized version of the model by Alesina & Spolaore (2003) and an outline of its features.<sup>1</sup> Let a country's population be uniformly distributed along a line normalized to length 1. There are two types of public goods in this model, type *A* and type *B*. Each individual has the following utility function, which is linear in consumption:

$$U_i = y - t_i - a_A l_{Ai} - a_B l_{Bi} \quad (1)$$

where  $a_A > 0$  and  $a_B > 0$ .  $l_{Ai}$  is the distance of individual  $i$  from public good *A* and  $l_{Bi}$  is the distance of individual  $i$  from public good *B*.  $y$  is exogenously given income and  $t_i$  is the tax individual  $i$  pays to the government for providing the public goods. The parameter  $a$  determines how quickly utility from consuming the public good decreases with distance from it. Thus an individual's utility is decreasing in the distance from the public good and linearly increasing in consumption.

In this paper we are interested into how many first order political subdivision a country chooses to divide itself. A first order subdivision by our definition is the first spatial level of government below the central authorities. For many countries different layers of government provide different sets of public goods. Legal systems and national defense are often provided at a central level of government, whereas police protection, prison systems and education are often delegated to the first order subdivisions. Providing such public goods is costly. The cost of providing public good *A*,  $k_A$ , is given by

$$k_A = \theta_A + \gamma_A S \quad (2)$$

where  $S$  is the size of the population within a particular subdivision. The cost of public good provision for public good *B* is therefore defined by

$$k_B = \theta_B + \gamma_B S \quad (3)$$

---

<sup>1</sup>For a much more detailed discussion of this model of decentralization, please refer to chapter 9 in Alesina & Spolaore (2003). We restrict our analysis to two public goods, resulting in two layers of government. One can extend the analysis to more public goods, but since we only observe the first layer of political subdivisions of countries, we only consider public goods *A* and *B*.

$\theta_{A[B]}$  is the fixed cost component of providing public good  $A[B]$ . Total variable costs are increasing in the size of population the each government has to provide the local public good to. Average costs of public good provision are therefore decreasing everywhere. The jurisdiction providing public good  $A$  to  $S$  individuals has to satisfy the following budget constraint:

$$\int_{i=1}^S t_i di = \theta_A + \gamma_A S. \quad (4)$$

The budget constraint for jurisdictions providing public good  $B$  is analogous.

A social planner is maximizing the sum of all individuals' utilities subject to the budget constraints given by equation 4. If public goods  $A$  and  $B$  can be provided separately by two separate governments with uniquely defined borders, the optimal number of jurisdictions providing the public goods  $A$  and  $B$ ,  $N_A$  and  $N_B$ , would be given by the integers closest to:

$$\begin{aligned} N_A &= \sqrt{\frac{a_A}{4\theta_A}} \\ N_B &= \sqrt{\frac{a_B}{4\theta_B}} \end{aligned} \quad (5)$$

Note that this does *not* imply a hierarchical structure of public goods provision, as we observe in the context of a federal government structure. In order to achieve a hierarchical structure of public goods provision, Alesina & Spolaore (2003) restrict citizens sharing the same public good  $B$  to also share the same public good  $A$  (the "essential good"), whilst not requiring the inverse. This restriction is quite intuitive. Two citizens of the same country can share the same national defense system, the level of which does not vary across the country. At the same time these two individuals do not have to share the same school system or level of police protection, which varies across geographic regions of a country.

Alesina & Spolaore (2003) show that if the ratio of heterogeneity costs to the fixed cost of public goods provision is greater for the essential good than for public good  $B$ , the optimal number of jurisdictions for good  $A$  and  $B$  are  $N_A^h = N_B^h = N_{AB}^h$  where  $N_{AB}^h$  is the closest integer to:

$$N_{AB}^h = \sqrt{\frac{a_A + a_B}{4(\theta_A + \theta_B)}} \quad (6)$$

Equation 6 implies that both public goods are provided by a central government. The number of subdivisions in this case will be smaller than  $N_A$  and larger than  $N_B$  in equation 5. This is a case where the very large heterogeneity costs of the essential good lead to centralized provision of all public goods. If however, the ratio of heterogeneity costs to the fixed cost of public goods provision is smaller for the essential good  $A$  than for good  $B$ , the optimal number of subdivisions in a world

of hierarchical public goods provision is given by equation 7 below subject to two constraints:<sup>2</sup>

$$\begin{aligned} N_A^h &= \sqrt{\frac{a_A}{4\theta_A}} \\ N_B^h &= \sqrt{\frac{a_B}{4\theta_B}} \end{aligned} \tag{7}$$

Keeping in mind the empirical application, this model has two main implications. The first being that first order political subdivisions will only arise if the heterogeneity costs of the essential good relative to the fixed cost of its provision are lower than the same ratio for public good  $B$ . An example of this could be a legal system provided centrally for an entire country, yet differential levels of police protection across states, satisfying the relatively high heterogeneity costs of law enforcement. It is easy to envision a third layer of subdivisions due to a public good with even higher heterogeneity costs, such as schooling. The number of first order subdivisions would not depend on the heterogeneity costs of schooling, giving rise to further subdivisions such as school districts.

This implies three types of countries. The first type is country with first order political subdivisions, providing one public good centrally ( $N_A^h = 1$ ) and another at a subnational level ( $N_B^h > 1$ ). The model above suggests a tradeoff in the number of first order subdivisions between increases in heterogeneity of a country's population and costs of the provision of public goods, which exhibit scale economies.

The second type is a country for which the heterogeneity costs of the essential good are too large and therefore it will choose to provide all of its public goods centrally. The third type is a country for which the predicted  $N_A^h = N_B^h = 1$  due to the parameters specific to the country. Both of these types would be countries for which the observed  $N_B^h$  would be one. Since the optimal number of subdivisions must be an integer greater than or equal to 1 for any given country, this brings up an interesting econometric issue, since there are two types of countries with no (or essentially one) first order subdivisions. These two types of countries are qualitatively different, but would be observed as countries with no first order subdivisions in the data. We address this estimation issue by using a zero inflated Poisson model in section 3, which allows for countries with essentially no first order subdivisions to be drawn from two different regimes, as is the case here.

The issue of how a country's size affects the number of subdivisions in this model is two-fold. The first measure of size, relates to how large a country's population is.<sup>3</sup>

---

<sup>2</sup>These two constraints essentially ensure that jurisdictions are not overlapping and that total costs of public goods provision are minimized by  $N_A^h$  and  $N_B^h$

<sup>3</sup>Since we normalize the country's size to be one for notational simplicity, population size does not enter the equations denoting the optimal number of subdivisions. It can be shown that similar to the model by Alesina et al. (2000) the number of subdivisions is linearly increasing in population size.

Alesina et al. (2000) find this effect to be significant and positive in the empirical application. Global population has more than doubled since 1950, while the area of inhabitable and arable land has remained roughly constant. There are no records suggesting that the total number of first order subdivisions has increased substantially over time, but anecdotal evidence suggests that some countries have added more political subdivisions due to population pressure. The Peoples' Republic of China in 1997 split the province of Sichuan into two political subdivisions (Sichuan and Chongqing). Sichuan at the time of the split was the most populous province in China and experiencing rapid population growth. Putting some political arguments aside, the split was mainly motivated by the rapid increases in population and fears of decreasing efficiency in governance of it. The Spearman correlation coefficient between population level and number of first order political subdivisions for our sample is 0.71 and highly significant.

A larger country by area increases the average distance between the individual and the public good, *ceteris paribus*.<sup>4</sup> Distance increases the cost of good provision. It is a fairly intuitive argument, to see that larger geographic areas will have more subdivisions. It is harder to provide a centralized public good, such as police protection or state courts, over a large area.

The model implies that the more heterogeneous the population of a country, the larger the optimal number of subdivisions. The empirical evidence presented by Alesina et al. (2000) supports this argument by showing that the number of school districts is increasing in the degree of heterogeneity of a county's population. This empirical finding may be dependent on the level of aggregation. As argued in the introduction, population heterogeneity may have an observable effect at the school district level. The argument here is that individuals choose to locate very closely to the most desired public good, without changing many other aspects of their life. This effect may decrease at a larger level of aggregation, such as states. Another argument is that people may have very well defined and heterogeneous preferences for goods provided at the local level such as schooling and police protection, but less heterogeneous preferences for goods provided at the state level such as prison systems or marginally different tax systems. If one combines those two arguments, one would observe a much stronger heterogeneity effect at the local level than at the state level.

On a country level one can envision heterogeneity increasing the number of subdivisions through two mechanisms. Heterogeneity in the context of this paper is defined by fractionalization in language as well as the degree of ethnic and religious heterogeneity of the population. Increased fractionalization could manifest a larger

---

<sup>4</sup>Due to the normalization, the distance between individuals does not enter the equations denoting the optimal number of subdivisions. It can be shown that similar to the model by Alesina et al. (2000) the number of subdivisions is increasing in the distance between individuals. Technically, distance between individuals is taken as a measure of heterogeneity and physical distance.

number of subdivisions through two mechanisms. Germany is an example of what the model by Alesina & Spolaore (2003) implies, since most of the catholic population is concentrated in the southern states, whereas the north is almost exclusively protestant. Switzerland, provides an example of a country where different languages coexist in three different spatial domains.<sup>5</sup>

Turkey is another example of heterogeneity increasing the number of subdivisions. It changed the number of subdivisions from 13 to 79 regions after World War II. This case is qualitatively different from Germany and Switzerland, since Turkey is home to a very active Kurdish minority. The heterogeneity may, however, in reality manifest itself in a threat of secession. Adopting a larger number of subdivisions, will enable local governments to provide a bundle of public goods better suited to the local population, therefore decreasing the probability of secession. Breaking up territory into smaller pieces will decrease the probability of a larger subdivision with a more desirable or larger set of potentially desirable characteristics to break away.

In the United States the issue of state size raised many questions at the American Constitutional Convention in 1787, moving many delegates to an uproar. The delegates debated at length the problems of state authority and state size in relation to the national government. James Madison, an opponent of the Federalist platform, remarked that the greater the size, the greater the 'variety of parties and interests'. Hence the probability of an abusive majority decreases. Texas, when it joined the union, preserved the right to split itself into four separate states.<sup>6</sup> In Puerto Rico, there is a well known movement to seek statehood of the United States.

Alesina et al. (2000) argue that groups of individuals with differing income levels will choose to live among each other. This is rational, since their tax payments are redistributed in the form of a public good. Therefore not the average level of income in a country, but the distribution of income should matter. Again, this could potentially take place at a lower level of aggregation, since taxes are collected at both a local and a state level. We will test whether this hypothesis does hold in the empirical section.

Higher fixed costs of providing a local public good, as reflected by a larger  $\theta$  increase the optimal number of subdivisions in a country.<sup>7</sup> In this model scale economies work through the size of a subdivision's population, with constant marginal costs, but decreasing average costs for each additional individual in a subdivision. The linearity of the cost function implies, however, that only the fixed cost component  $\theta$  impacts the optimal number of subdivisions. The fixed costs of providing

---

<sup>5</sup>The minority speaking *Romansch* is dispersed across a few regions, mainly in the German speaking part of Switzerland

<sup>6</sup>28th Congress of the United States, Session II, No. 8 Joint Resolution for Annexing Texas to the United States, 1 March A.D. 1845 (U.S. Statutes at Large, Vol. 5, p. 797)

<sup>7</sup>The model allows for no diseconomies of scale since the cost of providing the local public good is decreasing due to the specification in equation 4. A model with diseconomies of scale by allowing for convex costs of public good provision would be an interesting specification.

a bundle of government supplied public goods, keeping the empirical application in mind, is surely related to the physical characteristics of the geographic location. Following Alesina et al. (2000) we attempt to identify this impact by controlling for natural characteristics offsetting the fixed cost of local governments, which can be thought to be natural transportation infrastructure, such as waterways, coasts. A better natural transportation infrastructure may in the early days have offset the cost of tax collection, yet this effect certainly was minimal.

### 3 Empirical Model and Results

Due to data limitations the analysis in this paper is static, since we only have observations at one point in time. The number of political subdivisions is quite variable across countries. There is evidence of limited time series variation in the number of subdivisions as well. Even though for as long as most of us remember, there have been 50 United States, Alaska and Hawaii only became states fairly recently (1959). There are more examples of countries intentionally changing the number of subdivisions for a variety of reasons. We discussed the case of Turkey and the PRC. Other examples are New Zealand, Uganda, Algeria and most of the states of the former Soviet Union. Many countries observed today, are simply an agglomeration of previous countries or shires. Examples of this are Germany, Spain and up until the early 1990's the Soviet Union. If these "historical subdivisions" are optimal, we would observe them as the first order subdivisions. Some countries that arose from such agglomerations have decided to reassign their first order subdivisions by combining these historical shires or breaking them into smaller units. One example is Burgundy in France, which is a much smaller region than the count of Burgundy used to rule over.

We use the number of administrative regions as defined in the Central Intelligence Agency's World Fact Book (2000) as our measure of the number of political subdivisions.<sup>8</sup> The number of subdivisions ranges from 1 to 80.<sup>9</sup> The distribution of the number of political subdivisions across countries is given in Figure 1.

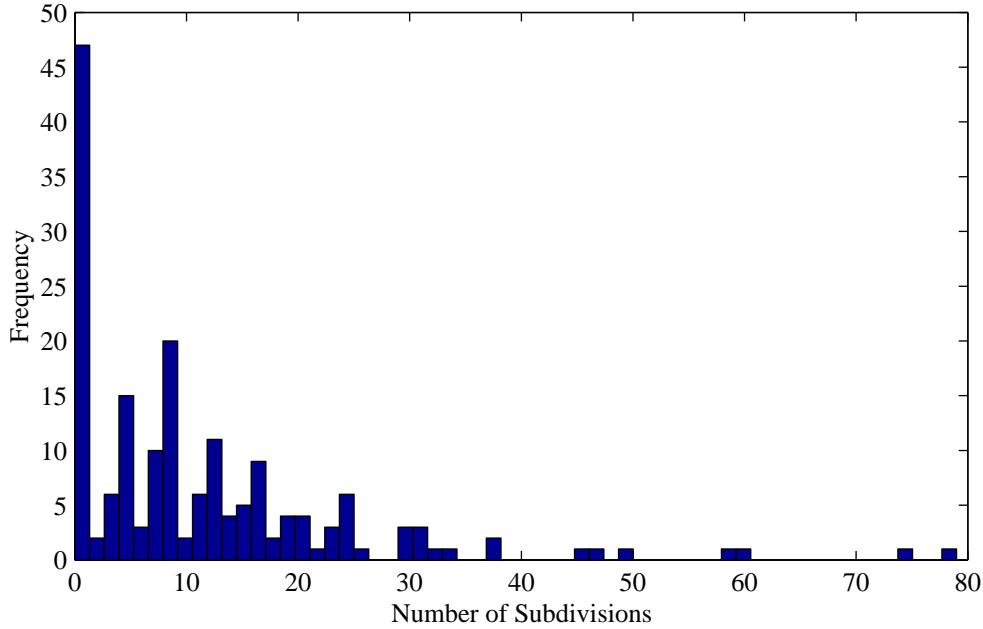
We will attempt to explain the variation in the number of first order subdivisions across countries by regressing this number onto variables reflecting the tradeoff between heterogeneity and cost. The variables reflecting heterogeneity include measures of land area and population heterogeneity. Following Alesina et al. (2000), the variables reflecting the cost of public goods provision mainly reflect physical char-

---

<sup>8</sup>We exclude municipalities and religious subdivisions, since they do not really reflect the notion of a 'political subdivision' in the sense of this paper. We inspected the World Fact Book and in the case of a conflict with our definition consulted the national statistical agencies. If there were conflicting reports we used the lower number of subdivisions. The criterion is the largest set of political jurisdictions with political power.

<sup>9</sup>A country with one subdivision would indicate that the country has no sub-national political structure or administrative regions.

Figure 1: Empirical Distribution of First Order Subdivisions



acteristics of the individual country. The size of population proxied for by using the level of population in 1990.

As measures of population heterogeneity we include measures of language, ethnic and religious diversity of a country as provided by Alesina, Devleeschauwer, East-erly, Kurlat & Wacziarg (2002).<sup>10</sup> These indexes of heterogeneity are calculated by subtracting the sum of squared shares of a certain group in the total population. *Ethnic [Religion, Language]*, is therefore one minus a Herfindahl index reflecting the degree of ethnic [religious, lingual] fractionalization in a country. The larger the index, the higher the degree of heterogeneity. According to the theory the number of subdivisions should increase with increasing diversity, according to the argument that alike individuals like to live in the same geographic region. As argued, this sorting effect could potentially take place on a more disaggregated level. Members of different ethnic [lingual, religious] groups tend to live in the same neighborhoods within cities. In the US for example, we do not experience a separation of ethnicity [language, religion] by state, yet we see a clear separation by neighborhoods. One only needs to stroll through the different neighborhoods of New York City and experience this sorting. If this is the case, we may not be able to detect the effect or get a very small effect. The same argument applies to the language variable.

<sup>10</sup>These measures of heterogeneity are an improvement over the ones provided by Parker (1997), who provides the percentage of the main language, religion and ethnicity in a country, which ignores the true degree of fractionalization.

The indicators of heterogeneity include the land area of a country in square kilometers. This reflects variability in the distance of the average citizen of a country from a centrally provided public good. We would expect a larger number of subdivisions for larger countries, in order to decrease that distance, which decreases individuals' utility in the model.

As proxies for fixed cost of public goods provision we follow Alesina et al. (2000) and include measures of the country's geographical features. This again, provides a testable hypothesis of the model. According to the theoretical model, smaller fixed costs of public goods provision would result in a larger number of subdivisions. Any features of a country facilitating public goods provision, such as better transportation infrastructure, would result in a smaller number of provinces. We include miles of coastline, an island dummy, miles of interior waterways and the number of natural harbors in the estimation. A larger number of these physical characteristics should result in countries with more subdivisions, since they provide a natural transportation infrastructure, which should result in lower fixed costs of public goods provision.

This argument, does however, ignore a "security" argument. Coastline, in the broadest terms, is a border without neighbors. If we look at countries like Austria, which borders seven countries, one would expect a large number of subdivisions along the border, in order to establish ownership of the land and its resources. Many small posts along a border also allow one to defend against invasions more easily. We also control for whether a country is landlocked or not. One would expect a landlocked country to have a larger number of subdivisions, since it will need to defend its people and resources from surrounding neighbors vying for its territory. The same holds for islands, since there are no directly adjacent neighbors, who would spill over into the nation's territory and take ownership of the resources in the border territories.

The number of large natural harbors should increase the number of provinces within a country. The notion here is that one would not want to grant one specific subdivision the benefit of multiple harbors. The access to a harbor has large implications on the ability of a province to conduct trade and to attract investment. This may be one reason why harbors are often located at the border between two subdivisions or very near that border. There are numerous examples of harbors, which are located at the borders of political subdivisions. The large natural harbors Boston, New York and Chesapeake Bay are all located near state borders. In Europe, Le Havre is located at the border between Haute-Normandie and Basse-Normandie. Rotterdam harbor is located at the junction of three political subdivisions. Locating harbors in this way decreases the incentives and ability for single subdivisions to secede from the country as well as maximize the benefits for the surrounding regions.

We further include one political variable, namely the concentration of the decision-

making authority. The larger the index the more power the subdivisions have in making their own political decisions. If subdivisions carry a large amount of decision making power, we argue that they are able to provide government services more efficiently, since they are 'closer to the customer'. This would reduce the need for more provinces, since a smaller number of provinces could provide the same level of services.

As the last class of physical characteristics we control for what continent the country is located on. In order to facilitate comparison, we omit the Europe dummy variable, since many of the non-European countries were colonized by European nations. The parameter estimates on the dummy variables therefore indicate whether there are structural differences in the number of provinces, relative to European countries.

The theoretical model argues that the level of income does not matter in the determination of the optimal number of subdivisions. We include per capita GDP in 1990 to test whether this point holds. Further, Alesina & Wacziarg (1997) provide convincing empirical evidence that the degree of trade openness is negatively correlated with country size due to its effective increase in market size. An argument could be made that a country with a larger market, which is achieved through larger openness to trade, would have more subdivisions, since the subnational economies are larger on average - *ceteris paribus*. The trade openness variable would be expected to carry a positive coefficient. We provide summary statistics of all variables used in estimation in Table 1.

As indicated in section 2, a country with no observed subdivisions could have the optimal number of subdivisions, meaning  $N_B^h = 1$ . The other group of countries, for which we observe no first order subdivisions, is one for which the heterogeneity costs for the essential good are very large.

The first regime where a country has no subdivisions is qualitatively different from the second regime. We define the number of subdivisions as the number of observed subdivisions minus one. A country with no first order subdivisions would therefore be observed as a zero in the data. A zero inflated Poisson model (Lambert, 1994) will allow us to control for the possibility that the zero observations may be what is first drawn from two regimes. As Alesina & Spolaore (2003) argue, really small countries are likely to be drawn from the second regime, since "small states often have exclusive control over the essential functions they would be better off sharing with their neighbors". They argue that small countries may have a desire to maintain full control over some essential functions with high heterogeneity costs. 71% of the zero observations come from countries that have a land area smaller than that of Massachusetts. 67% of the zero observations have a population less than one million people.

The second regime producing zero observations is the regular Poisson process, where  $N_A^h = N_B^h = 1$  according to equation 7. We let  $Regions_i = 0$  with probability

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max	Obs.
Regions	178.000	11.534	13.455	0.000	79
Population	31.860	121.447	0.007	1281.008	178
Area (km <sup>2</sup> )	0.752	2.224	0.000	21.978	178
locked	0.174	0.380	0.000	1.000	178
Island	0.230	0.422	0.000	1.000	178
Coastline	4.453	19.595	0.000	243.791	178
Harbors	6.073	5.904	0.000	49.000	178
Waterways	6.631	17.105	0.037	112.324	96
GDP (p.c.)	7.932	8.392	0.500	34.200	176
Gini Coef.	40.240	10.190	19.490	61.300	97
Open	70.630	39.505	7.458	221.662	147
Centralized	1.354	0.680	1.000	3.000	130
Religion	0.430	0.238	0.002	0.860	171
Language	0.395	0.290	0.002	0.923	162
Ethnic	0.448	0.265	0.000	0.930	164
Africa	0.309	0.463	0.000	1.000	178
Americas	0.219	0.415	0.000	1.000	178
Asia	0.213	0.411	0.000	1.000	178
Oceania	0.062	0.241	0.000	1.000	178

$\psi_i$  and let  $Regions_i$  be distributed as Poisson  $\lambda_i$  with probability  $(1 - \psi_i)$ . We define the Zero Inflated Poisson model as follows:

$$P[Regions_i = 0] = \psi_i + (1 - \psi_i)R_i(0) \quad (8)$$

$$P[Regions_i = j] = (1 - \psi_i)R_i(j) \quad (9)$$

where  $R_i(Regions = j) = \frac{e^{-\lambda_i} \cdot \lambda_i^j}{j!}$  and  $\lambda_i = e^{\beta' x_i}$ . We model the state probability to be distributed as  $\psi_i \sim \text{logistic}(\theta z_i)$ . The  $z_i$  here are variables, which determine the probability of a zero being drawn from the first regime. We estimate the probability of whether a count is zero via a logit procedure. The logit model uses the log of area and the log of population as independent variables. We then estimate the full model by maximum likelihood using data on 178 countries.

## 4 Estimation Results

The number of subdivisions clearly does not linearly depend on population size. We have experienced a 150% increase in global population over the past 51 years, yet the number of subdivisions has not increased in the same way. We conducted a likelihood ratio test of a model where population and area enter linearly, versus a model where they enter as natural logs. The hypothesis test rejects the null hypothesis of a linear relationship at the 1% level. We further test the logarithmic specification by including powers between 0 and 1, similar to a Box-Cox test for non-linearities. The search over non-linearity parameters using the log likelihood as a selection criterion, suggests that population and area enter as natural logs. We therefore include these variables in their log form.

The first stage logit estimation results suggest that country area is the main determinant of whether a country has any subdivisions at all.<sup>11</sup> Population does not enter any of the twelve estimated models statistically different from zero. The high correlation ( $\rho = 0.859$ ) between the log of population and the log of area may cause inflation of the standard errors.<sup>12</sup>

We conducted a range of robustness checks. We dropped the five largest outliers and re-estimated the model. None of the results change significantly. We further estimated all models by using a zero inflated negative binomial estimation technique, without any qualitative changes to the results. Estimation of the twelve linear models on the set of countries with more than one first order political subdivision via Ordinary Least Squares resulted in some parameter estimates no longer being

---

<sup>11</sup>Note that a success in the first stage estimation is having no subdivisions. The parameter estimates in the first stage should therefore be negative.

<sup>12</sup>We alternatively estimated the state probability  $\psi_i$  via probit estimation. The other parameter estimates did not differ significantly

statistically different from zero, yet the results do not change qualitatively. We provide the estimation results for the Zero Inflated Poisson estimation in tables 2 and 3.

All twelve estimated models include population and area. The parameter estimate on population is positive and significant in all models, suggesting an increased number of subdivisions for more populated countries. The coefficient on land area is also positive in all models, yet it is insignificant in models (5), (6) and (12). This may be due to collinearity issues with the population variable as discussed above.

Models (1) - (6) in table 2 focus on differences in the fixed costs of public goods provision by including measures of physical characteristics of countries. Models (1) and (2) include only measures capturing the fixed cost component. The parameter estimates on the island and landlocked dummies carry opposite signs, suggesting a larger number of subdivisions for landlocked countries and a smaller number for islands. It is noteworthy that the effect is similar in absolute magnitude. Coast is measured in kilometers of coastline. The statistically significant parameter estimate indicates that, Germany would have seven fewer subdivisions compared to Spain, simply due to differences in the length of its coastline.<sup>13</sup> The number harbors is also significant at the 1% level in all estimations. Although small, the Soviet Union with 47 major harbors, would be expected to have an additional 1.2 subdivisions compared to a country with no harbors, such as Mongolia. The signs and magnitudes of these parameter estimates support the implication of the model in that higher costs of public goods provision result in a smaller number of subdivisions. If one considers increased security and border safety as a decrease in fixed cost of public goods provision the parameter estimates of *Island* and *Locked* support the fixed cost argument. The coefficient on *Waterways* is small, yet significant. It has the opposite of the expected sign and opposite of the same variable in the school district estimations. Interior waterways typically tie an area to a harbor and can reduce the cost of controlling larger areas both in terms of communications as well as scale effects related to the reach of common laws/taxes/regulations over the harbor's natural trading area. The parameter estimate on *Harbors*, works in favor of the cost argument, since a natural harbor naturally provides transportation infrastructure. Lower cost of infrastructure should result in a larger number of subdivisions.

The parameter estimates on the continent shifter variables are rather interesting. It seems that there is no statistically significant difference in the intercept between African and European countries. This is not too surprising, since Africa, with the exception of Abyssinia and Liberia, was colonized by the Europeans until the 1930s. The estimation results suggest that African countries have the same mean number of subdivisions per country after controlling for differences in heterogeneity, cost and size. This is not true for the Americas, Asia and to some extent Oceania. The Americas and Asia have a greater number of political subdivisions per country

---

<sup>13</sup>We are using equation (2) to make predictions.

Table 2: Parameter Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	2.046 (20.41)**	2.040 (12.04)**	2.056 (12.48)**	1.973 (14.57)**	2.192 (15.65)**	2.104 (10.56)**
ln(Pop)	0.252 (10.67)**	0.204 (7.03)**	0.196 (7.55)**	0.201 (9.56)**	0.193 (8.08)**	0.140 (4.91)**
ln(Area)	0.061 (2.44)*	0.083 (2.60)**	0.049 (2.17)*	0.053 (2.51)*	0.037 (1.60)	0.028 (0.97)
Locked	0.178 (2.02)*	0.202 (2.12)*	0.132 (1.75)	0.183 (2.61)**	0.167 (2.28)*	-0.082 (0.91)
Island	-0.162 (1.91)	-0.290 (2.90)**	-0.315 (3.39)**	-0.272 (3.06)**	-0.322 (3.37)**	-0.338 (3.11)**
Coast	-0.003 (2.39)*	-0.004 (3.10)**	-0.003 (2.62)**	-0.003 (2.83)**	-0.002 (1.99)*	-0.003 (2.28)*
Harbors	0.021 (4.81)**	0.024 (4.98)**	0.017 (4.94)**	0.016 (4.70)**	0.018 (5.27)**	0.018 (4.72)**
Waterways	-0.006 (3.70)**	-0.008 (4.89)**				
Africa		-0.112 (1.06)	-0.056 (0.63)	0.036 (0.36)	-0.018 (0.21)	-0.008 (0.07)
Americas		0.226 (2.31)*	0.206 (2.26)*	0.279 (3.01)**	0.238 (2.70)**	0.163 (1.26)
Asia		0.428 (5.11)**	0.194 (2.42)*	0.272 (3.02)**	0.204 (2.55)*	0.387 (4.27)**
Oceania		0.291 (1.35)	0.207 (1.19)	0.280 (1.64)	0.360 (1.79)	0.192 (0.75)
Gini						0.004 (0.91)
Centralization					-0.093 (2.47)*	
GDP (p.c.)				0.002 (0.69)		
Openness			0.001 (0.50)			
ln(Pop)	0.230 (0.64)	0.230 (0.64)	-0.067 (0.27)	-0.111 (0.52)	-0.329 (0.99)	-0.004 (0.01)
ln(Area)	-0.920 (2.32)*	-0.919 (2.32)*	-0.604 (2.89)**	-0.588 (3.22)**	-0.784 (2.90)**	-0.905 (2.42)*
Constant	-4.566 (2.83)**	-4.566 (2.83)**	-3.331 (3.48)**	-3.098 (3.79)**	-3.355 (2.80)**	-3.940 (2.36)*
Log-Likelihood	-439.91	-412.77	-616.32	-668.82	-582.00	-474.43
Observations	96	96	147	176	130	97

Table 3: Parameter Estimates

	(7)	(8)	(9)	(10)	(11)	(12)
Constant	2.515 (33.98)**	2.587 (33.58)**	2.695 (27.13)**	2.515 (22.35)**	2.571 (22.32)**	2.109 (14.07)**
ln(Pop)	0.231 (13.32)**	0.228 (13.10)**	0.213 (10.90)**	0.220 (10.73)**	0.228 (10.97)**	0.238 (9.62)**
ln(Area)	0.079 (4.58)**	0.083 (4.73)**	0.089 (4.54)**	0.070 (3.50)**	0.083 (3.98)**	0.013 (0.50)
Locked						0.303 (4.01)**
Island						-0.173 (1.77)
Coast						-0.002 (1.45)
Harbors						0.020 (5.46)**
Africa						0.144 (1.52)
Americas						0.272 (2.87)**
Asia						0.223 (2.81)**
Oceania						0.520 (2.90)**
Religion	-0.740 (8.15)**	-0.643 (6.70)**	-0.667 (6.88)**	-0.692 (6.94)**	-0.640 (6.32)**	-0.766 (7.18)**
Language		-0.251 (3.19)**	-0.192 (1.83)	-0.152 (1.43)	-0.155 (1.44)	-0.159 (1.31)
Ethnicity			-0.137 (1.12)	0.029 (0.22)	0.084 (0.64)	0.060 (0.41)
Democratization				0.018 (3.14)**	0.026 (4.02)**	
Centralization					-0.107 (2.79)**	
ln(Pop)	-0.091 (0.43)	-0.029 (0.13)	0.136 (0.57)	-0.238 (0.71)	-0.237 (0.71)	0.148 (0.60)
ln(Area)	-0.572 (3.17)**	-0.578 (3.11)**	-0.834 (3.62)**	-0.825 (2.93)**	-0.824 (2.93)**	-0.847 (3.60)**
Constant	-3.084 (3.80)**	-3.160 (3.82)**	-4.081 (4.06)**	-3.522 (2.89)**	-3.522 (2.89)**	-4.141 (4.00)**
Log-Likelihood	-666.89	-650.51	-632.99	-567.02	-563.04	-610.18
Observations	171	162	156	124	124	156

compared to European nations. The countries in Oceania<sup>14</sup> have an upward shifted mean as well, similar in magnitude to the one of Africa and the Americas, yet it drops in and out of statistical significance in the different specifications.

Models (7) - (12) in table 3 control for measures of population heterogeneity. Religious heterogeneity is statistically significant and negative in all models. Language heterogeneity also has a negative effect, yet is significant in only one model. Ethnic heterogeneity also has a negative effect, yet the parameter estimate is not significant.<sup>15</sup> These estimation results do suggest the opposite of what is implied by the theoretical model, namely that increased heterogeneity decreases the number of subdivisions in a country, *ceteris paribus*. It is possible that sorting along ethnic dimensions happens at a smaller geographic scale, such as neighborhoods or cities, implying that public goods supplied at the state level have lower heterogeneity costs. If this was the whole story, one would expect an insignificant parameter estimate on the heterogeneity measure. This is the case for ethnic heterogeneity and in all but one model for language. Religious heterogeneity is statistically significant and carries a negative sign in all models. One explanation for this is that the institutions deciding on the number of first order subdivisions are not benevolent social planners, but do exhibit rent maximizing behavior. Alesina & Spolaore (2003) show that these "Leviathan" governments will divide a country into fewer subdivisions than optimal under the central planner regime. Models (10) and (11) include an index of democratization from the Polity III database, which indicates that more democratic countries have a statistically larger number of subdivisions. This suggests that the Leviathan argument may carry some weight. Another possible explanation for the unexpected effect of heterogeneity is that in order to prevent secession of (religious) minorities, governments design larger subdivisions, making it harder for any minority to gain a voting majority in a given state. A combination of these explanations suggests that we may observe a world where leaders of ethnically or religiously heterogeneous countries suppress political subdivisions along these lines to make it harder to organize secession.

To our surprise of the authors, economic factors do not seem to matter at all in the determination of the number of subdivisions of a country. The parameter estimates on per capita GDP and trade openness are statistically not different from zero. Alesina & Wacziarg (1997) identify an effect, resulting in a negative relationship between country size and trade openness. They argue that smaller countries that are closed to trade have a more difficult time, since they have small markets. Trade openness should create access to a larger/global market which will allow cultural minorities to split up within the country. Our results, even though we cannot

---

<sup>14</sup>We count Australia, Fiji, Micronesia, Kiribati, Marshall Islands, Nauru, New Zealand, Papua New Guinea, Solomon Islands, Tonga and Vanuatu as Oceania.

<sup>15</sup>The measures of heterogeneity used in this paper were constructed by Alesina et al. (2002) to improve on collinearity issues in existing measures.

directly test for this effect, would argue that trade openness does have no effect on the number of subdivisions, which is closely tied to country size. Economic heterogeneity, as measured by the Gini coefficient, also does not seem to have a statistically significant effect on the number of subdivisions. A measure of "geographical income inequality", which is more relevant in the context of this paper is not available for a large number of countries, but would provide an interesting insight as to whether individuals choose to live with people close to them in the level of income.

The last variable, which is only available for 121 countries, measures the degree of geographic concentration of decision of political decision making provided by Gurr, Jagers & Moore (1990). It ranges from one (fully centralized) to three (democracy). Our results indicate that the more decentralized the decision making process is, the fewer subdivisions a country will have. Regional governments are closer to their citizens than the federal or central institutions. They will be able to respond to the needs of the citizens of the subdivision. The decentralization and democratization variables may not be quite exogenous, but quite interesting. The size of the coefficients on these measures may be overestimated.

## 5 Conclusions

Our estimation results suggest that fixed costs of local public good provision across countries in the form of location and improved transportation infrastructure seem to account for a large share of the variance in the number for political subdivisions across countries. In addition, religious heterogeneity of countries population decreases the number of subdivisions a country has, which is opposite to what Alesina et al. (2000) observe for school districts across US counties.

We do not not interpret our results as a failure of the model proposed by Alesina & Wacziarg (1997), but argue that they show that population heterogeneity costs work at a lower level of aggregation than that of states. We argue that location choices of individual based on heterogeneity of population are made on a local not on a state level, where the costs of moving in a sorting sense, as suggested by Tiebout (1956), are much higher. Individuals are more likely to move into a new neighborhood within a city in order to generate a better match between their kids and a school, than they are to move to another state in order to gain marginally better tax structure or prison system. This is supported by the statistical insignificance of the parameter estimates on ethnic and lingual heterogeneity.

We interpret the significant and sizeable negative effect of religious heterogeneity on the number of subdivisions in conjunction with a positive effect of democratization on the number of subdivisions as evidence of a "nation-building" model, where leaders of ethnically or religiously heterogeneous countries suppress political subdivisions along these lines to make it harder to organize secession. There seem to be nations, that have adopted a different strategy. The big and positive outliers are

Thailand, Turkey and Vietnam. The fact that these countries have a large number of subdivisions could be explained by the fact that all three countries have an active secessionist movement (*e.g.* the Kurds in Turkey). By having a large number of political subdivisions you may make it more difficult for these forces to take over a sub-national government and then secede from the country.

Lastly, measures of market size such as wealth and openness to trade do not seem to have a statistically significant impact on the number of observed subdivisions across countries. In addition, we show that income inequality does not seem to have any affect either. In summary, estimation results from a Zero Inflated Poisson model suggest that physical, political and population characteristics have a significant impact on the number of subdivisions. The economic factors are insignificant, thereby supporting the typical treatment of the number of subdivisions as exogenous.

## References

- Alesina, A. & Spolaore, E. (1997), ‘On the number and size of nations’, *Quarterly Journal of Economics* **112**(4), 1027–1056.
- Alesina, A. & Spolaore, E. (2003), *The size of nations*, MIT Press, Cambridge, MA.
- Alesina, A. & Wacziarg, R. (1997), ‘Openness, country size and government’, *Journal of Public Economics* **69**, 305–321.
- Alesina, A., Baqir, R. & Easterly, W. (1999), ‘Public goods and ethnic divisions’, *Quarterly Journal of Economics* **114**(4), 1243–84.
- Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S. & Wacziarg, R. (2002), Fractionalization, Department of economics working paper, Harvard University, Cambridge, MA.
- Alesina, A., Hoxby, C. & Baqir, R. (2000), Political jurisdictions in heterogeneous communities, Working Paper 7859, NBER, Cambridge, MA.
- Berry, S. T. & Waldfogel, J. (1999), ‘Mergers, station entry, and programming variety in radio broadcasting’, *RAND Journal of Economics* **30**(3), 397–420.
- Central intelligence Agency (2000), ‘The world factbook 2000’, electronic: <http://www.cia.gov/cia/download.html>.
- Chambers, R. G. (1998), ‘The structure of multiplant technologies’, *American Journal of Agricultural Economics* **80**(4), 839–51.
- Coase, R. (1937), ‘The nature of the firm.’, *Economica* **4**, 386–405.

- Dahl, R. A. & Tufte, E. R. (1973), *Size and democracy*, Stanford University Press, Palo Alto, CA.
- Greene, W. H. (2000), *Econometric Analysis*, Prentice Hall International, London, UK.
- Gurr, T. R., Jagers, K. & Moore, W. (1990), 'The transformation of the western state: The growth of democracy, autocracy, and state power since 1800', *Studies in Comparative International Development* **25**(1), 73–108.
- Jagers, K. & Gurr, T. R. (1996), 'Polity iii: Regime change and political authority, 1800-1994', Electronic Database.
- Lambert, D. (1994), 'Zero-inflated Poisson regression with an application to defects in manufacturing', *Technometrics* **24**(1), 1–14.
- Lucas, R. E. (1978), 'On the size distribution of business firms.', *The Bell Journal of Economics* **9**(2), 508–523.
- Parker, P. M. (1997), *National Cultures of the world: A statistical reference*, Greenwood Press, Westport, CT.
- Tiebout, C. (1956), 'A pure theory of local public expenditures', *Journal of Political Economy* **64**(5), 416–424.
- World Bank (2000), 'World development indicators 2000', Electronic Database: CD ROM.