Inter-American Development Bank
Banco Interamericano de Desarrollo
Latin American Research Network
Red de Centros de Investigación
Research Network Working paper #R-443

Rentier States and Geography in Mexico's Development

by

Roberto Blum
Alberto Díaz Cayeros

Centro de Investigación para el Desarrollo, A.C. (CIDAC)

March 2002

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Blum, Roberto.

Rentier states and geography in Mexico's development / by Roberto Blum, Alberto Díaz Cayeros.

p. cm. (Research Network Working papers ; R-443)
Includes bibliographical references.

1. Mexico--Economic conditions--Effect of Administrative and political divisions on. 2. Mexico--Economic conditions--Econometric models. 3. Economic geography--Econometric models. I. Díaz Cayeros, Alberto. II. Inter-American Development Bank. Research Dept. III. Title. IV. Series.

330.9 B385--dc21

The Research Department (RES) produces the *Latin American Economic Policies Newsletter*, as well as working papers and books, on diverse economic issues. To obtain a complete list of RES publications, and read or download them please visit our web site at: http://www.iadb.org/res

Table of Contents

List of Tables and Graphs

Abstract[*]

This paper provides a long-term historical and econometric account of the way in which geography has shaped development in the Mexican states. The emphasis is placed on the way in which the natural geography is reinforced by political decisions, which configure the human geography of population density, urbanization and public good provision, which in turn determine income, growth and poverty. The paper presents brief historical instances of how geography has determined prospects for development at different moments in Mexican history. This anecdotal discussion seeks to highlight the intrinsic link of geography with political institutions, which is central to understanding the economic effects of geography. The paper then presents a descriptive statistical and geographical profile of the relationship between geography and development in Mexico. Econometric estimates of the effects of geography on income, growth and poverty are used to decompose regional inequality, separating the specific contribution of natural geographic factors (climate, location and population density) as compared to public good provision, in the form of urbanization and literacy, and political arrangements, as reflected in the fragmentation of political jurisdictions. The paper argues that the main channel through which geography affects development is political. The fragmentation of political jurisdictions in the form of municipal governments constitutes a proxy for man-made barriers to geographic mobility, which explain the interaction between geography, politics and development.

[*] We acknowledge research assistance of Diego Steinhendler in data processing and preparation of tables. Comments from John Lake Gallup, Alejandro Gaviria, Edna Jaime, Claudio Jones, workshop participants in the Geography and Development seminar held in Cuernavaca, Mexico, May 27-28, 1999 and other researchers at CIDAC are greatly appreciated. Eduardo Lora deserves special thanks for reading and rereading previous versions of the paper, offering always insightful comments. Of course all errors remain our sole responsability.

Introduction

When Hernán Cortez was asked by Charles I of Spain to describe the new land he had conquered, he is said to have taken a piece of parchment and crumpled it to illustrate the rugged aspect of the landscape. Microhistorian Luis Gonzalez has argued that Mexican history can only be understood as the stories of three hundred valleys that make up the *matrias*, or motherlands, to which Mexicans really pay allegiance. At the beginning of the twentieth century, dictator Porfirio Díaz was well aware of the power of geographic destiny when he lamented, "poor Mexico, so far from God and so close to the US." Geography has undoubtedly played a key role in the long-term economic development of Mexico, while the influence of geography continues to be felt in contemporary patterns of development such as the location of new industry in Northern mid-size cities, increasing migration flows from Southern Mexico and the central high-plateau to the Northern border region and the coastal areas, environmental degradation in some of the poorest regions in the South, or the intricate flows of temporary migration to specific cities in the US from particular regions of the country.

Despite its importance, the impact of geography on development has been little discussed in Latin America or Mexico. This paper aims to provide some insight into the relative importance of geographical conditions for Mexico's long-term economic and political performance. Political performance is central to the study because we believe geographic conditions determine some of the configurations of political forces and institutional arrangements that have led to particular economic policies, especially in the realm of taxation and the fragmentation of political jurisdictions. Those policies, in turn, hinder or promote economic development. We call those arrangements a country's "institutional ecology," a system of interrelated institutions built over time to achieve certain socially desirable purposes.

We are not, however, geographic determinists. Long-term processes of economic development are not the product of one causal factor, but instead result from multidimensional social, political and economic forces. Grasping those processes requires a multidisciplinary approach, combining various theoretical approaches, and the interaction of historical, social, political and economic evidence. We have chosen to put geographic factors in a prominent position, however, in order to reassess their importance.

Using data from Mexican states and municipalities, the paper tests some of the hypotheses of Gallup and Sachs (1999), Bloom and Sachs (1998) and Gallup (1998) concerning the role of geography in development. We go beyond econometric estimates, though, providing a long-term historical account of the process whereby geography shaped political arrangements, which produced specific policies with clear developmental impacts on the Mexican states. In particular, we believe that the fragmentation of political jurisdictions in the form of municipal governments constitutes a good proxy that explains the interaction between geography, politics and development.

The paper is organized as follows. The next section provides a brief overview of several recent contributions to the theoretical literature on linkages between geography and development. The section additionally explores the implications of the literature reviewed for the Mexican case. Section 2 is also theoretical in nature, briefly sketching a General Systems Theory model (drawn from Blum, 1999) to study the effects of geography on development. The systems model suggests that the interface between geography and development is to be found in the natural and "institutional" ecologies of society. Both theoretical discussions seek to provoke thoughts on how to approach geography and development, rather than providing a definite explanation of the causal linkages between geography, political institutions and economic performance.

Section 3 presents brief historical instances of how geography has determined developmental prospects at different moments in Mexican history. This discussion seeks to provide evidence of the intrinsic link of geography with political institutions, which is central to understanding the economic effects of geography. Section 4 presents descriptive statistical and geographical evidence on the relationship between geography and development in Mexico. Section 5 provides econometric estimates of the effects of geography on income, growth and poverty. This section decomposes regional inequality in Mexico, separating the specific contribution of geographic factors (climate, location and population density). Section 6 explores the relationship between the fragmentation of political jurisdictions in the form of municipalities, geography and development. That section assesses the political channel through which geography affects development. Section 7 provides policy implications and an agenda for future research.

1. Theoretical Linkages between Geography and Development

Geographic conditions have come to play a new theoretical role in explaining long-term economic development and growth. A seminal contribution, still widely cited by economic geographers, is Douglass North's (1955) explanation of the way in which the resource base determines possibilities for specialization in world trade. North's initial insights were subsequently developed mostly in an institutional direction, explaining long-term economic performance as a consequence of political institutions protecting property rights and generating competitive markets (North and Thomas, 1973; North, 1981; Landes, 1988). However, North's account of growth in the United States (1966) as a virtuous institutional arrangement, whereby three regionally specialized economies were able to profit from trade within a federal arrangement, gives a greater explanatory role to the resource base than his later works. In fact, one of the main questions North (1990) poses in his *Institutions, Institutional Change and Economic Performance*, regarding why the economic performance of two seemingly similar countries at the beginning of the nineteenth century, the U.S. and Mexico, diverged in such a striking manner, can probably be best answered if one combines institutional and geographical factors.

A variety of recent works by economists have explored the role of geography. These include the influential papers by Paul Krugman (1991) that revived interest in the role of geographic location in trade theory. In addition, several papers coauthored by Alessandra Casella (Casella and Frey, 1992; Casella and Feinstein, 1991) have studied the effect of political jurisdictions on the territorial distribution of economic activity; and, of course, the booming literature on regional convergence has been motivated by Roberto Barro and Xavier Sala-i-Martin's (1994) empirical work on economic growth. Environmental and weather conditions have additionally been highlighted in the recent literature. Sachs and Warner (1995), for example, have called attention to the role of droughts as a purely natural shock with momentous economic effects, particularly evident in sub-Saharan Africa. Also in Africa, growth regressions have increasingly incorporated aspects such as wars, economic and political conditions of neighboring countries, ethnolinguistic fractionalization and characteristics of physical infrastructure, which are geographically given (for a review, see Collier and Gunning, 1998). The recent papers in the project on geography and economic development at the Harvard Institute of

International Development (Gallup, Sachs and Mellinger, 1999; Sachs, 1997; Radelet and Sachs, 1998; Bloom and Sachs, 1998; and Gallup, 1998) have provided a more comprehensive research agenda in these areas, and the recent IADB (1998) report on inequality provides evidence of the importance of geography in the development of Latin America.

In a more provocative approach, evolutionary biologist Jared Diamond (1997) provides an explanation of how environmental geography has influenced societal development throughout history. Diamond's view is somewhat extreme when applied to historical and social processes, but his main insight on taking geography as a serious barrier or facilitating condition for human development is powerful, as his work convincingly shows. On the environmental front, the Brundtland report some years ago was highly influential in focusing questions of poverty and destitution as direct consequences of a vicious circle in which destitution produces degradation of the environment and environmental damage leads to further impoverishment of the already poor. This has made scholars interested in poverty and destitution more aware of the conditions of the environmental resource base (Dasgupta and Maler, 1995).

Geographical conditions do not change quickly, even though human transformation of the environment can open up vast expanses of land to agriculture or cattle raising; construction of roads and bridges might provide for the mobility of goods and services; swamps are drained, rivers are dammed, forests are burned or otherwise cleared. In general, however, geography remains very much the same in the short term, or at least in periods for which reliable regional statistical information might be available. Some resources, like minerals, are only exploited once a technology is found to process them. Some regions might be physically isolated only because a road or railroad has not been built. In this context, long-term performance must be measured not just in decades, but probably centuries. Hence the Mexican case is discussed taking into account a long historical period beyond that for which regional statistical information is available.

Gallup, Sachs and Mellinger (1999) consider four areas in which geography might play a direct role in economic productivity: transportation costs, human health, agricultural productivity, and proximity and ownership of natural resources. In Mexico, the performance of regional economies has been directly affected by analogous factors. Water and soils have determined the character of agriculture. Given the rugged topography and the absence of internal waterways, communication across regions has depended on transportation costs. In the colonial period, the location of mineral deposits determined the most important axis of internal trade flows. Energy resources conditioned the location of the first efforts at industrialization at the turn of the last century in the city of Monterrey, where nearby coal was available, and oil booms have had definite regional impacts on the industrialization of Veracruz during the 1910s and 1920s or in Tabasco during the last decade. Gallup, Sachs and Mellinger report not finding a direct effect of geography and health variables that would explain the shortfall in Latin America's economic growth relative to Asia (1999, p. 27). However, it is likely that the level of aggregation of the heterogeneous regions making up the large Latin American countries creates a fallacy of composition that hides geographic effects that could be studied at the regional level.

Regarding indirect effects of geography on economic development, Gallup and Sachs suggest that some economic policies, particularly tax policy, might be endogenous to geography. In particular, they provide a model in which the "optimal tax is an increasing function of transport costs, discount rate, and the probability of losing office; and a decreasing function of total factor productivity and the responsiveness of growth to the tax rate." This means that predatory elites, which in Olson's terms (1993) behave as roving bandits, are more likely to be present when regions are isolated and when they face many challengers. This is the pattern observed during the nineteenth century in Mexico. *Cacicazgos* (domains of local bosses) emerged probably as a second best solution, through which tax rates could be decreased because time horizons were long and the hold on office was secured, but the arrangement depended on making a region relatively impermeable and isolated. Internal tariffs (the long-lasting *alcabalas* in Mexico) might have been imposed not as a source of revenue, but as a way to keep transport costs high and maintain the *caciques*' hold on power. The seemingly irrational economic policies carried out in Mexico during much of the nineteenth century and the first half of the twentieth century regarding internal barriers to trade might thus be endogenized as part of the natural configuration of resources. In fact, the fragmentation of political jurisdictions in the form of municipalities emerging in the early nineteenth century might be explained to some extent by geographic conditions, coupled with the ruler's desire to establish internal barriers to the movement of goods and services.

This leads to a major area of study related to trade liberalization. One of the central hypotheses of recent studies is that a coastline allows for greater contact with other countries, hence regions near the coast will tend to promote policies of free trade. In the Mexican case, however, the coastline seems to have been of little consequence for trade flows. This is explained first by Mexico's tropical location, which until very recently made most of its coastline highly unhealthy. Tropical illnesses regularly decimated coastal settlements, and as a result few towns were established in the lowlands. Colonial Mexican ports were few in number and primarily served the shrinking international trade between the Spanish colonies in the Pacific area and the metropolis. Second, trade within the country did not proceed through the coastal waterways because its sparsely populated coastlines and formidable mountain barriers blocked communication to the more populated central high-plateau settlements. However, a very different coastline has emerged in the recent past, that of the border with the U.S. Although the Rio Bravo (known in the United States as the Rio Grande) is not navigable, the quality of infrastructure in the US has effectively transformed border cities into ports open to the global economy. The possibility of trade in international markets constitutes one of the most important escapes from adverse natural geographical conditions.

2. A Conceptual Model: Natural Ecology and Institutional Ecology as Interfaces between Geography and Economic Development

The need to trace and explain the multiple pathways whereby geography influences economic development requires the construction of a whole set of conceptual models. Providing all the interlinked models highlighting different aspects of these influences is clearly impossible. General Systems Theory (GST) allows, however, for this kind of complex and interdisciplinary modeling endeavor. From the simplest possible models in GST—integrating various "inputs" of energy, materials and information, their processing inside "black boxes" to produce the observable results, "outputs" consisting of the same three kinds of elements—to the very detailed and sophisticated "flow models" necessary to produce computer simulations, GST is a very useful instrument for understanding complex phenomena. We thus draw from a general but simple model, provided by Blum (1999), emphasizing "natural ecology" and "institutional ecology" as the interfaces between geography and economic development.

Figure 1. Natural and Institutional Ecology

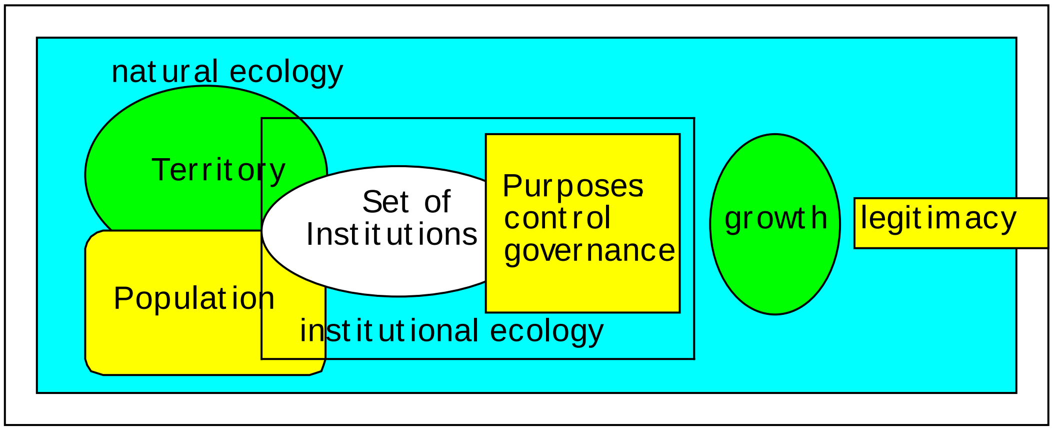


Figure 1 depicts both "natural" and "institutional" ecologies as the interfaces between the territory (geography) and population (social interactions), which together produce the phenomena we call growth and legitimacy. These social products cannot be well understood outside the innumerable and complex interactions occurring among the different elements of the system. Such interactions include, among many others, the way in which political processes are structured and boundaries between jurisdictions are created and enforced, often following "natural" barriers; the way in which production is organized, including the establishment of property rights over natural resources and raw inputs used in the production process; and the way in which tax resources are extracted, usually by the force of the state.

It is clear that in the long run humans are able to radically transform the natural environment. Not only are dwellings and roads built, rivers dammed, forests felled and mineral resources extracted, but humankind has established various symbiotic relations with other living species and thus multiplied its own effects on geographical features. Intensive mining processes and extensive cattle raising during the 300-year colonial period (1521-1821), for example, destroyed a large part of the original temperate forests existing in Mexico. Mezquite and low brush vegetation colonized large parts of the Northern region. Land erosion proceeded at a fast pace around mining towns, and local rainfall patterns changed during this period. An even more dramatic transformation of geography is observed in the central valley of Mexico. Its originally numerous lakes were deliberately drained to build Mexico City. Even now, people are still alive who remember a time in which rivers and creeks criss-crossed the Mexican capital and clear lakes surrounded the growing metropolis, now a veritable ecological catastrophe in the making. The "natural ecology" or environmental interface is the conceptual surface at which geography and man interact. Though geography is usually the passive extreme of this relationship, natural ecology is always interactive.

The other conceptual interface we need to consider is "institutional ecology." This is the interrelated system of institutions built over time to achieve certain socially desired purposes. The institutional ecology comprises a large diversity of: a) institutions, formal and informal, b) rules and meta rules, c) allowable group strategies and tactics, legal or illegal, and d) social and individual interests that continuously interact, creating some kind of stable equilibrium. Institutional ecologies can be more or less dense, according to the sheer weight of their different parts. A denser ecology is that which has built over time more institutions in a certain conceptual or real geographic space. A higher institutional density correspondingly implies greater costs of constsruciton, maintenance and transformation.

Institutional density implies "institutional inertia," which explains the difficulty of changing the setting as fast as conditions might require. A "lock-in" phenomenon occurs that might explain the different paths historical societies have taken. An institutional ecology can also be considered more or less robust, which implies the system's ability to keep its coherence over time, and robustness appears to be a function of institutional diversity. The number of municipalities emerging in the different regions in Mexico is thus a proxy measure to assess institutional density and the diversity of institutional arrangements emerging over time. In regions of recent settlement, where individual private property rights over land were established and towns were sparse, few municipalities were created. Where indigenous populations predated the institutional framework of the national state, communal property rights existed and population density was high, large numbers of municipalities were the rule. The difference in municipal configurations in Mexico reflected geographic, ethnic and political realities.

The interfaces of natural ecology and institutional ecology imply hidden and overt costs for society. Until recently, ecology was not even considered when national or regional economic accounts were produced. Environmental advocates have been able to bring to the forefront the need to integrate into the process of economic accounting the hidden—but not insubstantial—environmental costs. When these are considered, a more realistic evaluation of economic performance can be achieved. On the other hand, the institutional ecology costs have always been considered, though not formally, by decision-makers.

For example, public good provision in Mexico has been hindered by the fragmentation and dispersion of population, as reflected by municipal organization. It has been obvious that institution building and its transformation imply real costs to society. Though there are still no explicit and generally accepted methods to cost institutions, neither for their building or maintenance nor for the economic growth or stagnation they produce, the inclusion of both the ecology and institutional ecology costs is conceptually necessary to provide a better context for the analysis of economic development.

Tax systems and tax structures provide one area where including both natural and institutional ecology in the understanding of the development process might prove particularly fruitful. Revenue extraction is one of the oldest problems rulers face, and the natural and institutional characteristics of a given society might determine how this is done, and more importantly, what consequences a fiscal structure has on economic performance over time.

3. The Mexican Case: A Historical Account

A few historical instances for which good research and evidence exist illustrate the interaction of geography and social activity, which produce ecological transformations and facilitate policy decisions and institution-building. Over time, though, these processes produce “lock-in” phenomena that persist for long periods even though conditions have drastically changed.

A first example comes from the extensive research carried out mostly by social anthropologists (Palerm, 1952, Wittfogel, 1981, and Harris, 1985, among others) on pre-Hispanic societies in the central region of Mexico. Though their methodologies differ, they have seriously considered the "Marxian" concept of the "hydraulic societies" as a beginning point for their social analysis. The existence of numerous lakes in the Central valleys of the Mexican high plateau and the urgent need to control the regular but devastating floods that occurred, as well as use those same waters for irrigation, initiated a process of institution-building that produced the societies the Spaniards found when they reached Mexico in the sixteenth century.

Though these societies—the Aztecs, Mayans, Mixtecs, Zapotecs and Tarascans—greatly differed among themselves, they all shared some social organizational characteristics that were analogous to the classical hydraulic societies already being studied in Asia. All of these were "despotic" societies with large bureaucratic structures, supported by a large mass of landless peasants working small, communally held plots. These societies developed into centralized pre-states that depended on the tribute of many conquered peoples. Though these cultures' technology was primitive (e.g., metals were unknown), their social institutions were not. Great cities and large populations attest to the efficacy of these institutional complexes. As a result, the Spanish conquistadores were able to adapt many of the indigenous institutions they found to the Crown's and their own purposes. Thus, present-day Mexico cannot be well understood without considering the institutional "lock-in" phenomenon.

The regions where these "semi-hydraulic" pre-Hispanic civilizations were established, the Yucatan peninsula and the central valleys of Mexico, Michoacan, and Oaxaca, remain to this day areas where "institutional density," as measured by the number of municipalities, is above the national average. In these regions it is still possible to observe some of the archaic institutions, adapted or not, to the present conditions of modern Mexico. For example, the *ejido*, the most common form of land tenure in modern Mexico and a product of the 1910 Mexican revolution, is the direct descendant of the marriage of the Spanish medieval *ejido*, common land assigned to the townships, and the pre-Hispanic *calpulli*, state-held property worked by individual families.

This communal form of land tenure has maintained its central purpose for over 700 years. Though food production has been an important byproduct of this institution, its central purpose has been to maintain control over the tens of thousands of peasant communities that exist in Mexico. Control of these populations originally was needed to build and maintain the hydraulic infrastructure that pre-Hispanic societies and Colonial Mexico needed for their survival. When the natural ecology changed, the lakes were drained and the *chinampas* (floating gardens) became just a tourist attraction, however, the institutions created a long time before remained and their original purpose was redirected to serve new needs.

The PRI, the party established by the "revolutionary family" in the late 1920s, successfully used the *ejido* to keep political control of the country for over 70 years. Discretionary land distribution among poor peasants and the subsequent creation of new ejidos has rooted the growing Mexican rural population to specific regions and transformed them into clients, first of the local political "bosses" and then of the agrarian federal bureaucracies developed to control and extract rents from them.

A second example of geography and development producing important institutional changes can be found in the Bajio region of north-central Mexico during the early years of the nineteenth century. The region is a fertile valley traversed by the Lerma river. The land is mostly flat, and the region is relatively close to the mining towns of Guanajuato, Queretaro, San Luis Potosi, Zacatecas and Pachuca. Its population grew rapidly and developed modern agriculture to feed the surrounding booming silver mining towns. By the end of the eighteenth century, the Bajio was the breadbasket of Mexico. Thus we can observe two very different economies symbiotically united in that relatively small area. On one hand there were the mining towns' economies, sustained by the exploitation of silver and subject to the rentier state. On the other hand was a more modern agricultural economy made up of large private haciendas and small independent ranchers that were producing agricultural value through their hard work and improved technologies. These *rancheros* were subject to a more limited and modern institutional ecology.

The Bajio's independent agricultural producers depended on the continuous flow of work capital provided by the Catholic Church, a large rentier with excess liquidity that provided many financial services to society at a moderate rate. The Church as a financial institution had a long term horizon, and its credits to the Bajio farmers were renewed routinely. However, in the early 1800s the King of Spain ordered the Mexican Church to provide him with a "forced" loan to pay for the European wars in which he was engaged. When the Church began to call in its loans, the Bajio was suddenly plunged into a liquidity crisis, and tens of thousands of modern agricultural producers were left financially exposed, with resulting discontent throughout the region. Many Church leaders sympathized with them, and a potent revolutionary brew began to boil. Thus the war of independence had found a fertile ground in the Bajío, the crossroads of two different economies, the rentier and the modern limited. Those individuals used to working under a modern limited institutional ecology would not readily accept the heavy-handed approach of the rentier state structure. Significantly their battle cry was "Long live the King, down with bad government."

This conflict, between a heavy-handed rentier state and social and economic agents developing in a more modern limited institutional ecology, has been a constant in Mexico's modern history. Though in many aspects different, the 1910-20 Mexican revolution showed an eerie similarity to the underlying causes of previous social conflicts. In this second "revolution," modernizers (Monterrey's new industrialists, Sonoran export-oriented ranchers, discontented Northern politicians, labor unionists and the incipient urban middle class) teamed with "archaists" in Veracruz, Morelos and Oaxaca, who longed for a more simple and community-oriented society, to disrupt an institutional setting that either was not modern enough or too modern for the vastly different communities and populations comprising the Mexican nation.

As early as 1915, still in the midst of the armed phase of the "revolution," land reform laws began to be enacted in northern Mexico, especially the Gulf and Pacific coast areas, where the land's natural conditions allowed for modern export-oriented agriculture. The overt purpose of these early statutes was to promote the modernization of agricultural processes and increase their general productivity by dividing the mostly underdeveloped *latifundia* and distributing unproductive surplus lands among the peasants mobilized by the revolutionary armies, thus promoting the colonization of the barely populated North. This first phase of the agrarian reform[1] was led by a heterogenous group of revolutionary leaders who originated mostly in Mexico's northern region. These northerners took control of Mexico until 1934, when Lazaro Cárdenas assumed the presidency. The second phase of the agrarian reform began during the 1930s. Different purposes were behind the enactment of the later agrarian reform laws, which were designed mainly for Mexico's relatively more populated central area. In this phase, the federal government wanted to achieve two main purposes: 1) to mobilize rural resources, capital, entrepreneurship and labor to the urban markets to boost the industrialization program being developed, and 2) to establish an efficient corporatist structure of political control over the large peasant population.

Thus, the Mexican agrarian reform really comprises two different sets of phenomena and policies, originally designed and implemented by two different political groups and attuned to two different natural and institutional ecologies. It served different purposes and affected Mexico's development in different ways. While a strong case can probably be made regarding the impact of specific geographical conditions on the agrarian policies implemented in Mexico throughout the past four centuries, this impact seems especially clear in the two post-revolutionary phases of land reform, whether in terms of tenure or distribution.

Mexico is still torn by the conundrum of its enormous geographical differences and the "locked-in" rentier institutional ecology that has developed over the centuries. The costs of transforming this institutional setting are enormous, although not transforming them can be even more costly in terms of the "natural ecology" disaster that is emerging and the opportunity cost of development not achieved because of the many barriers and obstacles generated by existing institutions.

[1] Although a very early program of land distribution was enacted in the central states of Morelos, Mexico and Tlaxcala to provide land to the peasant rebels that formed the bulk of Emiliano Zapata's army, land reform in the early stages was attuned to the needs of development of Northern Mexico.

4. The Mexican Case: A Statistical and Geographic Profile

Most of Mexico is a tropical country characterized by great regional diversity, a landscape of natural barriers between regions, and a very dense institutional ecology. The 3,000 km border with the US makes the country unique in that flows of trade, migration and goods and services in general are largely determined by the rich neighbor to the North. The stable political arrangements that have characterized Mexico over much of the last 500 years have been historically punctuated by periods of upheaval. Notwithstanding wars of independence, reformation, the revolution, and the Cristero movement, political institutions have been extremely resilient to change, particularly in terms of informal practices that are still observed, mostly in some of the less developed regions. This is the "institutional ecology" in the country, which was briefly discussed above.

In relation to weather, the most prominent feature of Mexico's geography is the wide variation in rainfall, temperature and climates characterizing the country. The maps in Figures 2 to 4 depict the geography of average temperatures, average rainfall and climates in Mexico. These climatic profiles are also related to the nature of the terrain, with mountain ranges running North to South on both the East and the West, creating a temperate central plateau, which can be clearly distinguished from the tropical and semi-tropical coast and the desertic North. We can thus think about the country as divided into three major geographic areas: tropical coastal regions, the dry and warm North, and the relatively temperate central highlands.

Figure 2. Average Rainfall (in mm)

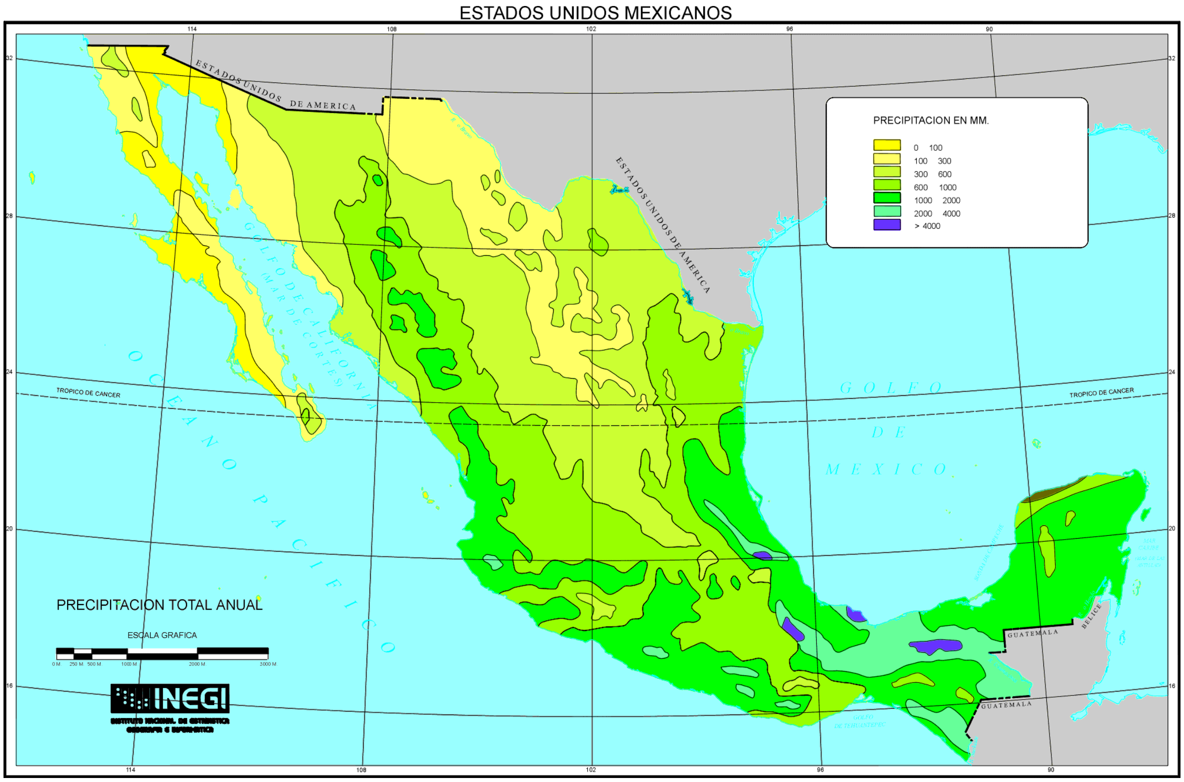


Figure 3. Climates (Hot, Dry and Temperate)

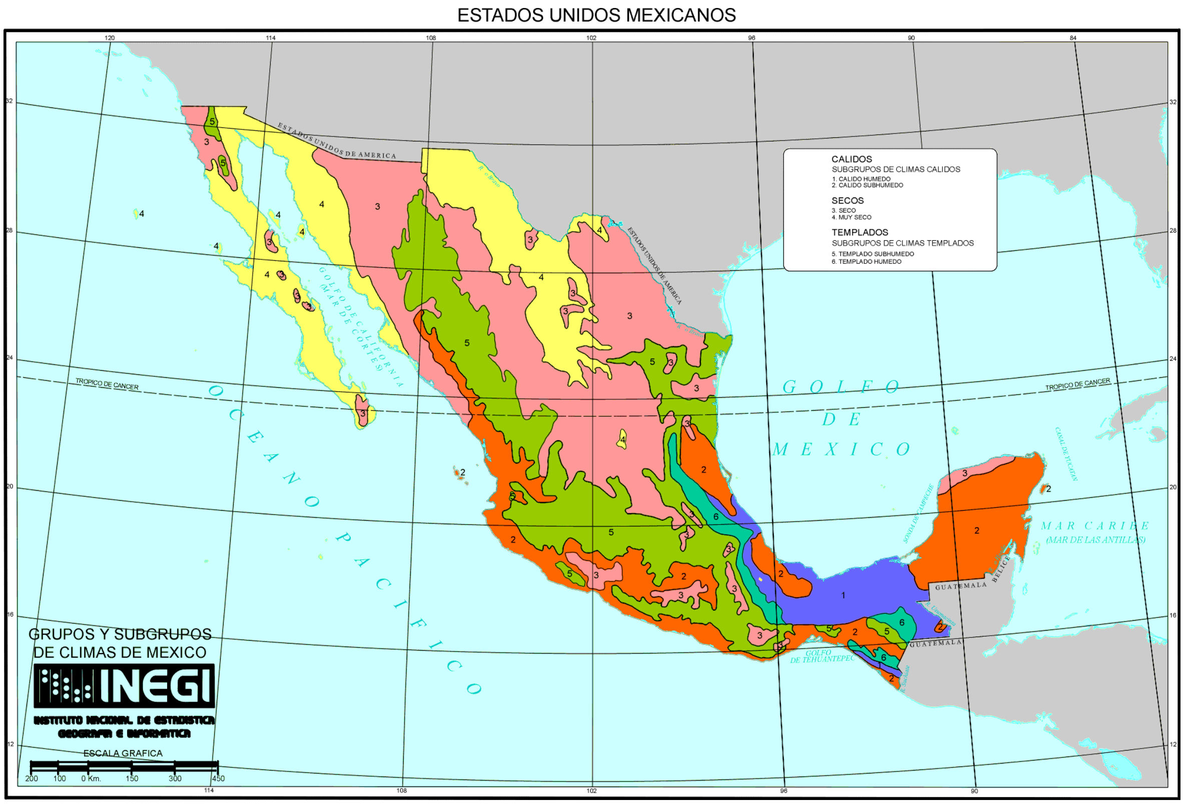
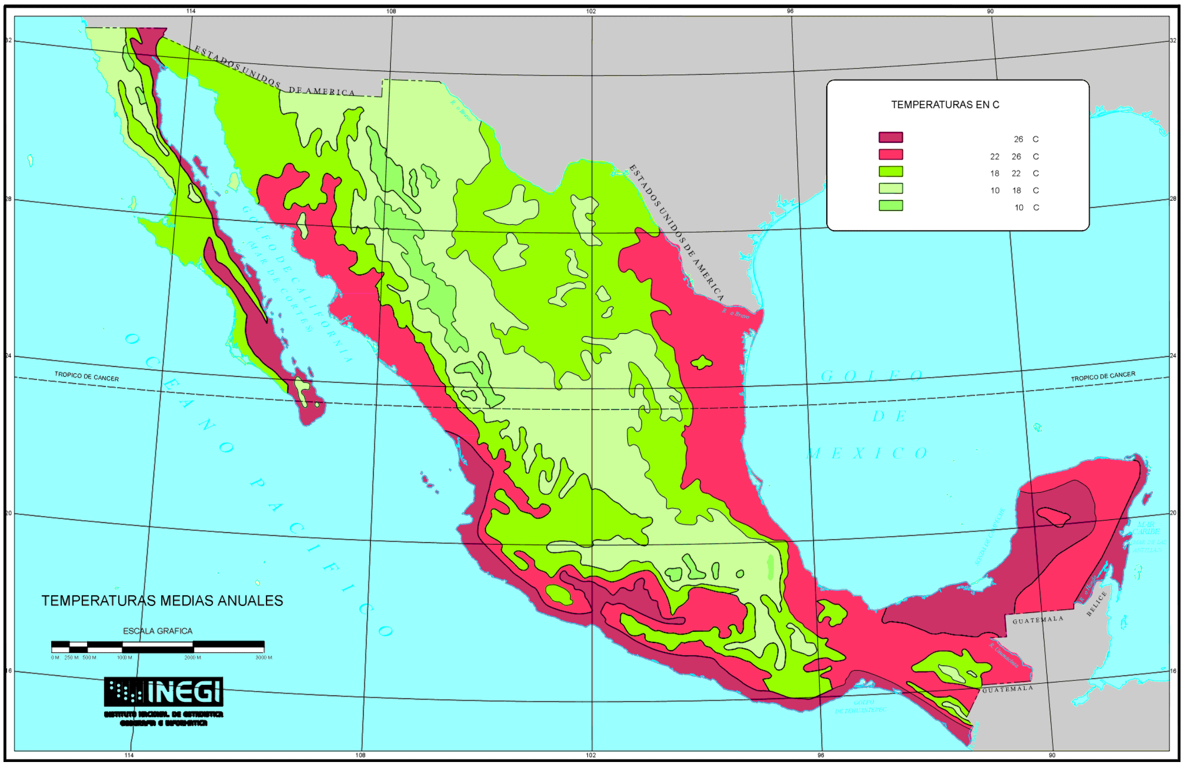


Figure 4. Average Temperatures (Centigrade Degrees)

ESTADOS UNIDOS MEXICANOS



This variation of climates might be related to GDP by state. Tables 1-5 provide calculations of the 1997 per capita GDP (in 1996 pesos) for the Mexican states according to latitude bands, temperature, range of average rainfall, GDP per square kilometer and an index of trade mobility.[2] Latitude bands, temperature, average rainfall and surface data come from INEGI, while the index of trade mobility is calculated by Díaz Cayeros (1995). Since there is no single statistic that best summarizes geographic variables (the mean, median or standard deviation do not fully capture the distribution underlying those natural features) we present ranges of those variables. Hence Table 1 provides a summary of how Mexican GDP is distributed according to various criteria of ranges of latitude bands, monthly variability of temperatures and rainfalls in the capital city of each state and a trade mobility index calculated as the combination of paved roads, railroad tracks, and number of cars circulating (*aforo vehicular*) per square kilometer.

Table 1. Summary Statistics of Mexican State GDP by Various Geographic Factors
(per capita pesos of 1996)

Latitude Bands	**28-32**	**24-28**	**20-24**	**16-20**
	7,555.7	9,466.2	6,479.9	9,066.9
Temperature	**10-18 °C**	**10-26 °C**	**18-26 °C**	**26°C or more**
	12,497.1	6,750.8	7,982.5	9,950.0
Rainfall	**0-600 mm**	**300-1000 mm**	**300-2000 mm**	**300-4000 mm**
	8,592.0	7,842.9	10,000.3	5,443.8
Trade mobility	**0-15**	**15-25**	**25-35**	**35 or more**
	7,267.7	7,662.3	4,831.3	7,148.2

Source: Authors' calculations. See Appendix.

There is no obvious North vs. South, hot vs. cold or wet vs. dry pattern, but it turns out that the lowest GDP tends to be found in the center South of the country; temperate regions are the richest, followed by the hottest tropical areas (which happen to be the oil-producing states of Campeche and Tabasco). Richer regions seem to be found in places with either little rainfall, or a moderate range; while the highest rainfall regions are the poorest. In terms of a man-made geographic feature, which is the index of trade mobility measuring the density of highway and

[2] Lacking official recent data, GDP figures come from an estimate by Díaz Cayeros (1997).

railroad tracks coupled with vehicle circulation, there is no specific pattern, except perhaps that some regions in the central highlands, which are endowed with relatively good infrastructure, are relatively poor (Puebla, Hidalgo, Guanajuato).

Gallup, Sachs and Mellinger(1999) argue that population density is one of the features that might account for economic development, in terms of a tendency to find population concentrating or migrating towards temperate climates, close to the sea or navigable rivers. Population density varies greatly among Mexican states, ranging from more than 4,000 inhabitants per square kilometer in the Federal District to a little over 5 in Baja California Sur. GDP density, calculated as GDP per square kilometer in Mexico is not distributed according to the world patterns reported in Gallup, Sachs and Mellinger (1999), but is rather concentrated in the central highlands of the country. The states of Mexico and Morelos, both adjacent to Mexico City, head the list, followed by the smallest states which, except for Colima, are also in the highlands: Aguascalientes, Tlaxcala and Queretaro. The next states are all large, but are also characterized by concentrating economic activity: Nuevo Leon, Puebla, Jalisco, Hidalgo and Veracruz. In the case of Mexico population density and GDP density do not seem to account for economic growth patterns but are instead mostly the consequence of the process of centralization of resources around Mexico City. As will be discussed futher below, econometric estimates failed to find an explanation for GDP density other than the degree of urbanization characterizing a particular state.

Having provided this brief sketch of geographic features, we believe it is important to provide some quantitative sense of how important the “natural ecology” of Mexico is for the economy. Until recently it was difficult to provide anyestimates of the way in which the development process in Mexico is related to the natural resource base. However, INEGI has recently produced a system of environmental national accounts (*Sistema de Cuentas Económicas y Ecológicas de México 1988-1996*) which provides some insight into this specific aspect of the interface between geography and development. We want to stress the issue of the natural resource base and environmental degradation because, although this is not really incorporated into the analysis that follows, we believe it is a way to quantitatively measure the impact of the natural ecology and geography in the development process. Keeping detailed environmental national, state and even municipal accounts should be a basic activity of government.

Table 2 provides the physical balances of natural resources in Mexico between 1988 and 1996 according to INEGI. The last column shows the relative change in the stocks or flows, which is the physical environmental cost of economic growth, both from depletion of resources and degradation of the environment. INEGI calculates this cost for 1996 at $258,366.9 million pesos, which is around 10 percent of conventional GDP.

Table 2. Physical Natural Resource Balances (1988-1996)

Resource	Unit of measurement	1988	1996	Annual average percentage change
Forests	Thousands cubic meters	2657	2420	-1.16
Oil Reserves	Million barrels	69000	62058	-1.32
Water Overexploitation (Recharge–Extraction)	Million cubic meters	-4034	-5628	3.39
Air pollution	Thousand tons	26266	37523	4.56
Earth pollution from municipal solid waste	Thousand tons	19142	31368	6.37
Water pollution	Million cubic meters	16652	18415	1.27
Soil erosion	Thousand tons	403302	616256	5.44

Source: INEGI (1999), Cuadro 1.

It is clear from Table 2 that some of the resources that are being depleted or degraded represent major sources of economic growth and sometimes government revenue. Oil reserves are the most obvious example, while water and soil, subject to pollution and erosion, are less obvious. From the percentage changes, however, one can note that municipal solid waste and soil erosion are advancing at very high rates, which will eventually have an impact on municipal finances and agriculture production. Since these statistics are relatively recent they do not reflect the previous degradation of forests which occurred for decades (if not centuries, as reflected in the previous section's discussion of the Bajio), which in turn promotes soil erosion and reduces water recharge.

Unfortunately, information on deforestation and depletion of mineral resources is not available at the state level, which might make it possible to assess the impact of environmental degradation and depletion on a state's growth. There are some cases, though, such as oil in Campeche and Tabasco or forests in Michoacan, where such a relationship would probably be found.

The lack of state-level data notwithstanding, Table 3 provides at least some indicator of the economic cost of the natural ecology, according to economic sector, as measured by INEGI. Regions where an economic sector with high costs to the natural ecology is more prominent are more likely to be basing their growth on geographic rather than other factors of production. The table shows sectoral GDP and INEGI calculation of the Net Domestic Environmental Product (NDEP), which is GDP minus depreciation (hence Net), minus environmental degradation and depletion (hence environmental). The figure also reports the environmental cost and what it represents as a percentage of GDP.

Assuming these costs are distributed relatively evenly across states, it is clear that those states whose GDP relies most on mining or on electricity, gas and water are those whose growth is most affected by environmental degradation. Chiapas would be the most clear example of this. States more oriented towards manufacturing and services would incur less costs, although costs in transport, storage and communications are probably highly correlated with manufacturing and services. Nuevo Leon would provide an example of such a state.

Table 3. Net Domestic Environmental Product by Sector, 1995

Sector	Gross Domestic Product (GDP)	Net Domestic Environmental Product (NDEP)	Depletion and Degradation Costs	Depletion and Degradation Costs as Percentage of Gross Domestic Product
Agriculture, forestry and fishing	91,899.3	49,464.9	22,429.9	24.5
Mining	29,071.5	10,449.9	9,782.0	33.7
Manufacturing Industry	350,155.6	276,357.9	6,454.8	1.8
Construction	68,358.1	55,977.0	75.4	0.2
Electricity, Gas and Water	21,331.4	6,962.6	7,160.2	33.6
Commerce, Restaurants and Hotels	351,744.6	336,957.7	0	0
Transportation, Storage and Communications	168,082.9	30,362.4	121,448.3	72.2
Financial Services, Insurance and Real Estate; Social, Communal and Personal Services	598,191.4	503,346.4	30,763.3	5.1
Total	1,678,834.8	1,428,063.2	198,113.8	11.8

Source: Authors' calculations, based on INEGI (1999), Cuadros 4-12.

Further research would be needed to disaggregate INEGI information by state in order to calculate NDEP by state, and hence better understand the dynamics of growth as related to deterioration and depletion of the environmental resource base. Furthermore, it would be important to calculate what percentage of government revenues are accounted for by the loss of the natural ecology. However, this first analysis of the data tells us that there might be a very strong relationship between the exploitation of the natural resource base and the process of development (or underdevelopment, if there is such a thing as a vicious circle of poverty and environmental degradation, as suggested by Chiapas).

We now turn to whether there are significant relationships between location, climate and other geographic factors and the process of development in Mexico from a state cross-sectional point of view.

5. The Effects of Geography on Income, Growth and Poverty: A Regression Analysis

Does geography influence income, growth and poverty? This section tests some hypotheses for the correlates of geography with development in Mexico. The main findings suggest that, although the role of geography is limited, a fair amount of regional inequality in Mexico is attributable to natural conditions and the social and political environment that reinforces such natural conditions. Moreover, since poverty is concentrated in risky environments, where geographic conditions are most precarious, the findings suggest that man-made changes in the environment might make living conditions less precarious (such as building a highway in order to improve mobility or introducing health facilities in humid tropical zones prone to infectious diseases). We measure development through four indicators: official INEGI per capita state GDP for 1993 and 1980, GDP growth between 1950 and 1993, and poverty in 1995, measured as the Foster-Greer-Thorbecke (FGT) index with a poverty line set at two minimum wages.

These indicators attempt to measure the level of development in a traditional closed economy relying on natural resource growth during the oil boom (1980 GDP), the patterns of regional income disparity in the midst of the economic transformation from a closed to an open economy (GDP in 1993), a long term indicator of household well-being that can reflect long term effects of regional inequality (moderate poverty levels in 1990), and the differential pace of modernization in different regions across the country (growth). Growth performance is quite distinct from the first three indicators, since it captures a dynamic aspect of development, while the indicators of development levels reveal cross-sectional variation among regions in Mexico. As one could expect, controlling for other relevant variables, including the initial level of GDP, this is the indicator that is least explained by geographic features.

These development indicators are regressed using geographic independent variables such as average temperature and rainfall, kilometers of coastline, population density, and the number of political subdivisions in the state as expressed in municipalities, which we believe is a proxy for geographic fragmentation. Throughout, we control for sociodemographic changes, as reflected in literacy levels and urbanization, in order to separate the effects of the "natural" environment from a conventional modernization account of regional disparities. The section ends by performing an exercise that decomposes regional inequality, measured through the Gini coefficient, in terms of the determinants produced by the regression coefficients. Climatological features are calculated from INEGI data, using averages for time periods that differ in each state, but usually range from 30 to 40 years, averaged over the weather stations located in the state. Economic data come from INEGI, while the poverty index was calculated by CIDAC from census data.[3]

The level of aggregation of the data is relatively high at the state level. This limits both the scope of the inferences and the confidence in the statitistical results. The degrees of freedom are given by the number of Mexican states (31, minus three missing data states in the Yucatan peninsula, for which climatic data was unreliable). However, under different specifications, geographic variables remained important determinants of regional disparities. While a more detailed study would need to work at the municipality, locality or even AGEB (basic geostatistical units defined by INEGI) level, our findings suggest that the geographic differences in Mexico are stark enough so as to uncover some regularities even at this, admittedly high, level of analysis. All estimates are Ordinary Least Squares regressions with standard errors corrected for heteroskedasticity.

[3] It was impossible to locate reliable climatic data for the states of Campeche, Quintana Roo and Yucatan, so they are excluded from this analysis.

a) *State GDP Levels in 1993*

Table 4 presents a first set of estimates for the geographic determinants of the level of per capita GDP in the Mexican states in 1993, measured in natural logs (LGDP93). The first equation includes the independent variables of climate and location, given by the average rainfall and temperature as measured in the meteorological stations found in each state over the last 30 years; kilometers of coastline; population density (measured as inhabitants/km); and a dummy variable, BORDER, for a state on the U.S. border.[4] The functional form for rainfall and temperature is quadratic, since a graphical inspection of the data reveals a non-linear relationship, whereupon both high and low levels of rainfall are associated with higher income levels.[5]

Table 4. Geographic Determinants of State GDP Levels, 1993

Dependent Variable: LPIB93

	(1)	(2)	(3)	(4)	(5)
Cons	**4.054627 (1.625)**	**3.783938 (10.216)**	**2.703537 (8.94)**	3.179507 (-0.18)	1.581167 (1.678)
Rainavg	-0.00068 (-1.243)	**-0.00084 (-1.569)**	-0.00033 (-1.068)	-6.3E-05 (0.537)	.0004818 (0.982)
Rain2	1.25E-07 (0.591)	2.34E-07 (1.213)	1.48E-07 (1.353)	6.16E-08 (0.567)	-1.58e-07 (0.886)
Tempavg	-0.08377 (-0.356)				
Temp2	0.002895 (0.511)				
Coast	7.07E-05 (0.588)				
Border	**0.432294 (2.533)**	**0.392953 (2.415)**	0.018401 (0.161)	0.087662 (0.851)	.0914926 (0.568)
Ln Density	**0.206533 (3.372)**	**0.168632 (2.393)**	0.02822 (0.465)	**0.054196 (2.212)**	**.1484329 (1.757)**
Urban			**1.953585 (5.325)**	**1.222225 (2.218)**	**1.077618 (2.066)**
Femill				**-1.826 (9.718)**	**-1.473351 (-2.034)**
Ln Mun/km					**-0.150266 (-1.720)**
F	4.08	6.55	13.32	19.96	11.87
R2	0.4349	0.4964	0.7073	0.7416	0.7877

T-statistics in parenthesis, n=29.

Rainfall and temperature seem to behave according to a U-shaped pattern, in terms of the signs of each variable, but they fail to reach statistical significance. Among the location variables, the border dummy has a powerful effect on income levels. The coefficients suggest

[4] The Appendix shows the effect of using the variable LANDLOCK for a state having no connection with the coastline or the borders

[5] Unreported estimates were also carried out with various measures of dispersion (standard deviation, coefficient of variation) and the median of the temperature and rainfall variables, but they failed to reach statistical significance.

that the border location increases income by 0.43. Given the range of variation in the dependent variable (which goes form 1.5 to 2.2), this implies that, ceteris paribus, if a state is located on the border it will not fall into the poorest 20 percent of the distribution of Mexican states. When population density and urbanization are taken into account, as in equations 3-5, the border is no longer a determinant of income. The COAST variable is positive but not significant, suggesting that access to the coast might be associated with higher incomes. However, this variable fails to reach significance under almost all specifications, as shown in the Appendix.

Table 5.1 in the Appendix shows shows that results for equation 1 hold when the COAST variable is dropped, and that the effects remain when BORDER is substituted for the dummy variable LANDLOCK. The signs suggest that landlocked states would have lower incomes, although the effect is smaller than with border states, and the significance of this variable is suspect. In fact, what is probably happening is that landlocked states only seem to be poorer because they are not on the border, and the really important location variable is the border with the U.S. Table 5.1 also shows that effects (and sizes of the coefficients) remain basically unchanged in a specification only containing the variables that are sometimes significant, namely rainfall (and its square), border and population density. This specification provides the baseline regression, reproduced in Table 4 as equation 2, to which we incorporate urbanization effects, quality of infrastructure, human capital, and finally the number of municipalities, which we believe is a central determinant of income levels due to a historical lock-in.

The first human modification to the natural environment is created by cities and their accompanying public goods. In cities radical transformation of the natural ecology take place, when water, sewage or electricity are introduced. Equation 3 provides an estimate of urbanization effects on per capita GDP, controlling for geographic variables in the baseline regression. The sign of the urbanization variable, defined as the percentage population living in localities with more than 5,000 inhabitants, is positive, which suggests the higher the income, the more urbanized the state. Such a result is hardly surprising. The difficulty with this finding is understanding which aspect of urbanization is relevant to generating higher incomes.[6]

[6] Given the extremely high significance of the urbanization and land density variables, an additional test suggested by John Gallup would be to find out whether geographic variables, particularly those related to climate and location, explain GDP density, which is the product generated per square kilometer. We have found, however, that GDP density in Mexico is randomly distributed in terms of climate and location; although it is higher where population is more concentrated, which in Mexico happens to be the central highlands.

As Table 5 shows, urbanization is highly correlated with measures of public good supply (percentage of homes with electricity, water and sewage) and human capital (such as total adult illiteracy, female illiteracy or the percentage of the population which speaks only an indigenous language). Given the multicollinearity problem involved in putting all these variables in the same estimate, we provide other estimates in Table 5.2 in the Appendix, using specifications which provide the same basic message: these variables are always significant and with the correct signs, in terms of better infrastructure being found in the richer states. The causality of the second observation is obviously complex, since it could well be that those regions have better services precisely because they are rich (this issue is further discussed below).

Table 5. Correlation of Infrastructure and Human Capital Variables

	Elect	Agua	Dren	Urban	Illite
Elect	1				
Agua	0.8407	1			
Dren	0.7332	0.7096	1		
Urban	0.7516	0.7852	0.7234	1	
Illite	-0.7245	-0.8095	-0.7468	-0.7621	1
Illfem	-0.7243	-0.8097	-0.7295	-0.7413	0.9941

Table 5.3 in the Appendix provides estimates of the effects of human capital, measured by female illiteracy (FEMILL) and percentage of the population that only speaks and indigenous language (LENGUA).[7] Equation 4 shows that when the human capital variables are introduced, the explained variance increases to almost 74.16 percent, slightly above the infrastructure variables. Nonetheless, while geographic variables alone accounted for 43 percent of the variance in income levels across Mexican states, an improvement to around 71 percent is achieved with the infrastructure variables.[8]

A last set of income level regressions, found in Tables 5.4 and 5.5 in the Appendix, deals with the number of municipalities in each state. We believe the number of municipalities is a good proxy for a geographic component, namely the division of the territory into valleys delimited by mountainous natural boundaries, combined with the role of political jurisdictions

[7] Estimates (unreported) were also done with an index of human capital measured as primary and secondary school enrollment and with total adult illiteracy, which yielded the same basic results.

[8] Unreported regressions of the income levels only with the urbanization variable and one of the quality of infrastructure variables, excluding geographic determinants, account for around 30 percent of the variance, which seems consonant with this improvement.

and a historical lock-in effect of rulers attempting to produce internal borders in order to prevent exit. Such internal borders, we believe, limit trade and enhance the predatory power of the ruler, thus hindering growth and development.

The specification of the variable “number of municipalities” was tried by using first the absolute number (MUNIC), then municipalities per capita (MUNPC), and finally the number per square kilometer (MUNKM). In all cases the geographic variables and urbanization were kept in the regression, plus a control dealing with indigenous populations or female illiteracy, both of which are highly correlated (ρ=0.8435). The reason to include the human capital control in the version that most reflects the indigenous component is that we want to ensure that the municipal variable is capturing something other than the fact that states with more indigenous population (namely, Oaxaca, Chiapas and Puebla) also have more municipalities.

The number of municipalities in the different measurements always had a negative effect on income levels and was mostly significant. The exceptions occurred in cases where female illiteracy was included as a control; this probably reflects the fact that the most isolated communities, with female illiteracy rates as high as 90 percent at the municipal level, are found precisely in the rugged states with the most municipalities. The correlation between the variables is relatively high (p=0.5662). The fit of the regressions improved as the number of municipalities was adjusted first by population and then by territory. In fact, the variance accounted for by incorporating number of municipalities went all the way to 79 percent.

An issue that must be addressed regarding the municipal variable is whether there is an endogeneity issue generated by a notion that regions with higher population growth and that are more densely populated might become impoverished due to degradation of the natural resource base. It could also be considered that the fragmentation of political jurisdictions could be the consequence of low income levels, rather than a cause. In order to test for this possibility, Table 5.5 in the Appendix reports estimates of GDP levels in 1993, controlling for geography, urbanization and human capital, with the lagged value of the municipal variable. This lagged value is taken back to its origin circa 1825, when municipalities were organized across the country, first as a consequence of Spain’s Cadiz Constitution in Spain and then after independence.[9] The lagged effect of the municipal variable is always negative and significant, yielding results very similar those found for present-day municipalities.

The above results suggest that population density and urbanization are the variables that exhibit the most significant and robust relationships of all, where more densely populated urban regions are richer. This could be the result of the natural endowments of those regions, but it is also clear that higher income represents a clear incentive for migration into those regions. In contrast to the Gallup, Sachs and Mellinger (1999) findings at the world level, the densely populated regions in Mexico are in the highlands, far from the coast or major waterways. Some of the more densely populated states are also relatively small, which suggests that another reason may underlie their performance: being small may have some advantage for development. State size measured by population was included in unreported estimates, but it failed to be significant once density was taken into account. Although this result would seem to undermine the importance of natural geography for development, the results in the next series of estimates, with indicators including GDP in 1980, growth and a poverty index, suggest that geography had become less important by the end of the twentieth century.

Moreover, other unreported estimates of the effect of geography on municipal revenue suggest that at a lower level of aggregation, rainfall and temperature might play a greater role than at the state level.[10] While those other estimates are not for per capita GDP, since no such statistics exist at the municipal level, revenue collected by municipal taxes is probably highly correlated with the resource base and income of a given location. It is important to note that although further research is necessary, natural geography remains an important determinant of tax collection controlling for welfare levels as defined by an index of satisfaction of basic public good provision in the municipality.

Before turning our attention to estimates of the effect of geography on poverty, growth and income levels in 1980, an additional issue that we address is whether there is a relationship between the previous results and the land types that characterize each state. In particular, Table 6 provides estimates of the effect of land types on 1993 GDP measured as the percentage of a state territory constituting land suitable for agriculture, grazeland, forest, bush, rainforest, and other

[9] The series was constructed based on Hernández Chávez (1993), Tables 1 and 2, and attributing municipalities to the states that were later formed out of the provinces of Nueva Vizcaya and San Luis Potosí with the maps in Archivo General de la Nación (1996).

types of land. The results suggest that agricultural land might have a negative effect on development, while the bush characterizing much of the North might have a positive effect. The significance of the other land types variable is mostly related to the high GDP of Tabasco, which is also characterized by a unique type of marshland.

Table 6. Land Types and State GDP Levels in 1997

	(1)	(2)	(3)	(4)	(5)	(6)
Rainavg	-0.0000292 (-0.102)	0.0003359 (0.712)	0.0003484 (0.734)	**0.0009068 (1.965)**	0.0002788 (0.667)	0.0009808 (1.356)
Rain2	4.81E-09 (0.04)	-1.17E-07 (-0.63)	-1.22E-07 (-0.669)	**-2.79E-07 (-1.688)**	-8.66E-08 (-0.54)	-3.19E-07 (-1.299)
Border	-0.0631508 (-0.587)	0.0363042 (0.249)	0.0367881 (0.274)	-0.0593565 (-0.497)	0.0463352 (0.381)	-0.0244796 (-0.178)
Lndens	**0.1362684 (2.682)**	**0.1386411 (1.574)**	0.138232 (1.536)	**0.1384746 (1.714)**	0.0594675 (0.832)	0.1030983 (1.303)
Urban	**1.648799 (4.076)**	**1.639327 (3.536)**	**1.629437 (3.895)**	**1.789713 (5.742)**	**1.545269 (3.677)**	**1.899039 (4.102)**
Lnmunkm	-0.0732613 (-1.495)	**-0.1674797 (-1.896)**	**-0.1674427 (-1.9)**	**-0.1573938 (-2.307)**	-0.1065821 (-1.395)	**-0.1924887 (-2.171)**
Agric	**-0.007983 (-4.755)**					
Graze		0.0002387 (0.041)				
Forest			-0.000317 (-0.112)			
Bush				**0.0056068 (2.452)**		
Other					**0.0101982 (3.467)**	
Rainfore						-0.0056079 (-1.299)
_cons	**2.083231 (4.152)**	1.020182 (1.029)	1.03071 (1.08)	0.5423051 (0.641)	**1.787259 (2.31)**	0.561887 (0.519)
F	18.88	8.04	8.01	13.38	65.1	9.09
R2	0.8373	0.766	0.7661	0.8022	0.8162	0.7843

A final possibility, tested in Table 7 is that what really matters is not exactly the land type, but the homogeneity of land characterizing a particular state. To test this we construct a land type fractionalization index, which is simply the Hirschman-Herfindahl index, with the land types of each state (grazeland, forest, bush, rainforest and other). The fractionalization index fails to be significant, although further research could well find other alternatives to measure the degree of land homogeneity. Table 7 also shows that a major feature of agriculture, the organization of a state in *ejidos* (the traditional communal land tenure system discussed in the historical section), correlates negatively with development, consonant with the negative sign previously found for agriculture in equation 1 of Table 6. However, as discussed at the end of

[10] We thank Eduardo Lora for pointing out the relevance of these findings for the discussion of state-level regressions.

this section, such a finding is probably more related to political jurisdictions than to natural geography.

Table 7. Fractionalization of Land Types and *Ejido* Organizations for Agricultural Production as Determinants of 1993 GDP

	(1)	(2)
Rainavg	0.0001968 (0.529)	0.0005764 (1.433)
Rain2	-6.95E-08 (-0.491)	-2.01E-07 (-1.291)
Border	0.0170378 (0.119)	0.0359733 (0.32)
Lndens	0.1320696 (1.529)	**0.1957718** **(2.834)**
Urban	**1.72082** **(3.881)**	**1.340769** **(3.122)**
Lnmunkm	**-0.1551498** **(-1.956)**	**-0.1329006** **(-2.208)**
Fracc	-0.0217427 (-0.649)	
Lnejidkm		**-0.1769077** **(-2.771)**
_cons	1.230453 (1.408)	0.3873119 (0.515)
F	7.95	11.07
R2	0.7694	0.8044

b) Poverty Levels in 1990

An alternative way to measure state development is not through GDP, but rather through poverty indicators. The Appendix provides a full set of tables (Tables 5.6 through 5.9) which assess the effect of geography on poverty levels measured through the FGT index calculated for 1990. The FGT index constitutes an indirect poverty measure, which is based on the reported income of a family according to census data. While more reliable income data from households surveys exists, it is not possible to disaggregate a poverty index at the state level from that source. Hence, the FGT index was calculated setting the poverty line at two minimum wages, and establishing in the index a concern for the distribution of poverty by making its parameter $\alpha=2$. It must be stressed that the dependent variable is not a welfare index that includes the infrastructure and urbanization variables as part of its components (such as INEGI's *indice de bienestar* or CONAPO's *indice de marginación*), but an indirect poverty index measured through family earnings.

As shown in Table 8, the basic finding is that natural geography variables are not robust, since quality of infrastructure and human capital account for most of the variance in poverty levels. Although at first sight location and population density seem to be important for poverty levels, once urbanization is taken into account, with all the public good provision issues it encompasses, those variables fail to reach significance. The bottom line in this respect is that poverty is concentrated in rural areas, so that urbanization almost uniquely determines poverty levels. However, a more crucial result is that the municipal variable remains important and significant for the determination of poverty levels.

Table 8. Geographic Determinants of State Poverty Levels 1990

Dependent Variable: FGT(2,2)

	(1)	(2)	(3)	(4)	(5)
Cons	.168338 (0.287)	**.521036 (7.863)**	**.372475 (3.462)**	**.4522231 (5.571)**	**.402986 (3.656)**
Rainavg	.0001752 (1.151)	.0000887 (1.488)	-.0000103 (-0.187)	2.77e-06 (0.064)	-.0000174 (-0.352)
Rain2	-2.09e-07 (-0.370)	-2.76e-08 (-0.989)	3.26e-09 (0.163)	4.98e-10 (0.033)	8.56e-09 (0.439)
Tempavg	.0084413 (0.143)				
Temp2	-.0005194 (-0.359)				
Coast	1.23e-06 (0.048)				
Border	**-.0735318 (-2.869)**	.036904 (1.423)	.021144 (0.976)	.0151645 (0.646)	.029022 (1.306)
Density	**-.0003827 (-2.952)**	.0001002 (1.301)	.0000496 (0.891)	-.0000149 (-0.311)	-.0000392 (-0.560)
Urban		**-.550246 (-5.629)**	**-.348977 (-2.706)**	**-.409791 (-3.876)**	**-.3848575 (-2.870)**
Femill			**.562566 (2.740)**	**1.60672 (4.783)**	
Language					**.443549 (2.219)**
Mun / km				**7.507978 (6.650)**	**7.14284 (4.707)**
F	11.57	14.12	23.51	87.30	20.99
R2	0.6337	0.7921	0.8568	0.9076	0.8915

An additional aspect that should be stressed is that, although the number of municipalities is greatest in states with a strong indigenous population, such as Oaxaca, Chiapas and Puebla, controlling for indigenous population with the variable LANGUAGE, which is the percentage of people in a state that only speak an indigenous tongue, yields still a highly significant effect of political framentation on poverty. More fragmented states tend to be poorer, once we have controlled for public good provision, human capital formation or ethnic conditions.[11]

c) Growth of GDP Regressions from 1950 to 1993

In terms of the geographic determinants of GDP growth, another set of tables in the Appendix (5.10 through 5.13) incorporate first pure geographic variables of climate, location and population density, then urbanization effects, followed by quality of infrastructure, human capital, and finally the number of municipalities.

Table 9 below reproduces the most important findings. In the growth regressions, all estimates are done controlling for the initial income levels, namely, state GDP per capita in 1950. Convergence is observed in terms of the negative and highly significant coefficient of this variable, reflecting that initially poor states have tended to grow faster than rich ones. Conditioning variables for this convergence are added in the spirit of the new literature on growth so that, instead of controlling for human capital through female illiteracy as in the previous estimates, we use the percentage of children enrolled in elementary school in 1959.[12] It is noteworthy that among the geographic variables, population density and rainfall always survive as determinats of growth; location on the border or along the coastline is no longer significant. Quite surprisingly, urbanization in 1960 is not a good predictor of economic growth, regardless of its importance in the previous estimates.

[11] One possible avenue for further research would be to use GIS data at the AGEB (Area Geoestadística Básica) level of rainfall, location, urbanization, population density, illiteracy, language and even land use, available from INEGI, combined with the newly released NIBA database, which provides poverty indicators also by AGEB.

[12] The Appendix shows that using 1940 instead of 1959 yields basically the same result. Education has not been a conditioning factor in the way found in much of the growth literature, although this might be to some extent a matter of measurement, since secondary school enrollment tends to be significant in estimates.

Table 9. Geographic Determinants of State Growth, 1950-1993

Dependent Variable: growth5093

	(1)	(2)	(3)	(4)	(5)
_cons	**3.853566 (2.605)**	**3.013644 (10.749)**	**3.026254 (11.084)**	**2.91656 (10.374)**	**2.943211 (5.863)**
lnpib50	**-0.5488505 (-7.199)**	**-0.5454843 (-9.572)**	**-0.5669299 (-6.791)**	**-0.6031166 (-7.306)**	**-0.6000654 (-5.247)**
Rainavg	**-0.0014015 (-3.664)**	**-0.0013783 (-4.442)**	**-0.0013487 (-3.718)**	**-0.0014186 (-4.145)**	**-0.0014283 (-3.933)**
rain2	**6.81E-07 (5.38)**	**6.95E-07 (6.214)**	**6.88E-07 (5.523)**	**7.12E-07 (6.418)**	**7.16E-07 (6.013)**
Tempavg	-0.0897579 (-0.617)				
Temp2	0.0024662 (0.732)				
Border	-0.0088027 (-0.068)				
Coast	-0.0001007 (-1.178)	-0.0000805 (-1.061)	-0.0000743 (-0.89)	-0.0000908 (-1.234)	-0.0000916 (-1.196)
lndens50	**0.0877558 (2.368)**	**0.0886773 (4.285)**	**0.082908 (2.536)**	**0.0846422 (2.675)**	**0.082734 (1.785)**
urb60			0.0979985 (0.278)	-0.0042092 (-0.012)	-0.009359 (-0.024)
iprim59				0.4704316 (1.562)	0.4708052 (1.53)
Ln mun / km					0.0033509 (0.055)
F	78.14	59.91	46.42	87.11	73.22
R2	0.8979	0.8914	0.8918	0.9002	0.9002

When controlling for all these variables, the variables for fragmentation of political jurisdictions was no longer significant. This result suggests that although initial levels of GDP in 1950 are determined by the number of jurisdictions, such a political variable does not have effects on the margin for changes of income through time. Although further research would be needed in order to prove this assertion, and maybe a two-state estimation procedure is called for, this is an encouraging result for the future prospects of development in the Mexican states. Growth regressions were also tested according to land use (according to INEGI) depending on whether land was unsuitable for agriculture, and land types classified by agricultural, bush, forest or rainforest. No significant results were obtained, but this could be a consequence of the level of aggregation.

d) GDP Levels in 1980

A relatively surprising finding in the course of this research was that geographic variables were stronger determinants of GDP in 1980 than in 1993. Such a result was also found for regressions carried out with GDP figures for 1950, 1960 and 1970. This might suggest that depending of the makeup of an economy and the type of specialization that characterizes it geography might be more or less important. In 1980 the Mexican economy was heavily reliant on oil, little diversified in its exports, and still heavily weighted by a history of an import substitution industrialization strategy. By 1993 radical changes had already occured in terms of a greater reliance on manufacturing exports and an insertion into the world economy which soon would become firmly embedded in the institutional framework of NAFTA. In a way, Mexico was a very different country in 1980 than in 1993; in 1980 geographic variables played a stronger role.

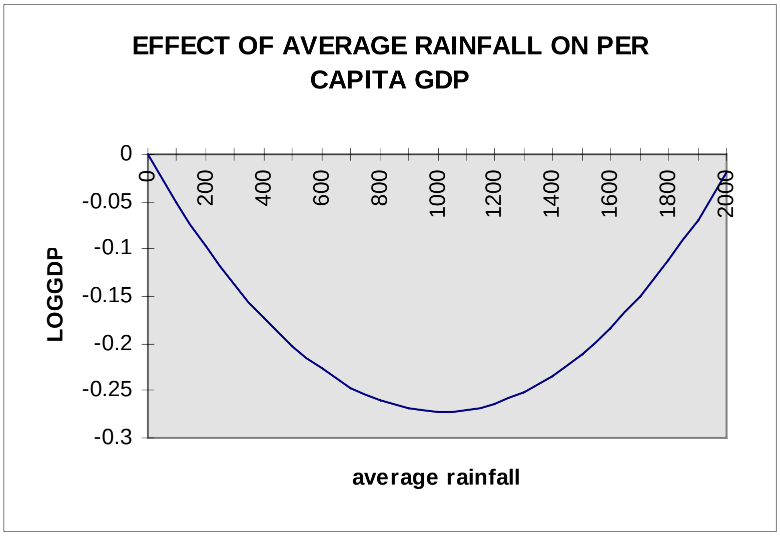
Table 10. Geographic Determinants of State GDP Levels, 1980

Dependent Variable: LPIB80

	(1)	(2)	(3)	(4)	(5)
Cons	2.4629 (1.0773)	**1.88822 (18.282)**	**1.37908 (11.306)**	**1.556826 (9.516)**	**1.422119 (8.999)**
Rainavg	**-.000535 (-2.497)**	**-.0005814 (-3.220)**	**-.0005331 (-4.551)**	**-.0003813 (-2.788)**	**-.0003435 (-2.940)**
Rain2	**2.63e-07 (3.223)**	**2.49e-07 (4.217)**	**3.09e-07 (6.795)**	**2.62e-07 (5.640)**	**2.45e-07 (5.948)**
Tempavg	-.06681 (-0.621)				
Temp2	.001831 (0.707)				
Coast	3.85e-06 (0.086)				
Border	**.179146 (2.734)**	**.168723 (2.775)**	.056026 (1.098)	.068052 (1.287)	.029569 (0.669)
Density	**.0001161 (5.868)**	**.0001169 (12.281)**	**.0000551 (4.043)**	**.0000554 (4.293)**	**.0000665 (7.054)**
Urban			**.694243 (4.387)**	**.454746 (2.191)**	**.629276 (3.141)**
Femill				**-.771651 (-2.965)**	**-.48519 (-1.869)**
Mun/km					**-13.76061 (-4.812)**
F	26.33	38.48	102.20	150.72	185.03
R2	0.7049	0.6782	0.8422	0.8740	0.9119

As Table 10 shows, in 1980 the findings are similar to those for levels in 1993, but there is now a very strong effect of the rainfall variable, which was not significant before. All the equations reveal a highly significant relationship with rain, where the negative sign of RAIN involves a lower income level for states with higher rainfall, but such a relationship reaches its bottom at the intermediate levels of rainfall, as can be seen in Figure 5, which uses the coefficients of this first equation to simulate the effect of rainfall. Thus in 1980 rainfall was associated with lower income, particularly for states in the 1,000 mm range (Colima, Guerrero, Hidalgo, Mexico, Morelos, Nayarit, Oaxaca and Puebla) but this effect was not important for the extreme cases of states like Baja California (151 mm of rainfall) or Tabasco (2,297 mm).

Figure 5.



The significance of this finding is that trade liberalization, and in general economic openness, seems to be an important escape rout from natural geographic handicaps. A region that is not well endowed in terms of rainfall and location variables would seem to do worse under a closed than an open economy, as suggested by the comparison of the 1980 and the 1993 results. Moreover, these estimates seem to suggest that the geography of public good provision is a much stronger and more relevant determinant of income levels in open than closed economies.[13]

[13] We owe this insight to Eduardo Lora. Further research should be pursued along the lines of the effect of trade openness on geographic determinants of income.

e) Regional Inequality Decomposed

Table 11 provides an estimate of GINI coefficients for simulations for inequality if the deviations of the independent variables were subtracted from their average value. That is, the exercise tells us how much regional inequality can be attributed to the specific inequality produced in the regression by the variance in each specific independent variable. The exercise is carried out incrementally, so that the first variable which is discounted is rainfall, to obtain a predicted dependent variable (GDP levels, growth or the poverty index), and then a GINI index to capture the overall distribution, without the rainfall effects. The next line in the table generates a new GINI coefficient for the previous predicted value subtracting the border effect, then population density, and so forth. Hence the last line of each estimate represents, in fact, a residual inequality that is not accounted for when the variances of all the independent variables have been eliminated.

Table 11. GINI Coefficients Isolating Effects of Explanatory Variables
(Cumulative effects)

	LGDP80	LGDP93	GROWTH	FGT22
Dependent variable (Y)	0.2605	0.2834	0.2142	0.2285
- average rainfall	0.2798	0.2955	0.2034	0.2281
- border (dummy)	0.2774	0.2896		0.2491
- coastline (km)			0.1984	
- density (pop/km2)	0.1813	0.2339	0.2093	0.2518
- urbanization	0.0876	0.1726	0.2012	0.1435
- female illiteracy	0.0704	0.1352		0.1051
- primary school enrollment			0.2013	
- political jurisdictions (municipalities/km)	0.0559	0.1129		0.0807
- initial GDP			0.0884	

Table 12 now provides the percentage of inequality which is cumulatively produced by "neutralizing" each of the independent variables on top of the previous one.

Table 12. Relative Contribution to Inequality Measured by GINI Index
(Cumulative effects, as percentage of dependent variable GINI)

	LGDP80	LGDP93	GROWTH	FGT22
Rain	-7.4	-4.3	5.0	0.2
Border	-0.9	2.1		-9.2
Coast			2.3	
Density	36.9	19.7	-5.1	47.4
Urban	36.0	21.6	3.8	
Illiteracy	6.6	13.2		16.8
School			0.0	
Municipal	5.6	7.9		10.7
Initialgdp			52.7	
Unaccounted	21.5	39.8	41.3	35.5

It is clear that the most prominent contribution to income inequality is made by urbanization, which is highly correlated with all the public good variables (water, electricity, sewage). When the urbanization effect is discounted, the GINI coefficient is smaller. This means that the distribution of public goods in Mexico has actually enhanced regional inequality. Although there has been a tendency for some convergence in the provision of public goods across states throughout the whole century, this means that the policies that have provided those goods have, nonetheless, generated greater regional inequality. It is important to note that this effect remains controlling for density, which is the other variable that contributes most to inequality, which means that such an effect of urbanization is related to public goods, not just to the mobility of population through migration towards more attractive geographic locations. Average rainfall has the opposite effect, in that when the rainfall effect is neutralized, inequality increases. Such an effect, is however, relatively small.

6. The Meaning of Municipalities

A question arises as to the precise meaning of the municipalities variable. One could argue that the number of jurisdictions is unrelated to geography, but produced by policy variables or an optimal size given by economic processes. Moreover, there is an issue as to whether an endogeneity problem exists in the previous findings. The remarkable aspect of this variable is that the number of municipalities has been quite constant during the last two centuries. Tables 13 and 14 show the evolution of municipalites in Mexico. The first table provides estimates for the number of municipalities by state in 1825, 1917 and today. The second provides more detailed information concerning municipalities in 1917 and the information that exists on what institutional arrangement immediately preceding them in the nineteenth century.

Table 13. Number of Municipalities by State

	1825	1917	1999
Aguascalientes	*1*	8	11
Baja California			5
Baja California Sur			5
Campeche	*1*	8	9
Coahuila	*4*	37	38
Colima	*1*	8	10
Chiapas		59	111
Chihuahua	*2*	64	67
Distrito Federal	*1*	13	16
Durango	*2*	43	39
Guanajuato	**14**	33	46
Guerrero	**33**	67	76
Hidalgo	**63**		84
Jalisco	*15*		124
México	**72**	118	122
Michoacán	**90**	75	113
Morelos	**17**		33
Nayarit	*1*	17	20
Nuevo León	**7**	49	51
Oaxaca	**200**		570
Puebla	**172**	142	217
Querétaro		6	18
Quintana Roo		18	8
San Luis Potosí	**10**	55	58
Sinaloa		16	18
Sonora		76	70
Tabasco		17	17
Tamaulipas	**7**	37	43
Tlaxcala	**42**	44	60
Veracruz	**6**	183	207
Yucatán	**160**		106
Zacatecas	**3**	50	56
	2,749	3,160	4,427

Sources: For 1825, Hernández Chávez (1993) in bold type and Secretaría de Gobernación (1996) in italics; for 1917 INEGI (1997); for 1999, Cedemun (1999).

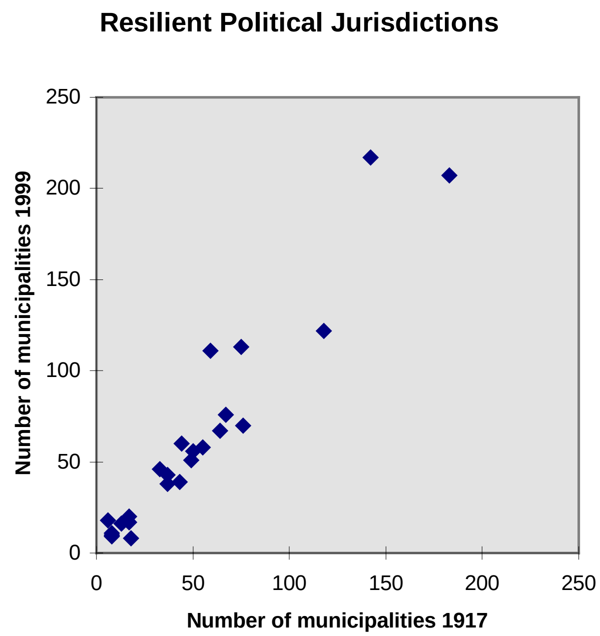
Table 14. Evolution of Territorial Division from the Late Nineteenth Century to the Twentieth Century

	Municipalities before 1917	Municipalities in 1917
Aguascalientes	(18/10/1868) divided into 4 partidos	8 municipios libres
Baja California	n.d	n.a.
Baja California Sur	n.d	n.a
Campeche	(13/07/1877) divided into 5 partidos	8 municipios libres
Coahuila	(20/12/1868) divided into 5 distritos	6 distritos judiciales and 37 municipios libres
Colima	(13/07/1867) 2 partidos and 6 municipalidades	8 municipios libres
Chiapas	(05/02/1857) divided into 7 departamentos	59 municipios libres
Chihuahua	(1867) 5 distritos and 17 cantones	64 municipios libres
Distrito Federal	(05/02/1857) 1 municipalidad and 4 partidos	13 municipalidades
Durango	(1867) divided into 13 partidos	43 municipios libres
Guanajuato	(05/02/1857) 5 deptos and 20 municipalidades	33 municipios libres
Guerrero	(18/05/1847) 4 distritos	15 distritos and 67 municipios libres
Hidalgo	(16/01/1869) 11 distritos	n.a.
Jalisco	(30/12/1836) 8 dsitritos and 19 partidos	(22/08/1864) 8 cantones and 28 departamentos.
México	(14/10/1870) 16 distritos	118 municipios libres
Michoacán	(1867) 17 distritos, 75 municipalidades, 216 tenencias	(24/04/1868) 17 distritos, 75 municipalidades, 216 tenencias
Morelos	(17/04/1869) 5 distritos	n.a.
Nayarit	(12/12/1884) 6 partidos	17 municipios libres
Nuevo León	(22/08/1846) 3 distritos, 7 partidos, 31 municipalidades	49 municipalidades and 1 congregación
Oaxaca	(05/02/1857) 25 distritos and 22 partidos	50 municipal departments
Puebla	(14/12/1853) divided into 24 partidos	(1867) 18 distritos and 142 municipalidades
Querétaro	(18/01/1869) 6 dsitritos	6 municipios libres
Quintana Roo	(24/11/1902) 2 prefecturas	n.a.
San Luis Potosí	(24/05/1869) 3 partidos and 52 municipalidades	55 municipios libres
Sinaloa	(03/03/1865) 2 departamentos	16 municipios libres
Sonora	(14/05/1869) 9 distritos	76 municipios libres
Tabasco	(18/12/1883) 17 municipalidades	17 municipalidades
Tamaulipas	(05/02/1857) 3 dsitritos and 11 partidos	37 municipios libres
Tlaxcala	(03/03/1865) 5 dsitritos and 27 municipalidades	44 municipios
Veracruz	(05/02/1857) 18 cantones	183 municipios libres
Yucatán	(05/02/1857) 13 partidos	n.a.
Zacatecas	(1867) 12 partidos	50 municipalidades

Source: INEGI (1997).

Figure 6 shows just how resilient political jurisdictions in Mexico seem to be, in that for those states where data is readily available, the correlation between municipalities in 1917 and 1999 is very high.

Figure 6.



Finally, Table 15 reports that the number of municipalities in 1825 is a very good predictor of municipalities 170 years later, particularly if controls are introduced for population at the turn of the last century (POB1893) and the territory measured in square kilometers. Table 15 also reports that climate and location variables do not explain the number of municipalities, when the initial number is controlled for. However, as the last estimate in the table shows, when the initial number of municipalities is not included in the estimation, the variables of rainfall and coastline are important determinants of number of municipalities. More jurisdictions exist in the coast and at middle ranges of rainfall. Further exploration with topographical measures might reveal that the number of municipalities is quite geographically determined, although we believe that the basic thrust of this variable is political. Municipalities can be taken as a useful proxy of a historical lock-in phenomenon that incorporates geography and political incentives, and the numbers should be taken seriously as a determinant of income levels.

Table 15. Historical Origin of Number of Municipalities
Dependent Variable: Munic

	(1)	(2)	(3)	(4)	(5)	(6)
Cons	**33.22175 (3.053)**	-20.9455 (1.205)	-6.425667 (-0.367)	-26.05414 (-1.2255)	-362.4151 (-1.503)	-629.4326 (-1.060)
Mun1825	**1.491698 (2.682)**	**1.3168 (2.335)**	**1.28880 (2.316)**	**1.29608 (2.308)**	**1.538409 (2.545)**	
Km2		**0.00044 (2.373)**	**.0003252 (2.050)**	**.0005186 (2.168)**	**.0005451 (2.642)**	**0.0005213 (1.669)**
Pob1893		**0.086 (2.29)**	**.0966676 (2.297)**	**.086208 (2.028)**	.038580 (1.428)	**0.1270358 (1.988)**
Border				-25.1015 (-.0983)		10.2253 (0.389)
Coast				.015848 (0.870)		**0.0655094 (2.006)**
Landlock			-28.23828 (-1.284)			
Rainavg					.100647 (1.453)	**0.3807909 (2.044)**
Rain2					-.0000185 (-0.780)	**-0.0001138 (-1.855)**
Tempavg					29.6829 (1.257)	43.84365 (0.873)
Temp2					-.755366 (-1.318)	-1.204517 (-0.991)
F	7.19	6.22	5.06	3.73	3.39	2.93
R2	0.5783	0.6838	0.6972	0.6957	0.7916	0.5343

How do we understand this process to have developed? Mexico's natural ecology shows several distinct regions that very early affected population patterns. During pre-Hispanic times, the available primitive technologies limited large populations to areas where sufficient food was easily produced. This meant that those regions with stocks of water, rich soils and appropriate temperature were first settled, while less well endowed areas remained relatively vacant. These more favorable areas were the Michoacan and Guanajuato lakes region, the central Valley of Mexico, the Valley of Oaxaca, small areas in the Veracruz midlands and the tropical Mayan region. Northern Mexico was sparsely populated by nomads, while jungles and mountains were left as refuge areas to weaker and smaller nations.

The sixteenth century Spanish conquest introduced new technologies and institutions in Mexico. The victorious Spaniards, however, immediately became overlords and began extracting the rents that had formerly been controlled by the dominant Indian groups. The demographic catastrophe[14] that followed the military conquest required that if rent extraction

[14] The population dropped in the sixteenth century from somewhere around 20 million Indians in 1520 to barely 2 million in 1600.

were to be continued, the Indian population had to be carefully controlled and kept in one geograhical location. This meant that both institutions and policies had to be adapted to the new low-density reality. Individuals, now fewer in number, became more valuable and had to be confined to the land which they made productive. Allied Indian chieftains were given townships and territorial jurisdictions to govern and from which extract rents. These entities maintained the indigenous communal land tenure system and in time became the origin of most municipalities in central Mexico. Spaniards, on the other hand, were given *encomiendas* (land grants) and *repartimientos de indios*[15] (site-specific allocations of indigenous labor in an arrangement similar to serfdom) to make these lands productive. This practice became the origin of the large *haciendas* and of new settlements in the newly opened regions. Mexico's economic development has thus displayed since its begining the seeds of two very different models: one based solely on rent extraction of existing resources, in populated central Mexico, and the other based on new technologies, stock accumulation and productivity increases in geographic regions opened by the insertion of Mexico into the Spanish-European colonial economy, and centuries later by its insertion into the world and global economies.

Municipalities thus developed in two very different ecological settings with different results. Where population density was high because of propitious natural conditions for the production of food by the available primitive technologies (the central Valleys of Mexico and Oaxaca, the midlands of Veracruz and the lake regions of Michoacan and Guanajuato), municipalities became efficient rent-extracting mechanisms. Where population density was low, because of poorer natural conditions, the introduction of new food-producing technologies (western agriculture techniques, irrigation and/or extensive cattle raising) or the discovery of valuable mining resources, municipal institutions contributed to faster colonization, population growth and economic development. The institutional "lock-in" phenomenon would seem to explain the negative correlation found between the number of municipalities and economic wealth.

Although further research is called for on this topic, one immediate question arises as to whether some of the "lock-in" phenomena of the institutional ecology might be correlated. That is, it could well be that the number of municipalities is correlated to the historical conformation

[15] *Encomiendas* had the purpose of christianizing the indians by having them under the tutorship of "old Ohristians" who had to provide education and religious instruction. *Repartimientos* were established as rewards to the Spanish soldiers who contributed to the conquest of Mexico by giving them whole Indian towns to exploit and benefit from.

of tax authority and the organization of production in agriculture as reflected by ejidos. Although we do not attempt to probe into the possibility that all of these variables might be measuring an underlying institutional density, Table 16 shows that this is a definite possibility as reflected by the correlation matrix of the number of *ejidos*, the locations of taxes on trade in 1810 (*alcabalas*), and the number of municipalities in 1917, 1825 and today. The low correlation between *ejidos* and municipalities in 1825 at their original inception suggests that these variables measure different phenomena, or that at least the current number of *ejidos* is vary different from what it might have been originally. The *alcabala* posts in 1810 show a very high correlation with the number of all municipalities variables, which suggests that the multiplication of political jurisdictions might be concurrent with the establishment of tax authority. However, this is mostly speculation, since further research is necessary in order to ascertain these relations.

Table 16. Correlation Matrix of the Number of Municipalities and Other Institutional Density Variables

	ejidos	alcab810	mun1917	munic	mun1825
Ejidos	1				
alcab810	0.5074	1			
mun1917	0.7547	0.7537	1		
Munic	0.7334	0.7689	0.9592	1	
mun1825	0.1861	0.7892	0.5673	0.6879	1

A final important issue is whether the number of municipalities provides an explanation for the deficient provision of local public goods in vast regions in Mexico. As Table 17 shows, estimates using the percentage of homes with sewage, water, electricity, where indigenous languages are spoken or the degree of female illiteracy in 1990 fail miserably to be explained by the number of municipalities. Perhaps as much of a surprise comes from observing that initial GDP does not provide an explanation either. We believe the problem with this estimates lies in the level of analysis, and that a more disaggregated approach might prove to be a fruitful avenue for further research, since it is quite likely that fragmentation of localities, for example, within a municipality explains quite a lot of the deficiency in public good provision.

Table 17. Municipalities as an Explanation for Public Good Provision

	Sewage	Water	Electricity	Language	Femill
Lnmunkm	0.0124444 (0.327)	0.0124361 (0.384)	0.0031767 (0.279)	-0.0001719 (-0.027)	-0.0072523 (-0.32)
Lndens	0.0437953 (1.487)	0.0190272 (0.792)	**0.0165098** **(1.772)**	-0.0029385 (-0.593)	-0.0026592 (-0.157)
lnpib50	**0.1101855** **(2.388)**	0.0325018 (0.806)	0.0162528 (0.85)	-0.0099609 (-1.27)	**-0.0669561** **(-2.598)**
Rainavg	-0.0003092 (-1.351)	-0.0002001 (-1.218)	-0.0000902 (-1.112)	0.0000427 (1.163)	0.0002015 (1.498)
rain2	1.09E-07 (1.248)	1.78E-08 (0.293)	1.44E-08 (0.419)	-8.69E-09 (-0.504)	-4.82E-08 (-0.881)
Border	-0.0448053 (-0.796)	0.0007333 (0.018)	-0.0019583 (-0.086)	0.0102295 (1.029)	0.0233623 (0.679)
_cons	0.494646 (1.356)	**0.9255813** **(3.344)**	**0.9006226** **(8.963)**	0.0177903 (0.291)	0.1442824 (0.667)
F	3.87	14.76	2.97	1.49	8.32
R2	0.5046	0.6084	0.4535	0.4366	0.6794

7. Policy Implications and Research Agenda

Mexico's past as a colonial society, based on natural resource exports, namely silver, produced rent-seeking political institutions to serve a predatory elite that had no incentives to compete. The oil booms in the 1920s and 1970s were not altogether so different, in that natural resource exports did not produce an endogenous process of development. Instead, the country was characterized by a great institutional density. This would be reflected in internal barriers to trade which made exchange even more difficult than what the already important natural barriers entailed. Thus Mexico has been primarily a fragmented, closed, protected economy. At the regional level, only when transport costs declined with the arrival of the railroad, at the end of the nineteenth century, did the North begin accelerated growth that was open and subject to competition, and subsequently reflected in political demands. The North took advantage of the existence of coal in northern Coahuila, and Monterrey started its industrialization. This development can only be explained by a crucial locational factor, namely the shared border with the United States. Geographic destiny plays a key role in the development prospects in the country even today, as NAFTA determines much of the dynamic growth of mid-size cities in the North of the country.

Geography has played key roles in development at various moments. The ease of maritime transport through steamers, together with the tropical climate, allowed for the development of plantation economies, for example in Yucatan (henequen), Veracruz (sugar) and

Chiapas (coffee), accompanied by the emergence of authoritarian semi-slavery political institutions. The political and demographic center of the country specialized in incipient manufactures and traditional foodstuffs for the national market, which was kept relatively closed due to transport barriers. Coastlines remained relatively unpopulated due to the risk of malaria.

This pattern of regional development has long-lasting effects that are still felt today. While the relatively young cities of the North have become thoroughly integrated into global production and trade networks, creating democratic political institutions that are conducive to citizen participation and involvement, the Gulf states are still backward not only in economic but also political terms. Large populations have been excluded from the benefits of free trade and markets.This is due largely to historical privations, to which one must add isolated geographies, harsh climatic conditions, and public policies that have not been able to extend the benefits of urbanization, literacy and communication to those areas. Poverty in Mexico is, in fact, closely related to geography, although the exact characteristics of this relationship are still a topic that merits much future research.

This paper has attempted to put geograhic determinants of development into perspective, using mostly state-level information in the case of Mexico. However, the main findings point towards the need to engage in a more local level of analysis that should first concentrate on municipalities and then probably move on to localities within each political jurisdiction.

On the other hand, we have stressed the role of institutional ecology in the way in which geography can determine development by promoting the creation of some types of political institutions rather than others. While much of this remains a hypothesis rather than a proved relationship, a very important area of future research constitutes being able to characterize local political institutions at the municipal level in a meaningful way, seeking to find whether the relationship with geography holds at that level of analysis.

Further studies should provide an empirical basis for formulating population policy. At present, the Mexican population has largely settled in areas that are not geographically adequate. Most Mexicans live at more than 3,000 feet above sea level. In addition, a large portion of the population lives in mountainous areas with difficult communications, and a growing number is invading the southern tropical rain forests. All of these settlement patterns indicate the existence of institutions that are providing the wrong signals to social actors. This suggests that study should be devoted to the feasibility of policies to improve health conditions along the coastline, perhaps promoting migration towards the sea. This would involve promoting the “revolution” of air conditioners and the construction of means of communications towards the coasts and the borders, which seem to be natural areas for growth in the coming years.

The provision of public goods in new settlements on the coasts and lowlands would probably require the creation of statutes, incentives and financial instruments to facilitate a gradual population flow into places with adequate services. The results we have provided in the paper show that urbanization and its correlates (electricity, sewage and water) play a key role in the development prospect, controlling for other variables. The way in which geographic conditions might make the provision of local public goods more or less difficult is a topic that merits futher research.

Recent political developments in Mexico point towards a trend for a greater decentralization of decision-making to the municipal levels, especially on those issues connected with fiscal sovereignty and regulation. This is another major area of future research, since one can think of policies that might promote the competition of different institutional models prevailing in different regions. For example, one can imagine that innovative policies that sacrifice current revenue collection in order to reward efficiency and later increase future tax collection could be strategically proposed by municipal authorities and then, when they are successful, become diffused through imitation.

An additional area that merits further research, and one with important policy implications, is the need for ecology audits (both natural and institutional) to understand the hidden and overt costs that Mexico is paying for maintaining its current set of institutions and exploiting its natural resources. This should be done at the state and municipal levels, as well as regionally, in order to understand interjurisdictional spillover effects.

But the most prominent area where we believe a fruitful analysis of the effects of geography in development should be carried out is poverty and geographic poverty traps. Poverty is usually concentrated in specific places, which share common characteristics not only in the relative deprivation of public goods and services, but also in the natural resources and political institutions that prevail. Understanding whether there are policy prescriptions of what needs to be done to open up those poverty traps, thus removing barriers to many Mexicans’ sharing in the benefits of an open economy, is one of the greatest tasks ahead.

Those barriers could be natural, such as rivers, forests or mountains, or linguistic and cultural, but they could well be man-made in terms of unintended effects of current public good provision policies and even poverty relief efforts. These barriers might also represent a byproduct of greater decentralization, which might entrench predatory political elites in poor regions. If researchers could gain further insight into the way in which poverty and destitution can be alleviated within a sophisticated understanding of geographic conditions and local public goods, they might have important prescriptions to offer to governments and policymakers in the most important topic for social development.

8. References

Barro, R., and X. Sala-i-Martin. 1994. *Economic Growth*. New York, United States: McGraw-Hill.

----. 1991. “Convergence Across States and Regions.” *Brookings Papers on Economic Activity* (1): 107-58.

Bates, R.H., and D-H.D. Lien. 1985. “A Note on Taxation, Development and Representative Government.” *Politics & Society* 14(1): 53-70.

Bloom, D.E. and J.D. Sachs. 1998. “Geography, Demography, and Economic Growth in Africa” Harvard Institute for International Development: Harvard University.

Blum, R. 1999. *México 2018*. Mexico, D.F., Mexico: CIDAC. Manuscript.

Caravaglia, J.C., and J.C. Grosso. 1987. *Las Alcabalas Novohispanas (1776-1821)*. Mexico, D.F., Mexico: Archivo General de la Nación.

Carmagnani, M. 1994. *Estado y Mercado*. Mexico, D.F., Mexico: Fondo de Cultura Económica.

Casella, A., and B. Frey. 1992. “Federalism and Clubs: Towards an Economic Theory of Overlapping Political Jurisdiction.” *European Economic Review* 36(2/3): 639-46.

Casella, A., and J. Feinstein. 1991. “Public Goods in Trade: On the Formation of Markets and Political Jurisdiction.” CEPR Discussion Paper Series No. 511. London, United Kingdom: Centre for Economic Policy Research.

Centro de Desarrollo Municipal (CEDEMUN). 1999. *Los Municipios de México: Información para el Desarrollo.*Mexico, D.F., Mexico: CEDEMUN.

Collier, P., and J.W. Gunning. 1998. “Explaining African Economic Performance.” Forthcoming in *Journal of Economic Literature*.

Dasgupta, P.S., and K.-G. Maler. 1995. “Poverty, Institutions and the Environmental Resource-Base.” In: J. Behrman and T.N. Srinivasan, editors. *Handbook of Development Economics*. Volume 3(A). Amsterdam, The Netherlands: North Holland.

Diamond, J. 1997. *Guns, Germs and Steel: The Fates of Human Societies* New York: W.W. Norton.

Díaz Cayeros, A. 1995. *Desarrollo Económico e Inequidad Regional: Hacia un Nuevo Pacto Federal en México*. Mexico, D.F., Mexico: CIDAC/Miguel Angel Porrúa/ Fundación Naumann.

----. 1997. “Balance Fiscal de los Estados en el Sistema Federal.” Mexico, D.F., Mexico: CIDAC. Mimeographed document.

Gallup, J.L. 1998. “Agriculture Productivity and Geography.” Cambridge, United States: Harvard University, Harvard Institute for International Development. Mimeographed document.

Gallup, J.L., J.D. Sachs and A.D. Mellinger. 1999. “Geography and Economic Development.” CAER Discussion Papers No. 39. Harvard Institute for International Development: Harvard University.

Gómez, Aurora. 1997. “El desempeño de la Fundidora de Hierro y Acero de Monterrey durante el Porfiriato.” In: M. Cerutti and C. Marichal, editors. *Historia de las Grandes Empresas en México 1850-1930*. Mexico, D.F., Mexico: Universidad Autónoma de Nuevo Leon/Fondo de Cultura Económica.

Harris, M. 1985. *The Sacred Cow and the Abominable Pig: Riddles of Food and Culture*. New York, United States: Simon and Schuster.

Hernández Chávez, A. 1993. *La Tradición Republicana del Buen Gobierno*. Fondo de Cultura Economica, Mexico

Inter-American Development Bank (IADB). 1998. *Facing up to Inequality in Latin America: Economic and Social Development Report 1998*. Washington, DC and Baltimore, United States: IADB/Johns Hopkins University Press.

Instituto Nacional de Estadística Geografía e Informática (INEGI). 1999. *Sistema de Cuentas Económicas y Ecológicas de México 1988-1996*. Mexico, D.F., Mexico. INEGI: México.

Krugman, P. 1991. *Geography and Trade*. Cambridge, United States: MIT Press.

Landes, D.S. 1988. *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*. New York, United States: W.W. Norton.

North, Douglass C. 1995. “Location Theory and Regional Economic Growth.” *Journal of Political Economy* 72(3): 243-58.

----. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge, United Kingdom: Cambridge University Press.

----. 1981. *Structure and Change in Economic History*. Cambridge, United Kingdom: Cambridge University Press.

----. 1966. *The Economic Growth of the United States 1790-1860*. New York, United States: W. W. Norton and Co.

----. 1955. "Location Theory and Regional Economic Growth." *Journal of Political Economy* 63(3):243-58.

North, D.C., and R.P. Thomas. 1973. *The Rise of the Western World: A New Economic History*. Cambridge, United Kingdom: Cambridge University Press.

North, D.C., and B.R. Weingast. 1989. "Constitution and Credible Commitments: the Evolution of the Institutions of Public Choice in 17th Century England." *Journal of Economic History* 59(4): 803-32.

Olson, M. 1993. "Dictatorship, Democracy, and Development *American Political Science Review* 87(3): 567-76.

Palerm, A., and I. Kelly. 1952. *The Tajin Totonac*.Washington, DC, United States: Bureau of American Ethnography.

Radelet, S., and J.D. Sachs. 1998. "Shipping Costs, Manufactured Exports, and Economic Growth." Cambridge, United States: Harvard University, Harvard Institute for International Development. Mimeographed document.

Sachs, J.D. 1997. "Geography and Economic Transition." Cambridge, United States: Harvard University, Harvard Institute for International Development. Mimeographed document.

Sachs, J.D., and A.M. Warner. 1995. "Natural Resource Abundance and Economic Growth." HIID Development Discussion Paper No. 517a. Cambridge, United States: Harvard University, Harvard Institute for International Development.

Sala-i-Martin, X. 1993. *Apuntes de Crecimiento Económico*. Barcelona, Spain: Antoni Bosch.

Weingast, B.R. 1997 "The Political Foundations of Democracy and the Rule of Law." *American Political Science Review* 91(2): 245-263.

Wilkie, J. 1978. *La Revolución Mexicana: Gasto Federal y Cambio Social*. Second edition. Mexico, D.F., Mexico: Fondo de Cultura Económica.

Wittfogel, K. 1981. *Oriental Despotism: a Comparative Study of Total Power*. New York, United States: Random House.

Yates, P. L. 1961. *El Desarrollo Regional de México* Mexico, D.F., Mexico: Banco de México Departamento de Investigaciones Industriales.

Appendix. Descriptive Profile of GDP and Geography in Mexico and Full Set of Results for Section 5

Table 1. Mexican Regional GDP by Latitude Band

State Latitude	State GDP 97	Population 97	TOTAL per capita GDP
28-32			
Baja California	19568227.82	2249968	**7,555.74**
Sonora	21041600.68	2157252	
Chihuahua	14546691.24	2892725	
TOTAL	**55,156,519.75**	**7,299,945**	
24-28			
Baja California Sur	3714582.643	398437	**9,466.16**
Sinaloa	14117438.54	2478535	
Durango	9600107.839	1454979	
Coahuila	22140023.74	2225752	
Nuevo León	51582303.9	3680565	
Tamaulipas	20402011.77	2602891	
TOTAL	**121,556,468.43**	**12,841,159**	
20-24			
Nayarit	5791387.523	916270	**6,479.94**
Zacatecas	6447420.395	1372087	
Jalisco	52495308.18	6241683	
Aguascalientes	7028804.284	900551	
Guanajuato	15794298.38	4588751	
San Luis Potosí	17624673.11	2275205	
Querétaro	10719840.48	1309470	
Hidalgo	12656466.73	2184178	
Yucatán	10084780.46	1607534	
TOTAL	**138,642,979.54**	**21,395,729**	
16-20			
Colima	5025784.63	502887	**9,066.91**
Michoacán	18247845.66	3997565	
México	83899081.79	12198634	
DF	191902943.4	8519305	
Morelos	12834899.05	1511287	
Tlaxcala	4438425.173	916800	
Puebla	25682516.08	4875158	
Veracruz	39371891.79	7090128	
Guerrero	27795199.84	3049167	
Oaxaca	13668961.72	3420659	
Tabasco	11769477.8	1824104	
Chiapas	23396154.57	3851555	
Campeche	13060255.18	671343	
Quintana Roo	11225134.37	766895	
TOTAL	**482,318,571.01**	**53,195,487**	

Table 2. Mexican Regional GDP by Temperature

State Temperature	State GDP 97	Population 97	TOTAL per capita GDP
10-18			
Aguascalientes	7028804.284	900551	**12,497.05**
DF	191902943.4	8519305	
Edo México	83899081.79	12198634	
Querétaro	10719840.48	1309470	
Tlaxcala	4438425.173	916800	
TOTAL	**297,989,095.10**	**23,844,760**	
10-22			
Chihuahua	14546691.24	2892725	**6,632.81**
Coahuila	22140023.74	2225752	
Durango	9600107.839	1454979	
Jalisco	52495308.18	6241683	
Hidalgo	12656466.73	2184178	
San Luis Potosí	17624673.11	2275205	
Zacatecas	6447420.395	1372087	
Guanajuato	15794298.38	4588751	
Morelos	12834899.05	1511287	
TOTAL	**164,139,888.66**	**24,746,647**	
10-26			
Chiapas	23396154.57	3851555	**6,873.36**
Puebla	25682516.08	4875158	
Sonora	21041600.68	2157252	
Veracruz	39371891.79	7090128	
Michoacán	18247845.66	3997565	
Guerrero	27795199.84	3049167	
Nuevo León	51582303.9	3680565	
Oaxaca	13668961.72	3420659	
TOTAL	**220,786,474.23**	**32,122,049**	
18-26			
Baja California S	3714582.643	398437	**7,982.54**
Baja California	19568227.82	2249968	
Colima	5025784.63	502887	
Quintana Roo	11225134.37	766895	
Tamaulipas	20402011.77	2602891	
Sinaloa	14117438.54	2478535	
Yucatán	10084780.46	1607534	
Nayarit	3714582.643	398437	
TOTAL	**87,852,542.88**	**11,005,584**	
26 or more			
Campeche	13060255.18	671343	**9,950.01**
Tabasco	11769477.8	1824104	
TOTAL	**24,829,732.98**	**2,495,447**	

Table 3. Mexican Regional GDP by Ranges of Rainfall

State	State GDP 97	Population 97	TOTAL per capita GDP
Rainfall			
0-600			
Baja California	19568227.82	2249968	**8,592.03**
Baja California S	3714582.643	398437	
Coahuila	22140023.74	2225752	
Sonora	21041600.68	2157252	
Zacatecas	6447420.395	1372087	
Aguascalientes	7028804.284	900551	
TOTAL	**79,940,659.57**	**9,304,047**	
300-1000			
Querétaro	10719840.48	1309470	**7,842.86**
San Luis Potosí	17624673.11	2275205	
Guanajuato	15794298.38	4588751	
Tlaxcala	4438425.173	916800	
Nuevo León	51582303.9	3680565	
TOTAL	**100,159,541.04**	**12,770,791**	
300-2000			
Colima	5025784.63	502887	**10,000.27**
Campeche	13060255.18	671343	
Chihuhua	14546691.24	2892725	
DF	191902943.4	8519305	
Durango	9600107.839	1454979	
México	83899081.79	12198634	
Jalisco	52495308.18	6241683	
Quintana Roo	11225134.37	766895	
Tamaulipas	20402011.77	2602891	
Sinaloa	14117438.54	2478535	
Yucatán	10084780.46	1607534	
Nayarit	3714582.643	398437	
Michoacán	18247845.66	3997565	
Guerrero	27795199.84	3049167	
Morelos	12834899.05	1511287	
TOTAL	**488,952,064.56**	**48,893,867**	
300-4000			
Chiapas	23396154.57	3851555	**5,443.80**
Hidalgo	12656466.73	2184178	
Puebla	25682516.08	4875158	
Tabasco	11769477.8	1824104	
Veracruz	39371891.79	7090128	
Oaxaca	13668961.72	3420659	
TOTAL	**126,545,468.68**	**23,245,782**	

Table 4. Regional GDP / squared km.

	GDP 1997	km 2	GDP / km 2
México	83,899,081.79	21,355	3,928,779.29
Morelos	12,834,899.05	4,950	2,592,908.90
Aguascalientes	7,028,804.28	5,471	1,284,738.49
Tlaxcala	4,438,425.17	4,016	1,105,185.55
Colima	5,025,784.63	5,191	968,172.73
Querétaro	10,719,840.48	11,449	936,312.38
Nuevo León	51,582,303.90	64,924	794,502.86
Puebla	25,682,516.08	33,902	757,551.65
Jalisco	52,495,308.18	80,836	649,405.07
Hidalgo	12,656,466.73	20,813	608,103.91
Veracruz	39,371,891.79	71,699	549,127.49
Guanajuato	15,794,298.38	30,491	517,998.70
Tabasco	11,769,477.80	25,627	459,260.85
Guerrero	27,795,199.84	64,281	432,401.48
Chiapas	23,396,154.57	74,211	315,265.32
Michoacán	18,247,845.66	59,928	304,496.16
Baja California	19,568,227.82	69,921	279,861.96
San Luis Potosí	17,624,673.11	63,068	279,455.08
Yucatán	10,084,780.46	38,402	262,610.81
Campeche	13,060,255.18	50,812	257,030.92
Tamaulipas	20,402,011.77	79,384	257,004.08
Sinaloa	14,117,438.54	58,328	242,035.36
Quintana Roo	11,225,134.37	50,212	223,554.82
Nayarit	5,791,387.52	26,979	214,662.79
Coahuila	22,140,023.74	149,982	147,617.87
Oaxaca	13,668,961.72	93,952	145,488.78
Sonora	21,041,600.68	182,052	115,580.17
Zacatecas	6,447,420.40	73,252	88,016.99
Durango	9,600,107.84	123,181	77,934.97
Chihuahua	14,546,691.24	244,938	59,389.28
Baja California Sur	3,714,582.64	73,475	50,555.74

Table 5. Mexican Regional GDP by Index of Trade Mobility

State	GDP	Population	Total per capita GDP
0-15			
Chiapas	23,396,154.57	3,851,555	**7,267.73**
Oaxaca	13,668,961.72	3,420,659	
Zacatecas	6,447,420.40	1,372,087	
Guerrero	27,795,199.84	3,049,167	
Campeche	13,060,255.18	671,343	
Durango	9,600,107.84	1,454,979	
Quintana Roo	11,225,134.37	766,895	
Baja California S	3,714,582.64	398,437	
Total	**108,907,816.56**	**14,985,122**	
15-25			
San Luis Potosí	17,624,673.11	2,275,205	**7,662.31**
Veracruz	39,371,891.79	7,090,128	
Tabasco	11,769,477.80	1,824,104	
Yucatán	10,084,780.46	1,607,534	
Michoacán	18,247,845.66	3,997,565	
Nayarit	5,791,387.52	916,270	
Tamaulipas	20,402,011.77	2,602,891	
Jalisco	52,495,308.18	6,241,683	
Chihuahua	14,546,691.24	2,892,725	
Coahuila	22,140,023.74	2,225,752	
Nuevo León	51,582,303.90	3,680,565	
Sonora	21,041,600.68	2,157,252	
Baja California	19,568,227.82	2,249,968	
Total	**304,666,223.67**	**39,761,642**	
25-35			
Puebla	25,682,516.08	4,875,158	**4,831.35**
Hidalgo	12,656,466.73	2,184,178	
Guanajuato	15,794,298.38	4,588,751	
Sinaloa	14,117,438.54	2,478,535	
Total	**68,250,719.72**	**14,126,622**	
35 or more			
Tlaxcala	4,438,425.17	916,800	**7,148.18**
Querétaro	10,719,840.48	1,309,470	
México	83,899,081.79	12,198,634	
Morelos	12,834,899.05	1,511,287	
Aguascalientes	7,028,804.28	900,551	
Colima	5,025,784.63	502,887	
Total	**123,946,835.40**	**17,339,629**	

Full Set of Results for Section 5

Table 5.1. Geographic Determinants of State GDP Levels, 1993

Dependent Variable: LPIB93

	(1)	(2)	(3)	(4)	(5)
Cons	4.054627 (1.625)	4.064782 (-1.661)	4.113786 (1.565)	4.103227 (18.195)	3.783938 (10.216)
Rainavg	-0.00068 (-1.243)	-0.00081 (0.855)	-0.0013 (-2.743)	-0.00131 (-2.892)	-0.00084 (-1.569)
Rain2	1.25E-07 (0.591)	1.67E-07 (-0.332)	3.12E-07 (1.579)	3.30E-07 (1.786)	2.34E-07 (1.213)
Tempavg	-0.08377 (-0.356)	-0.07705 (0.508)	-0.02089 (-0.086)		
Temp2	0.002895 (0.511)	0.002838 (2.503)	0.000934 (0.16)		
Coast	7.07E-05 (0.588)				
Border	0.432294 (2.533)	0.41256 (3.375)			0.392953 (2.415)
LnDensity	0.206533 (3.372)	0.201973 (1.654)	0.223623 (3.388)	0.218667 (3.968)	0.168632 (2.393)
Landlock			-0.28603 (-1.736)	-0.338 (-2.416)	
F	4.08	4.85	3.87	6.06	6.55
R2	0.4349	0.4518	0.3805	0.4195	0.4964

Table 5.2. Geographic Determinants of State GDP Levels 1993, Including Infrastructure

Dependent Variable: LPIB93

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cons	3.783938 (10.216)	2.703537 (8.94)	1.176299 (1.17)	2.113241 (3.378)	2.672633 (7.933)	2.861849 (3.35)	2.583502 (6.124)	2.574741 (8.57)	3.717788 (3.901)
Rainavg	-0.00084 (-1.569)	-0.00033 (-1.068)	-0.00057 (-1.123)	-0.00049 (-1.108)	-0.00019 (-0.515)	-0.00034 (-1.032)	-0.00032 (-1.02)	-0.0002 (-0.598)	-0.00019 (-0.54)
Rain2	2.34E-07 (1.213)	1.48E-07 (1.353)	1.88E-07 (1.154)	2.13E-07 (1.402)	7.20E-09 (0.06)	1.48E-07 (1.289)	1.49E-07 (1.373)	6.03E-08 (0.455)	-7.09E-11 (0)
Border	0.392953 (2.415)	0.018401 (0.161)	0.356318 (2.247)	0.33832 (2.17)	0.296489 (2.341)	0.010628 (0.086)	0.029883 (0.241)	0.135006 (0.771)	0.12932 (0.735)
LnDensity	0.168632 (2.393)	0.02822 (0.465)	0.110946 (1.455)	0.112536 (1.672)	0.061782 (0.968)	0.028481 (0.46)	0.02892 (0.464)	0.032464 (0.519)	0.033703 (0.518)
Urban		1.953585 (5.325)				2.007929 (4.017)	1.864856 (3.322)	1.064467 (1.352)	1.089266 (1.322)
Elect			2.864115 (2.84)			-0.20689 (-0.187)			-0.76987 (-0.629)
Agua				1.903167 (3.126)			0.192635 (0.301)		-0.97795 (-0.731)
Dren					1.678719 (6.248)			0.937332 (1.553)	1.555829 (1.576)
F	6.55	13.32	16.29	10.98	21.33	10.35	14.38	16.5	11.66
R2	0.4964	0.7073	0.5743	0.5969	0.7085	0.7075	0.7079	0.7297	0.7433

Table 5.3. Geographic Determinants of State GDP Levels 1993, Including Literacy and Indigenous Population

Dependent Variable: LPIB93

	(1)	(2)	(3)
Cons	2.703537 (8.94)	3.179507 (-0.18)	3.336482 (9.408)
Rainavg	-0.00033 (-1.068)	-6.3E-05 (0.537)	-4.7E-05 (-0.13)
Rain2	1.48E-07 (1.353)	6.16E-08 (0.567)	4.81E-08 (0.401)
Border	0.018401 (0.161)	0.087662 (0.851)	0.059486 (0.4)
Density	0.02822 (0.465)	0.054196 (2.212)	0.065749 (1.055)
Urban	1.953585 (5.325)	1.222225 (-2.218)	1.096808 (1.91)
Femill		-1.826 (9.718)	-3.07582 (-1.833)
Lengua			4.898 (1.023)
F	13.32	19.96	11.69
R2	0.7073	0.7416	0.7538

Table 5.4. Geographic Determinants of State GDP Levels 1993, Municipal Effects

Dependent Variable: LPIB93

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cons	1.37908 (11.306)	1.46203 (9.833)	1.55172 (9.241)	1.59739 (10.099)	1.509947 (10.676)	1.35786 (10.066)	1.422119 (8.999)
Rainavg	-.0005331 (-4.551)	-.0004249 (-2.777)	-.0003565 (-2.383)	-.0003406 (-2.274)	-.0004145 (-2.785)	-.0003838 (-3.420)	-.0003435 (-2.940)
Rain2	3.09e-07 (6.795)	2.73e-07 (5.097)	2.51e-07 (4.806)	2.39e-07 (4.494)	2.62e-07 (4.927)	2.58e-07 (6.530)	2.45e-07 (5.948)
Border	.056026 (1.098)	.092574 (1.461)	0.770224 (1.357)	.084035 (1.560)	.093363 (1.618)	.039856 (0.845)	.029569 (0.669)
Density	.0000551 (4.043)	.0000621 (3.836)	.0000564 (4.087)	.0000563 (4.613)	.0000604 (4.300)	.0000725 (6.539)	.0000665 (7.054)
Urban	.694243 (4.387)	.519593 (2.518)	.4413085 (2.048)	.387566 (1.931)	.476538 (2.487)	.681575 (3.783)	.629276 (3.141)
Lengua		-1.43437 (-2.154)			-1.08514 (-1.259)	-1.29613 (-1.941)	
Femill			-.669026 (-2.472)	-.59494 (-2.420)			-.48519 (-1.869)
Munic		-.0001663 (-1.904)	-.0001317 (-1.295)				
Munpc				-1058.636 (-1.992)	-1117.851 (-1.896)		
Munkm						-15.02066 (-6.309)	-13.76061 (-4.812)
F	102.20	241.99	233.36	143.80	97.78	203.05	185.03
R2	0.8422	0.8665	0.8777	0.8968	0.8849	0.9094	0.9119

Table 5.5. Geographic Determinants of State GDP Levels 1993, Municipal Effects 1825

Dependent Variable: LPIB93

	(1)	(2)	(3)
Cons	1.37840 (11.218)	1.52254 (9.174)	1.43842 (9.962)
Rainavg	-.0004417 (-3.387)	-.0003558 (-2.476)	-.0004076 (-2.751)
Rain2	2.72e-07 (5.344)	2.49e-07 (4.982)	2.65e-07 (5.134)
Border	.059150 (1.163)	.067619 (1.259)	.081882 (1.367)
Density	.0000534 (4.186)	.0000543 (4.206)	.0000595 (3.931)
Urban	.655766 (4.213)	.477489 (2.283)	.545052 (2.782)
Femill		-.624572 (-2.301)	
Lenind			-1.442691 (-1.990)
Muni1825	-.0005866 (-2.534)	-.0003494 (-1.616)	-.0004737 (-2.375)
F	155.58	172.08	160.18
R2	0.8626	0.8801	0.8730

Table 5.6. Dependent Variable: fgt22

	(1)	(2)	(3)	(4)
Cons	.168338 (0.287)	.121371 (0.205)	.164487 (0.288)	.1210375 (2.314)
Rainavg	.0001752 (1.151)	.000254 (2.384)	.0001725 (1.621)	.0001852 (1.688)
Rain2	-2.09e-07 (-0.370)	-4.35e-08 (-0.951)	-2.00e-08 (-0.456)	-3.97e-08 (-0.870)
Tempavg	.0084413 (0.143)	.0004635 (0.008)	.0089126 (0.156)	
Temp2	-.0005194 (-0.359)	-.00021 (-0.147)	-.0005283 (-0.375)	
Coast	1.23e-06 (0.048)			
Border	-.0735318 (-2.869)		-.073862 (-3.436)	-.0684467 (-2.840)
Density	-.0003827 (-2.952)	-.0004304 (-3.103)	-.0003822 (-3.108)	-.0002447 (-2.443)
Landlock		.060328 (2.082)		
F	11.57	8.35	9.30	9.46
R2	0.6337	0.6164	0.6336	0.5068

Table 5.7. Dependent Variable: fgt22

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cons	.521036 (7.863)	.853163 (3.870)	.656646 (6.431)	.548774 (8.033)	.506230 (7.269)	.697858 (3.798)	1.146895 (4.335)	.637288 (2.898)
Rainavg	.0000887 (1.488)	.0000768 (1.363)	.0000723 (1.346)	.0000479 (0.868)	.0000415 (0.634)	.0000914 (1.056)	.0001055 (1.126)	.0000491 (0.840)
Rain2	-2.76e-08 (-0.989)	-2.55e-08 (-1.121)	-2.90e-08 (-1.102)	8.01e-08 (0.032)	1.30e-08 (0.524)	-3.73e-08 (-1.064)	-2.82e-08 (-0.892)	5.41e-09 (0.187)
Border	.036904 (1.423)	.020375 (0.763)	.024485 (0.978)	-.006543 (-0.214)	-.042554 (-1.770)	-.050251 (-2.078)	-.054197 (-1.905)	-.010806 (-0.312)
Density	.0001002 (1.301)	.0001136 (1.482)	.0001008 (1.372)	.0000659 (0.960)	8.57e-07 (0.017)	-.0000704 (-0.967)	-.0000318 (-0.413)	.0000697 (0.924)
Urban	-.550246 (-5.629)	-.4336787 (-3.278)	-.451181 (-3.793)	-.232484 (-1.581)				-.209343 (-1.226)
Elect		-.434733 (-1.487)					-1.06982 (-3.901)	-.235433 (-0.667)
Agua			-.218828 (-1.387)			-.607940 (-3.079)		.151433 (0.691)
Dren				-.316914 (-2.717)	-.471810 (-6.312)			-.345406 (-1.924)
F	14.12	12.46	13.30	14.46	16.31	9.03	21.06	10.97
R2	0.7921	0.8119	0.8066	0.8394	0.8225	0.6896	0.7043	0.8444

Table 5.8. Dependent Variable: fgt22

	(1)	(2)	(3)
Cons	.372475 (3.462)	.441444 (5.714)	.4029722 (3.655)
Rainavg	-.0000103 (-0.187)	.0000226 (0.453)	8.41e-07 (0.015)
Rain2	3.26e-09 (0.163)	-9.36e-09 (-0.532)	-1.87e-09 (-0.091)
Border	.021144 (0.976)	.0059445 (0.247)	.008509 (0.361)
Density	.0000496 (0.891)	.0000879 (1.274)	.0000704 (1.146)
Urban	-.348977 (-2.706)	-.3943003 (-3.912)	-.3563798 (-2.713)
Femill	.562566 (2.740)		.2338118 (0.879)
Lengua		1.87271 (4.920)	1.319963 (2.502)
F	23.51	52.67	44.32
R2	0.8568	0.8677	0.8724

Table 5.9. Dependent Variable: fgt22

	(1)	(2)	(3)	(4)	(5)	(6)
Cons	.521036 (7.863)	.372558 (3.578)	.343522 (3.405)	.405195 (5.422)	.4522231 (5.571)	.402986 (3.656)
Rainavg	.0000887 (1.488)	-.0000418 (-0.745)	-.0000381 (-.0732)	-6.15e-06 (-0.119)	2.77e-06 (0.064)	-.0000174 (-0.352)
Rain2	-2.76e-08 (-0.989)	1.82e-08 (0.855)	1.93e-08 (0.925)	6.86e-09 (0.362)	4.98e-10 (0.033)	8.56e-09 (0.439)
Border	.036904 (1.423)	.006857 (0.306)	.0098163 (0.453)	.0000514 (0.002)	.0151645 (0.646)	.029022 (1.306)
Density	.0001002 (1.301)	.0000339 (0.668)	.0000471 (1.001)	.0000786 (1.454)	-.0000149 (-0.311)	-.0000392 (-0.560)
Urban	-.550246 (-5.629)	-.321179 (-2.611)	-.301272 (-2.536)	-.349134 (-3.610)	-.409791 (-3.876)	-.3848575 (-2.870)
Lengua				1.419545 (3.231)	1.60672 (4.783)	
Femill		.426679 (2.032)	.439119 (2.208)			.443549 (2.219)
Munic		.0001788 (3.393)				
Munpc			731.9381 (3.086)	664.549 (2.495)		
Munkm					7.507978 (6.650)	7.14284 (4.707)
F	14.12	58.82	27.58	37.76	87.30	20.99
R2	0.7921	0.8838	0.9004	0.9017	0.9076	0.8915

Table 5.10. Geographical Determinants of Per Capita GDP Growth (1950-1993)

Lnpib50	-0.5488505 (-7.199)	-0.5965216 (-7.731)	-0.5532859 (-9.945)	-0.5454843 (-9.572)	-0.5758974 (-8.277)
Rainavg	-0.0014015 (-3.664)	-0.0013259 (-3.432)	-0.0012764 (-3.772)	-0.0013783 (-4.442)	-0.0013361 (-4.031)
Rain2	6.81E-07 (5.38)	6.58E-07 (4.954)	6.45E-07 (5.49)	6.95E-07 (6.214)	6.80E-07 (5.547)
Tempavg	-0.0897579 (-0.617)	-0.0971559 (-0.669)	-0.073668 (-0.538)		
Temp2	0.0024662 (0.732)	0.002595 (0.764)	0.0020618 (0.647)		
Coast	-0.0001007 (-1.178)			-0.0000805 (-1.061)	
Border	-0.0088027 (-0.068)	0.071877 (0.672)			0.0356931 (0.376)
Landlock			0.0568391 (0.564)		
Lndens50	0.0877558 (2.368)	0.1115465 (2.566)	0.0947465 (2.311)	0.0886773 (4.285)	0.1082454 (4.438)
_cons	3.853566 (2.605)	3.92258 (2.645)	3.558483 (2.603)	3.013644 (10.749)	2.987933 (10.489)
F	78.14	48.07	56.48	59.91	51.02
R2	0.8979	0.8912	0.8907	0.8914	0.886

Table 5.11. Geographical Determinants of Per Capita GDP Growth (1950-1993), Including Human Capital

lnpib50	-0.5669299 (-6.791)	-0.5860826 (-6.151)	-0.6031166 (-7.306)
Rainavg	-0.0013487 (-3.718)	-0.0012693 (-3.217)	-0.0014186 (-4.145)
rain2	6.88E-07 (5.523)	6.52E-07 (4.683)	7.12E-07 (6.418)
Coast	-0.0000743 (-0.89)	-0.0000997 (-1.086)	-0.0000908 (-1.234)
lndens50	0.082908 (2.536)	0.0770735 (2.063)	0.0846422 (2.675)
urb60	0.0979985 (0.278)	-0.0066703 (-0.017)	-0.0042092 (-0.012)
iprim40		0.318186 (0.61)	
iprim59			0.4704316 (1.562)
_cons	3.026254 (11.084)	3.02546 (11.342)	2.91656 (10.374)
F	46.42	41.15	87.11
R2	0.8918	0.8943	0.9002

Table 5.12. Geographical Determinants of per capita GDP Growth (1950-1993), Municipal Effects

	(1)	(2)	(3)
Lnpib50	-0.5709212 (-5.242)	-0.5496595 (-7.087)	-0.6000654 (-5.247)
Rainavg	-0.0012228 (-4.271)	-0.0011128 (-4.268)	-0.0014283 (-3.933)
rain2	6.53E-07 (7.154)	6.09E-07 (6.983)	7.16E-07 (6.013)
Coast	-0.0002487 (-1.715)	-0.0002162 (-1.379)	-0.0000916 (-1.196)
lndens50	0.0691924 (0.989)	0.0637001 (2.055)	0.082734 (1.785)
urb60	0.0203156 (0.057)	0.0176345 (0.051)	-0.009359 (-0.024)
iprim59	0.4292524 (1.655)	0.2185105 (0.502)	0.4708052 (1.53)
lmun17km	0.0016033 (0.017)	-0.0506374 (-0.788)	
Lnmunkm			0.0033509 (0.055)
_cons	2.803242 (4.729)	3.004297 (5.991)	2.943211 (5.863)
F	110.65	77.97	73.22
R2	0.9271	0.9335	0.9002

Table 5.13. Geographic Determinants of State GDPLevels 1980

Dependent Variable: LPIB80

	(1)	(2)	(3)	(4)	(5)
Cons	2.4629 (1.0773)	2.4535 (2.349)	2.52395 (2.203)	2.060947 (34.363)	1.88822 (18.282)
Rainavg	-.000535 (-2.497)	-.000544 (-3.019)	-.0007371 (-4.736)	-.0007399 (-4.841)	-.0005814 (-3.220)
Rain2	2.63e-07 (3.223)	2.65e-07 (3.732)	3.22e-07 (4.697)	3.28e-07 (4.838)	2.49e-07 (4.217)
Tempavg	-.06681 (-0.621)	-.06558 (-.0633)	-.04629 (-0.421)		
Temp2	.001831 (0.707)	.001809 (0.722)	.001143 (0.435)		
Coast	3.85e-06 (0.086)				
Border	.179146 (2.734)	.178091 (2.775)			.168723 (2.775)
Density	.0001161 (5.868)	.0001164 (6.059)	.0001183 (5.689)	.0001251 (11.465)	.0001169 (12.281)
Landlock			-.09306 (-1.496)	-.09039 (-1.809)	
F	26.33	31.98	25.89	37.45	38.48
R2	0.7049	0.7048	0.6325	0.6282	0.6782

Table 5.14. Geographic Determinants of State GDP Levels 1980, Including Infrastructure

Dependent Variable: LPIB80

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cons	1.88822 (18.282)	1.37908 (11.306)	.654662 (1.665)	1.07292 (4.190)	1.36311 (10.059)	1.31556 (4.048)	1.23523 (6.706)	1.32838 (10.855)	1.61689 (4.386)
Rainavg	-.0005814 (-3.220)	-.0005331 (-4.551)	-.0005309 (-2.876)	-.0004917 (-3.014)	-.0004427 (-2.900)	-.0005314 (-4.287)	-.0005161 (-4.143)	-.0004723 (-3.201)	-.0004674 (-3.202)
Rain2	2.94e-07 (4.217)	3.09e-07 (6.795)	2.99e-07 (4.891)	3.08e-07 (5.297)	2.46e-07 (4.712)	3.09e-07 (6.615)	3.11e-07 (6.906)	2.70e-07 (4.510)	2.59e-07 (3.913)
Border	.168723 (2.775)	.056026 (1.098)	.164028 (2.664)	.154783 (2.642)	.149048 (2.742)	.05967 (1.036)		.105659 (1.410)	.100674 (1.287)
Density	.0001169 (12.281)	.0000551 (4.043)	.0000905 (10.324)	.0000872 (10.241)	.0000685 (7.936)	.0000555 (3.895)	.0000565 (3.967)	.0000586 (4.407)	.0000574 (4.377)
Urban		.694243 (4.387)				.669891 (3.168)	.587412 (2.793)	.312103 (0.978)	.336866 (0.999)
Elect			1.28327 (3.390)			.08467 (0.212)			-.333352 (-0.610)
Agua				.85656 (3.358)			.233442 (0.942)		-.086214 (-0.208)
Dren					.639021 (5.580)			.402743 (1.599)	.519269 (1.365)
F	38.48	102.20	71.35	95.58	163.93	87.72	95.15	118.98	115.43
R2	0.6782	0.8422	0.7683	0.7859	0.8524	0.8424	0.8463	0.8617	0.8651

Table 5.15. Geographic Determinants of State GDP Levels 1980, Including Literacy and Indigenous Population

Dependent Variable: LPIB80

	(1)	(2)	(3)
Cons	1.37908 (11.306)	1.556826 (9.516)	1.556245 (9.249)
Rainavg	-.0005331 (-4.551)	-.0003813 (-2.788)	-.0003817 (-2.714)
Rain2	3.09e-07 (6.795)	2.62e-07 (5.640)	2.62e-07 (5.524)
Border	.056026 (1.098)	.068052 (1.287)	.068576 (1.249)
Density	.0000551 (4.043)	.0000554 (4.293)	.0000556 (3.874)
Urban	.694243 (4.387)	.454746 (2.191)	.454435 (2.134)
Femill		-.771651 (-2.965)	-.761538 (-1.786)
Lengua			-.042127 (-0.035)
F	102.20	150.72	124.81
R2	0.8422	0.8740	0.8740

Table 5.16. Geographic Determinants of State GDP Levels 1980, Municipal Effects

Dependent Variable: LPIB80

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cons	1.37908 (11.306)	1.46203 (9.833)	1.55172 (9.241)	1.59739 (10.099)	1.509947 (10.676)	1.35786 (10.066)	1.422119 (8.999)
Rainavg	-.0005331 (-4.551)	-.0004249 (-2.777)	-.0003565 (-2.383)	-.0003406 (-2.274)	-.0004145 (-2.785)	-.0003838 (-3.420)	-.0003435 (-2.940)
Rain2	3.09e-07 (6.795)	2.73e-07 (5.097)	2.51e-07 (4.806)	2.39e-07 (4.494)	2.62e-07 (4.927)	2.58e-07 (6.530)	2.45e-07 (5.948)
Border	.056026 (1.098)	.092574 (1.461)	0.770224 (1.357)	.084035 (1.560)	.093363 (1.618)	.039856 (0.845)	.029569 (0.669)
Density	.0000551 (4.043)	.0000621 (3.836)	.0000564 (4.087)	.0000563 (4.613)	.0000604 (4.300)	.0000725 (6.539)	.0000665 (7.054)
Urban	.694243 (4.387)	.519593 (2.518)	.4413085 (2.048)	.387566 (1.931)	.476538 (2.487)	.681575 (3.783)	.629276 (3.141)
Lengua		-1.43437 (-2.154)			-1.08514 (-1.259)	-1.29613 (-1.941)	
Femill			-.669026 (-2.472)	-.59494 (-2.420)			-.48519 (-1.869)
Munic		-.0001663 (-1.904)	-.0001317 (-1.295)				
Munpc				-1058.636 (-1.992)	-1117.851 (-1.896)		
Munkm						-15.02066 (-6.309)	-13.76061 (-4.812)
F	102.20	241.99	233.36	143.80	97.78	203.05	185.03
R2	0.8422	0.8665	0.8777	0.8968	0.8849	0.9094	0.9119