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THE ECONOMIC EFFECTS OF GEOGRAGHY: COLOMBIA AS A CASE STUDY

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The Economic Effects of Geography: Colombia as a Case Study

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Abstract

This paper quantifies the economic impact of geographical features using Colombian data at the municipal level. We use the proportion of slave population in 1835 as an instrument of current institutions. We find that, controlling for institutional quality, geographical characteristics, such as the percentage of flat terrain or the proximity to the marketplace, are statistically-significant determinants of income per capita and have large economic effects. The estimates are also consistent with sizable economies of scale and agglomeration. We discuss how the results contribute to the economic literature.

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At some level, it is evident that geography matters for economic performance. Except for a few oil-producing and island states, the tropics are poor and backward while the temperate regions of the globe are rich and prosperous. In effect, the terms north and south are embedded in economics as signifiers of a country's stage of development or underdevelopment. This paper quantifies the impact of geographical characteristics on income using data from Colombia at the municipal level. A by-product of the paper is a quantitative assessment of the effects of institutional quality on income per person.

The study of the economic effects of geography is not marred by considerations of reverse causality. The reason is that geographical features can be safely assumed to be exogenous with respect to income per person. But, until recently, the economic literature had neglected the role of geographical features in explaining the variability of income. As a matter of fact, there is no consensus on the relative importance of the mechanisms governing the influence of geography on economic development.

In our reading, the literature recognizes various direct channels by which geography affects development. The direct channels emphasize the effects of geography on productivity and offer several reasons to explain this influence. First, as one would naturally expect, geographical characteristics might account for the extent and productivity of primary activities such as agriculture, farming, mining, fishing, and forestry. Second, going back to Marshall, many economists have stressed how extreme climes and temperatures might diminish labor productivity because they affect nutrition, health, and work effort. Third, higher productivity might be the consequence of spillovers and positive externalities from clustering, agglomeration or proximity to the marketplace. Examples of proponents of the direct channels of geography include Mellinger, Sachs and Gallup (2000), McArthur and Sachs (2001), Sachs (2001), and Fujita, Krugman and Venables (1999). If the direct channels are correct then geography has contemporaneous effects on income per person.

The literature also recognizes that geography might affect income via the indirect channel of institutional quality. In this context, institutions are good if they limit the scope of predatory government behavior, serving as catalysts for the establishment of secure property rights. In a leading article, Engerman and Sokoloff (1997) tell us how the adoption of exploitative institutions by Europeans in the Americas (slavery and forced labor) was largely determined by geographical endowments. In the same spirit, Acemoglu, Johnson and Robinson (2001) theorize that weak and extractive institutions were more likely to be established in places dominated by unfavorable geographical characteristics. Hall and Jones (1999) claim that geography affected institutional quality because fifteenth-century Europeans had an incentive to settle in sparsely populated areas with climates similar to Europe. Proponents of the indirect channel underscore that geography matters for development because of its past effect on institutional quality under that assumption that there is persistence in the evolution of institutions.[1]

From an econometrical standpoint, there is substantial agreement on the statistical significance of the institutional channel of geography.[2] In contrast, recent work disputes the empirical relevance of some of the direct channels. Acemoglu, Johnson and Robinson (2001) find that health-related variables, which one would expect to affect labor productivity, have no significant impact on income per person. Mendoza and Rosas (2004) report that, controlling for institutional quality, infant mortality and malaria incidence do not have a significant negative effect on income per person in a sample of Colombian municipalities. Rodrik, Subramanian and Trebbi (2002) go even further and affirm that geographically-related variables are, at best, weak direct determinants of income per capita again controlling for institutions, using various cross-country samples and econometric specifications.

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[1]In an empirical study of American states, Berkowitz and Clay (2003) present evidence that colonial institutions are significant determinants of current institutional quality.

[2]For example, Acemoglu, Johnson and Robinson (2001) use mortality rates faced by European settlers to instrument for current institutions and find statistical support for their hypothesis in a sample of sixty former colonies. Hall and Jones (1999) assume that the quality of a country's social infrastructure, including the security of property rights, the checks and balances in government and the efficacy of the judicial system, is increasing on the degree of influence from Western Europe. These authors report strong effects of a measure of geography, distance from the equator, on social infrastructure.

This paper contributes to the literature by focusing on two questions: What geographical variables appear to have direct effects on the level of income per capita? and what is the magnitude and economic significance of these effects? To answer these questions we take into account the role of institutional quality as a determinant of income per capita. In contrast to the bulk of existing studies, our empirical strategy is to utilize regional data from a single country. Specifically, we use a dataset of close to nine hundred Colombian municipalities.

We believe that Colombia is an excellent candidate to study the economic impact of geography because of its exceptional regional variability in geographical patterns. Hence, the use of data at the subnational level does not sacrifice sample variability in a significant manner. On the other hand, the utilization of subnational observations has two unambiguous advantages with respect to the approach of relying on cross-country regressions. To begin with, we have many more degrees of freedom than any cross-country study because of a much larger sample size. In addition, while we still control for differences in institutional quality, we abstract from sources of variation in institutions commonly found in cross-country studies. Examples of these sources are the degree of ethnolinguistic fractionalization, the origin of the colonizer, the type of judicial system or the prevalence of particular religions. In this sense, this paper tests the power of institutions to understand patterns of development even within a national unit.

To preview our findings, we identify various geographical features, notably the steepness of the terrain, the proximity to the marketplace, and measures of scale and agglomeration, as significant direct determinants of income per person. But, we also encounter that other geographical features, altitude, temperature and precipitation among them, fail to exert a significant direct influence on income per person. The estimation also highlights the robustness of institutional quality in explaining economic performance.

1 The Geography of Colombia

Colombia is located in the northern section of South America between the Pacific and Atlantic Oceans. The country covers an area of 1,140,050 square kilometers, about the combined areas of Texas and California. The country exhibits exceptional regional variability in geographical, including climatic, patterns. While it occupies less than one percent of the surface of the earth, the country has ten percent of all forms of animal and plant life and ranks first in the world in the number of birds and amphibians, second in the number of plants and reptiles and seventh in the number of mammals.[3] As a matter of fact, the biodiversity of Colombia exceeds that of much larger countries like China, the Russian Federation and even the United States.[4]

The geographical diversity of Colombia stems from its location and geology. Although Colombia lies in the geographical tropics, its climatic patterns are far from being uniformly tropical. The country is divided by three chains of the Andes mountains: the Western, Central, and Eastern Cordillera. These chains, which run in a roughly north-south direction, give rise to a temperate zone of upland valleys and plateaus. The Eastern and Central cordilleras are separated by the Magdalena River, which reaches the Caribbean Sea in the port of Barranquilla. The Central and Western mountain ranges are separated by the Cauca river. The eastern part of Colombia, extending south and east of Bogotá, is comprised by hot, humid grasslands falling within the drainage basins of the Orinoco and the forested Amazon. The types of terrain of the country include flat coastlands, plains, highlands,

[3] Sources: Instituto Humboldt (1999) and The World Resources Institute (1998, pages 322-325).

[4] The following figures on the total number of known species illustrate this point:

	Mammals	Birds	Higher Plants	Reptiles	Amphibians
Colombia	359	1,695	50,000	584	585
China	394	1,100	30,000	340	263
Russian Federation	269	628	-	58	23
United States	428	650	16,302	280	233

Source: The World Resources Institute (1998, pages 322-325).

forests, jungles, and Andean plateaus.

Even within regions of the country geographical characteristics are highly heterogeneous. Consider the Andean region as an example. This region includes peaks over eighteen thousand feet high and valleys as low as one thousand feet above sea level. Horna (1992, page 31) tells us how within the borders of the Andean region, temperature levels vary greatly from a medium of eighty degrees Fahrenheit in the tropical zones (below 3,500 feet) to a low of twenty degrees Fahrenheit in the inhabited parts of the cordilleras. Although the Andean region is distinctive for its two annual dry and rainy seasons, there is high variability in the amount of precipitation depending on exposure and elevation. In some valleys precipitation levels are negligible, while in others precipitation may reach as much as 140 inches per year.

2 Geography and Productivity: The Direct Channels

The first link emphasized by the direct channels is the effect of geography on the occurrence and productivity of primary forms of production such as agriculture, farming, mining, fishing, and forestry. In turn, this effect might obtain for a number of reasons. We have long understood the influence of the slope of the terrain, the availability of water and the type of soil, among other factors, on agricultural productivity. For instance, tropical soils are of poor quality because much of their mineral content is washed away by everpresent rains. Gallup (1998) estimates that land productivity in wet temperate zones exceeds land productivity in wet tropical zones by a factor of two.[5] Some authors have also stressed that different modes of production, such as shifting cultivation, plantation agriculture or yeoman farming are strongly affected by the natural environment. For example, Butler (1980, page 12) attributes the wide prevalence of sheep grazing in western regions of the United States to both "limited rainfall and long distance to markets". Some other authors have

[5] See the work of Gallup, Sachs and Mellinger (1999) and Sachs (2001) for more evidence on the link between geography and agricultural productivity.

advanced the idea that geographical characteristics might help to determine the growth rate of technological change as well as the diffusion of existing technologies. Lastly, the location and development of mining, fishing, and forestry is obviously fundamentally conditioned by geographical endowments.

The direct channels also underline the possibility that geography might impact labor productivity via its effect on work effort, health, and nutrition. Early writers, most prominently Aristotle and Montesquieu, believed that work effort was higher in cold rather than hot climates. More recently, Marshall (1890:1953, page 195) wrote:

> A warm climate impairs vigour. It is not altogether hostile to high intellectual and artistic work; but it prevents people from being able to endure very hard exertion of any kind for a long time. More sustained hard work can be done in the cooler half of the temperature zone than anywhere else;

In the words of Butler (1980, page 135), "lower economic efficiency in many tropical countries results from debilitating diseases and poor nutrition...". In fact, Gallup and Sachs (2000, page 1) find that income per capita in non-malarial countries is about five times income per capita in malarial countries.

Finally, according to the direct channels, there might be a link between geography and productivity because of the existence of externalities and spillovers from clustering, agglomeration, as well as from proximity to the marketplace. The new economic geography underlines how these externalities and spillovers might be a function of transportation costs and the size of the market in the presence of imperfect competition and increasing returns. Several authors have studied the interplay between the spatial economy of a region and its geographical features. For example, Mellinger, Sachs and Gallup (2000, page 182) estimate that

> A striking 67.6 per cent of the world's GDP is produced within 100 km of the sea, though that area comprises only 17.4 per cent of the world's landmass. Meanwhile

67.2 per cent of the world's GDP is produced in the temperate climates, though these account for only 39.2 per cent of the world's landmass.

These authors also find that GDP density is much higher in the temperate regions of the globe than in the tropics.

3 The Data

We have a dataset of Colombian municipalities which are the jurisdictional equivalent to counties in the United States. Appendix A describes the data sources in detail. Appendix B presents summary statistics of the variables used in the estimation.

Official Colombian statistics of income per person are available only at the departmental level. Each of the 32 Colombian departments is composed by several municipalities. Following Sánchez and Nuñez (2000), we proxy the level of income in each municipality in 1999 with the sum of the municipal property taxes and municipal industry and commerce taxes between 1997 and 1999.[6] Using population data for 1999 we computed the log of income per person in each municipality, INCOME. The correlation coefficient between our measure of income per capita, aggregated by departments, and the official figure is 0.96.

With respect to geographical characteristics, we first consider climatic variables:

- ALT: Altitude in meters above sea level.
- ALT2: Altitude squared.
- TEMP: Average yearly temperature in degrees Celsius.
- TEMP2: Average yearly temperature squared.

[6]We had 874 observations on municipal taxes for 1999. In order to reduce the number of missing observations for 1999 we imputed 134 values using municipal taxes for 1998 and 1997. The imputed values are the predicted values of OLS regressions of municipal taxes in 1999 against municipal taxes in 1998 and 1997. Our results are robust to the exclusion of the imputed observations.

- RAIN: Average yearly precipitation in millimeters.

- ALTRAIN: The product of Altitude and Rain.

- TEMPRAIN: The product of Temperature and Rain.

We expect climatic variables to affect both agricultural and labor productivity because of their possible influence on crop types, size and quality, and on the health, nutrition and effort of the labor force. We include altitude and temperature squared to allow for non-linear effects of climate on performance as suggested by the empirical estimates of Masters and McMillan (2000). We also include the interaction terms ALTRAIN and TEMPRAIN because we believe that the marginal impact of more or less precipitation is likely to be conditioned by both altitude and temperature.

We also consider indicators of the relative steepness of the terrain:

- PLAIN: The percentage of flat terrain in the municipality, where flat is defined as an average gradient of less than ten percent.

- SLOPE: The average gradient of the terrain in the municipality.

As it has been well established by economic geographers, plains and grasslands are much more productive for agriculture than mountainous and steep terrains. Hence, we expect these variables to influence income via their effect on agricultural productivity. Further, the relative steepness of the terrain might matter for performance, according to the direct channels, because of its effect on transportation costs.

Next, we include the following variables of location:

- DRIVER: Average Euclidian distance to the twenty major rivers of the country in kilometers.

- DMAGDALENA: Average Euclidian distance to the Magdalena river in kilometers.

- DCAUCA: Average Euclidian distance to the Cauca river in kilometers.

- DMARKETS: Euclidian distance, in kilometers, from the municipality to the country's nearest main city (Cali, Medellín, and Bogotá) or seaport (Barranquilla and Buenaventura), to consider the possible effects of transportation costs and market size on productivity.

The location of a region is likely to affect transportation costs and the effective size of the market. The distance to major rivers might be an indicator of the hydrological potential of a municipality besides being correlated with the type and quality of the soil. The Magdalena and its main tributary, the Cauca, have been the most important means of fluvial transportation. The Magdalena river flows from south to north for 1,540 km ending its course, as mentioned above, in the Caribbean Sea near the port of Barranquilla. The Cauca river starts in the western section of the country and joins the Magdalena in the lowlands of northern Colombia. We enclose a map of the main rivers of Colombia after Appendix B.

We also take into account the possible effect of agglomeration and clustering on productivity by including:

- LNPOP99 and LNPOP85: The logs of population in 1999 and 1985.

- DENSITY85: Population density in 1985.

These variables measure the scale of economic activity and the size of the market. According to the direct channels, we would expect higher spillovers and externalities in larger and denser municipalities.

Some of the geographical features that we have considered, such as altitude or rain, are first nature, in the sense of being unchanged by the existence of men. Some other, such as distance to markets or population density, are not first nature because they are the consequence of past human behavior. One might argue that some non-first-nature variables might reflect the past effect of first-nature variables. If correct, this observation would not affect the validity of our econometric results, but would rather guide their interpretation. At any rate, we make the plausible identifying assumption that all the variables considered are predetermined with respect to current levels of income.

4 Regressions without Institutions

Do all the direct channels of geography matter? How much of the variance of income per capita can be attributed to these channels? Tables 1 to 4 present regressions of the logarithm of income per person in 1999 against our set of geographical variables using Ordinary Least Squares. We do not include altitude and temperature in the same regression because they are almost collinear: a correlation coefficient of -0.985. Because the effects of altitude and temperature might be non-linear, each table considers one of the following specifications:

- Specification A: altitude, altitude squared, and altrain.
- Specification B: temperature, temperature squared, and temprain.
- Specification C: altitude and altrain.
- Specification D: temperature and temprain.

As a test of robustness, each table also experiments with various combinations of the remaining variables. We use PLAIN and SLOPE, as measures of the steepness of the terrain, in alternate columns. In the first two columns of each table we use the log of population in 1999 as a scale variable. In columns 3 and 4 we consider the log of population in 1985 rather than in 1999, to account for the possibility that population levels in 1999 are not exogenous to the level of income in 1999. Columns 5 and 6 of each table employ population density in 1985 instead of the log of population.

What can we learn from these regressions? The regressions tell us that geographical characteristics are significant determinants of income per person with levels of confidence ranging from ninety to ninety-nine percent. Indeed, except for temperature and temperature squared in Table 2, each of the geographical features included in the estimation is statistically significant under some specification. The importance of geography is also expressed in the relatively high R-squares of the regressions, just under twenty-percent, in spite of the absence of additional controls for income per capita.

According to the estimation, income per capita appears to be a concave function of altitude and temperature. When altitude and altitude squared are included, Specifications A and C, precipitation has a positive sign and the interaction term between altitude and precipitation is negative. When temperature and temperature squared are included, Specifications B and D, precipitation has a negative sign and the interaction term between temperature and precipitation is positive. Taking into account the interaction terms, precipitation has a positive effect on income in the average municipality. The results imply that steeper terrains and higher distances to rivers and markets are associated with lower incomes.[7] The estimation also says that both population size and population density have a positive impact on development.

What is the order of magnitude of the effects of geography on income per capita? Simple calculations suggest large economic effects. Consider regression (1) of Table 1 as an illustration. This regression indicates that a one-standard-deviation change in altitude, equivalent to 893 meters, would change income by about twenty-four percent in the average municipality. Also, if precipitation increases by one standard deviation, then the average municipality would enjoy four percent higher income. The same regression suggests that if the percentage of flat terrain in a municipality, PLAIN, is one-standard deviation above the mean, then income per person would be eighteen percent higher than in the average municipality.

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[7]The exception is DCAUCA, distance to the Cauca river. The positive sign of DCAUCA might be explained by the legacy of slavery which was widely prevalent in the Cauca region until the middle of the nineteenth century. This is consistent with the arguments developed in the next sections of the paper.

Turning to variables of location, the estimation implies that a one-standard deviation increase in distance to markets, approximately 99 kilometers in this sample, would result in as much as forty percent lower income per person (Table 4). According to the regressions, if a municipality is sixteen kilometers further away from a major river, its income per person would be roughly ten percent lower. In our sample, the average distance to major rivers is twenty-three kilometers with a standard deviation of twenty-four kilometers.

The regressions reveal scale and agglomeration effects. The estimated elasticity of income per person with respect to population is between 0.17 and 0.27. These estimates imply that in a municipality one-standard-deviation more populated than the average income per capita would exceed the average by a factor of two. The regressions also tell us that a municipality one-standard-deviation denser than the average would have as much as nineteen percent higher income.

5 Institutional Variability in Colombia

The fundamental shortcoming of the previous estimates is that they do not consider the possibility of differences in institutional quality across Colombian regions. This neglect is non-trivial because Colombia exhibits great regional variability in the efficiency of institutions. As a matter of fact, the history of Colombia suggests that geography has influenced institutional quality in harmony with the theories of Engerman and Sokoloff (1997), Acemoglu, Johnson and Robinson (2001), and Hall and Jones (1999).

The institutional differences of Colombian regions are rooted in the historical evolution of the country. As in other colonial experiences in the Americas, Spanish settlers chose to establish permanent residence in regions endowed with favorable geographical characteristics. Colonizers placed high value on regions of temperate climates and flat terrains and avoided the extreme conditions of the tropics or the Andean slopes and the higher elevations. In the former regions, the administrative structure and political institutions resembled those of the

Spanish metropolis. In the latter, there was sparse European occupation and the Spaniards establish exploitative institutions in order to control the means of production and the population. The chief exploitative institutions in Colombia, as in the rest of Spanish America, were slavery and two forms of forced labor called *El Corregimiento* and *La Encomienda*.[8]

But geography not only influenced the type of Spanish settlements during colonial times. Rugged and diverse geography has been an obstacle to inter-regional trade and migration, and thereby convergence in levels of income, even after the country's political independence. Rafael Reyes, President of Colombia in the second half of the nineteenth century, observed that Colombians only met regularly with nationals from other regions during the country's civil wars.

Isolated regional development has resulted in fragmented polities and institutions. The variability on the quality of institutions is reflected in large regional differences in the presence of the state and in the security of property rights. In some regions, such as Bogotá, the Colombian state provides much more public security and justice than in places such as the Chocó, a tropical region near the Pacific coastline. In places like the Chocó, the effective rulers are local agents, typically landowners or drug lords, who compete for both the allegiance of people and the power to tax them by providing public goods not offered by the Colombian state. Because in many areas of the country the rule of the state has been either nominal or severely constrained by regional idiosyncrasies, local conditions are crucial determinants of the effectiveness of the Colombian state's laws and institutions.[9]

We have defined good institutions as those which limit the scope of predatory government behavior serving as catalysts for the establishment of secure property rights. But there are no readily available empirical counterparts to this definition. We propose then two measures

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[8]Romoli (1941), Earle (2000), Avellaneda (1995) and Henao and Arrubla (1938) provide interesting accounts of the importance of climate and topography in the European colonization of Colombia.

[9]Huber and Safford(1995), Kline (1999) and Oquist (1980) focus on the influence of geography and climate in the formation of the Colombian state. Bushnell (1993), Richani (2002), and Safford and Palacios (2002) document the spatial variability in the effectiveness of the state and in the quality of institutions in Colombia.

of institutions which we believe to be correlated with the true, albeit unavailable, measure of institutional quality.

The first measure is LNCOURTSPC, the log of the number of judicial courts per person in 1998. We believe that this variable captures the presence of the state and is likely to be correlated with the security of property rights across regions. Judicial courts are the cells of the administration of justice in Colombia. Each court has one judge and one secretary besides administrative staff. Their common organization makes judicial courts comparable across regions.

We also use LNCOMMPC, the log of the number of communal organizations per person as of 1998, as a second measure of institutional quality. These organizations employ voluntary labor in local infrastructure projects using private means and some modest support from the state. Communal organizations also provide a mechanism of conflict resolution at the neighborhood level as an alternative to the formal judicial system. We believe that the number of communal organizations reflects the security of property rights and the degree of government accountability because higher community involvement constrains self-interested government behavior.[10]

The correlation between LNCOURTSPC and LNCOMMPC is 0.61. Further, the dispersion of institutional quality across Colombian regions is not negligible. The coefficients of variation of LNCOURTSPC and LNCOMMPC are 69% and 88%. For comparison, the main measure of institutions used by Rodrik, Subramanian and Trebbi (2002) has a coefficient of variation of 105% across 140 countries.

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[10]See Buscaglia and Ratliff (2001) and Safford and Palacios (2002) for more on the number and characteristics of communal organizations in Colombia.

6 Regressions with Institutions

To consider the effect of geography on income while accounting for institutional variability we estimate the following equation:

$$(1) \qquad INCOME = \beta_0 + \beta_1 \; GEOGRAPHY + \beta_2 \; INSTITUTIONS + \epsilon,$$

where GEOGRAPHY collects all the geographical features under consideration, and ϵ is an stochastic error term. Granted, institutions differ across regions. But, institutional quality is also likely to be influenced by higher levels of income per person. In other words, higher income might lead to better institutional quality instead of or in addition to the effect of institutions on income.

In order to consider the possible endogeneity of institutional quality we use PORSLAVE, the proportion of slave population in 1835, as an instrument of current institutions. As suggested by the work of Engerman and Sokoloff (1997) and by the historical accounts of Sharp (1976) and Wade (1993) among others, we expect PORSLAVE to capture the extent of exploitative institutions in 1835.[11] We believe that some of the present variation in institutional quality is exogenously explained by the prevalence of slavery in 1835 at least, in part, because of the isolated historical development of the country's regions. The correlation coefficient between PORSLAVE and LNCOURTSPC, the log of the number of judicial courts per capita, is -0.25. The correlation between PORSLAVE and LNCOMMPC, the log of the number of communal organizations per capita, is -0.30.

The proportion of slave population in 1835 is clearly exogenous with respect to current income per capita. We also make the assumption that PORSLAVE is uncorrelated with the

[11]Sharp (1976) and Wade (1993) describe the poor social institutions of Colombian regions in which slavery was prevalent during colonial times. These institutions were characterized by insecure property rights as well as by lack of trust, reciprocity, and solidarity among the population.

error term in equation (1).[12]

Tables 5 to 12 present the results of the estimation. In Tables 5 to 8 we use PORSLAVE as an instrument of LNCOURTSPC. Tables 9 to 12 use LNCOMMPC as an alternative measure of institutions. The columns of these tables mimic the specifications considered in Tables 1 to 4 except for the addition of our measures of institutional quality. Tables 5 to 12 report the first stage F-statistic of the excluded instrument, PORSLAVE. The F-statistics provide support for our utilization of the proportion of slave population in 1835 as an instrument of current institutional quality.[13]

What can we learn from the estimation? The results reveal that institutions are significant determinants of the variance of income per person. The estimated elasticity of income per person with respect to the number of courts per person ranges from 2.0 to 3.1. The estimated elasticity of income with respect to the number of communal organizations is between 2.2 and 3.6. Even the more modest of these estimates imply that if a municipality were to improve its institutional quality by one standard deviation, it would more than double its income per person.

How do the results differ from the regressions without institutions? The estimation implies that, controlling for institutional quality, many geographical features cease to be significant determinants of income per person. That is, the estimation suggests that many geographical variables, most notably climatic ones, have influenced the variability of institutional quality in Colombia, but do not have direct effects on income per person. Altitude, altitude squared, temperature, temperature squared, and the average distance to major rivers are not significant under any specification. Precipitation and its interaction terms with al-

[12]The statistics of the Hansen-Sargan J test of overidentifying restrictions in Mendoza and Rosas (2004) support the use of PORSLAVE as an instrument of institutions. These authors include PORSLAVE in their list of instruments of health status and institutional quality across Colombian regions.

[13]In discussing single-equation instrumental variables regressions, Staiger and Stock (1997) recommend a threshold value of 10 for the first-stage F-statistic. Notice that all the F-statistics in Tables 5 to 12 are higher than this threshold value.

titude and temperature are seldom significant using the log of communal organizations as a measure of institutions. Distance to the river Magdalena is significant at the ninety percent level only in regression (5) of Table 6. Distance to the river Cauca, DCAUCA, is significant under some specifications. When significant, DCAUCA has the expected negative sign suggesting that in the OLS regressions, which failed to control for institutions, the estimated positive sign might have reflected the legacy of slavery.

Nevertheless, the estimation also implies that some geographical variables continue to be statistically-significant determinants of income per person after accounting for institutional quality. In particular, we find three groups of variables that are consistently significant and have the expected signs across all specifications: the relative steepness of the terrain, measured both by PLAIN and SLOPE; the distance to markets; and variables of scale and agglomeration, measured by the log of population and population density. Next, we quantify the magnitude of the economic effects of these geographical variables.

According to our estimation, the percentage of flat terrain, PLAIN, and the average gradient of the terrain, SLOPE, have large effects on income per person. The point estimates of their coefficients are consistently higher with measures of institutions than without them in the regressions. The effect of income per capita of a one-standard-deviation increase in the percentage of flat terrain is between 13% (Regression 1, Table 9) and 46% (Regression 5, Table 8). The results also imply that a one-standard-deviation increase in the average gradient of the terrain would lead to between 12% (Regression 1, Table 9) and 45% (Regression 6, Table 8) lower income per person.

Distance to markets is significant at the ninety-nine percent level of confidence with an estimated coefficient of about -0.003 across all specifications. This estimate implies that a municipality one-standard-deviation further away from major markets would be twenty-seven percent poorer. In this sample, the average distance to markets is 91 kilometers.

The results also indicate large effects of scale and agglomeration. The log of population, both in 1985 and 1999, and population density in 1985 are significant at the ninety-nine percent level of confidence in every regression. The estimated elasticity of income with respect to municipal population ranges from 0.81 to 1.17. This implies that income per capita would be at least four times the average in a municipality with one standard deviation more people. The estimated coefficient of population density is between 0.06 and 0.08. According to this estimate, a one-standard-deviation increase in density would raise income per person between eighteen and twenty-four percent in the average municipality.

7 Relation to the Literature and Limitations

In line with the economic literature we find that institutions are a robust and powerful determinant of income per person. The magnitude of the effect of institutional quality on income is noteworthy because it takes place within a country. Further, our results imply that the statistical significance of many geographical features is a mirage in regressions that do not consider institutional variability. Our estimation is also consistent with the theories of Engerman and Sokoloff (1997), Acemoglu, Johnson and Robinson (2001), and Hall and Jones (1999) that view institutional quality as a mechanism by which geography affects development.

The importance of institutional quality has led some authors to claim that institutions dwarf every other factor as a determinant of economic performance. Rodrik, Subramanian, and Trebbi (2002, page 4) write "we find that the quality of institutions trumps everything else. Once institutions are controlled for...geography has at best weak direct effects". Our findings are in sharp contrast with this maximalist view of the relevance of institutions. Our results support the theories and empirical studies suggesting direct effects of geographical features on income through their influence on productivity. Examples are Mellinger, Sachs and Gallup (2000), Sachs (2001), and Fujita, Krugman and Venables (1999).

An important extension of the paper, using other samples and richer data, would be to unravel the particulars of the relationship between geography and productivity. Is it the case that geography affects the productivity of each factor uniformly? Does geography encourage the accumulation of some factors of production in lieu of others? What is the influence of geography on the extent of primary activities? What is the effect of geography on productivity via lower transportation costs? Why are climatic variables seemingly irrelevant when one would expect agricultural productivity to be naturally affected by them? To what extent are the findings dependent on idiosyncratic elements of the Colombian economy that we have failed to identify? Answering these questions would also help us to understand the general applicability of our findings.

Finally, we would like to remain silent in terms of recommendations for active policy to deal with the economic effects of geography. A necessary condition to formulate such policy is a precise identification of possible externalities or market distortions caused by geographical features. We would also like to remain cautious with respect to the desirability of policies aimed at improving institutional quality. We believe that our two measures of institutions are but proxies of the true, empirically not available, measure of institutional quality. Further, it might be reasonable to presume that institutions evolve slowly. Thus, an increase in the number of courts per person or in the number of communal organizations, perhaps engineered by active policy-making, might not necessarily involve much change in income per person.

8 Summary

This paper quantifies the effects of geography on income per person. We use a dataset of close to nine hundred Colombian municipalities. We control for institutional quality by using the proportion of slave population in 1835 as an instrument of current institutions.

The estimation reveals that institutional quality is a powerful determinant of economic development. Further, the estimation also tells us that, controlling for institutional quality, many geographical variables cease to be significant determinants of income per person.

Nonetheless, we also find that some geographical features have large economic consequences even after accounting for the variability of institutions. In particular, we find that the proportion of flat terrain, the average distance to the marketplace, population size, and population density have a significant direct impact on the level of economic activity.

Appendix A

All the sources refer to Colombian publications and institutions. To estimate per-capita magnitudes we used population values in 1999 [Source: Departamento Administrativo Nacional de Estadística (DANE), División de Estadísticas Vitales].

- Income: Approximated with the log of per-capita property taxes and industry and commerce tax revenues. Source: Dirección de Desarrollo Territorial. Departamento Nacional de Planeación. 1997, 1998, 1999. Original values are in thousands of pesos.
- Lncourtspc: Log of the number of judicial courts per capita. Source: Municipios y Regiones de Colombia. Fundación Social. 1998.
- Lncommpc: Log of the number of communal organizations per capita. Source: Municipios y Regiones de Colombia. Fundación Social. 1998.
- Porslave: Slaves as a fraction of the total population in 1835 (at the departmental level). Source: Fernando Gómez, "Los censos en Colombia", Tables 6, 7, 8, in Miguel Urrutia and Mario Arrubla, eds., *Compendio de estadísticas históricas*, Bogotá, 1970. We matched the current jurisdictional demarcation with the jurisdictional demarcation of 1835 found in the original source.
- Alt: Meters above the sea level. Source: Instituto Geográfico Agustín Codazzi. 1998.
- Rain: Mean annual rain precipitation in mm. Source: Instituto Geográfico Agustín Codazzi. 1998.
- Temp: Mean annual temperature in Celsius degrees. Source: Instituto Geográfico Agustín Codazzi. 1998.
- Plain: The percentage of flat terrain in the municipality, where flat is defined as an average slope of less than ten percent. Source: Departamento de Ecología y Territorio de la Facultad de Estudios Ambientales de la Pontificia Universidad Javeriana. 2003.
- Slope: The average gradient of the terrain in the municipality. Source: Departamento de Ecología y Territorio de la Facultad de Estudios Ambientales de la Pontificia Universidad Javeriana. 2003.
- Driver: Average Euclidian distance to the twenty major rivers of the country in kilometers. Source: Departamento de Ecología y Territorio de la Facultad de Estudios Ambientales de la Pontificia Universidad Javeriana. 2003.

- Dmagdalena: Average Euclidian distance to the Magdalena river in kilometers. Source: Departamento de Ecología y Territorio de la Facultad de Estudios Ambientales de la Pontificia Universidad Javeriana. 2003.

- Dcauca: Average Euclidian distance to the Cauca river in kilometers. Source: Departamento de Ecología y Territorio de la Facultad de Estudios Ambientales de la Pontificia Universidad Javeriana. 2003.

- Dmarkets: Euclidian distance from the municipality to the nearest main city (Cali, Medellín, and Bogotá) or seaport (Barranquilla and Buenaventura) of the country. Source: Departamento de Ecología y Territorio de la Facultad de Estudios Ambientales de la Pontificia Universidad Javeriana. 2003.

- Lnpop99: Log of total population in 1999. Source: Dirección de Censos. Departamento Administrativo Nacional de Estadística. 1999.

- Lnpop85: Log of total population in 1985. Source: Dirección de Censos. Departamento Administrativo Nacional de Estadística. 1985.

- Density85: Population density in 1985. Source: Dirección de Censos. Departamento Administrativo Nacional de Estadística. 1985. Source for land areas: Centro de Investigación e Información Georeferenciada de la Pontificia Universidad Javeriana, in hectares.

Appendix B
Mean and Standard Deviations

Variable	Tables 1 to 4 896 observations Mean	 Std. Dev.	Tables 5 to 8 876 observations Mean	 Std. Dev.	Tables 9 to 12 892 observations Mean	 Std. Dev.
Income	2.269688	1.216971	2.246687	1.216037	2.268322	1.219103
Courts per capita	-	-	0.0001405	0.0001248	-	-
Comm. org. per capita	-	-	-	-	0.0008763	0.0006081
Alt	1267.519	892.6484	1269.789	892.8462	1272.613	891.3816
Alt2	2371326	2450466	2376705	2449790	2381864	2450884
Temp	21.11258	4.959764	21.09731	4.963215	21.08879	4.958072
Temp2	470.3128	204.5591	469.7017	204.7904	469.2919	204.4449
Rain	1833.125	1031.9	1841.553	1038.335	1831.211	1033.438
Altrain	2090885	1801217	2105146	1812699	2098904	1801225
Temprain	39712.33	26580.69	39863.27	26741.09	39622.77	26596.3
Plain	0.6230808	0.3002034	0.6201745	0.3006094	0.6213906	0.29981
Slope	9.447921	6.982382	9.5064	6.990043	9.489957	6.969668
Drivers	23.20567	24.36632	23.35688	24.42294	23.30213	24.37812
Dcauca	165.9142	112.7061	163.7443	101.9942	162.9479	102.3115
Dmagdalena	134.511	113.9571	132.394	106.3058	131.9083	105.6746
Dmarkets	150.5603	99.3163	149.1295	90.89561	148.1466	91.02387
Population in 1999	43287.12	240659.5	40933.77	242409.8	43334.56	241195.8
Population in 1985	31934.03	164301.7	30508.92	165614.6	31977.83	164666.8
Density85	1.205499	4.257218	1.000438	3.122409	1.210813	4.266021

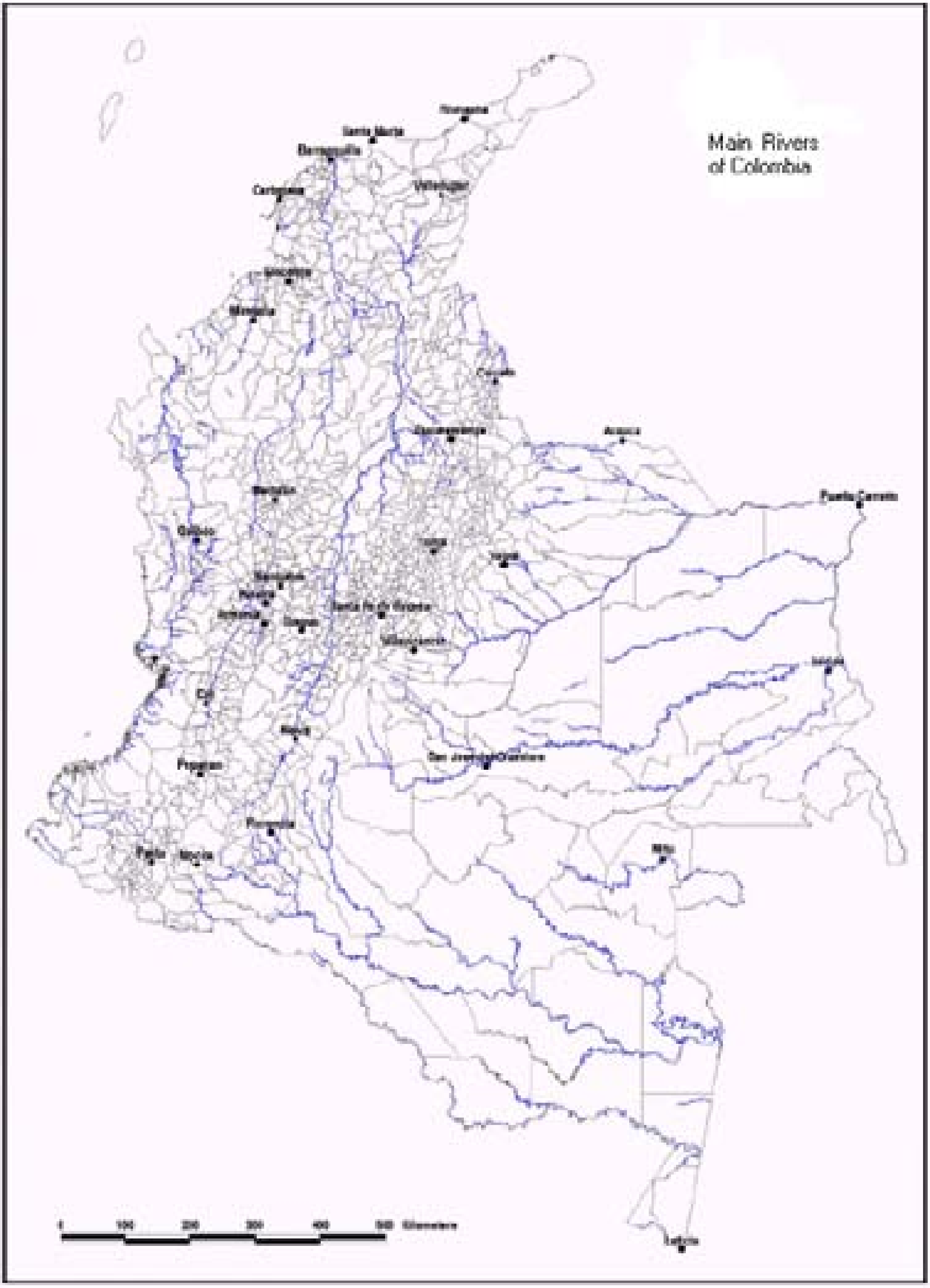
Main Rivers
of Colombia
Santa Marta
Barranquilla
Cali

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Table 1: Regressions without Institutions
Specification A.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-.0260775	.5133441	-.7321081	-.1808191	1.854765	2.50527
	(0.05)	(1.11)	(1.50)	(0.38)	(7.58)***	(13.59)***
Alt	.0007291	.0006761	.0007593	.0007067	.0006246	.0005762
	(3.61)***	(3.37)***	(3.76)***	(3.53)***	(3.29)***	(3.06)***
Alt2	-1.36e-07	-1.19e-07	-1.42e-07	-1.25e-07	-1.16e-07	-1.01e-07
	(2.17)**	(1.92)*	(2.27)**	(2.01)**	(1.96)*	(1.71)*
Rain	.0001218	.0001237	.0001236	.0001252	.0001132	.0001152
	(1.95)*	(1.97)**	(2.00)**	(2.01)**	(1.84)*	(1.86)*
Altrain	-6.36e-08	-6.57e-08	-6.62e-08	-6.82e-08	-6.66e-08	-6.82e-08
	(1.74)*	(1.78)*	(1.81)*	(1.84)*	(1.90)*	(1.92)*
Plain	.5878441		.5908541		.6425922	
	(4.01)***		(4.08)***		(4.44)***	
Slope		-.0201758		-.0204474		-.0233915
		(3.19)***		(3.25)***		(3.78)***
Drivers	-.006351	-.0063975	-.0064103	-.0064538	-.0058188	-.0058381
	(2.71)***	(2.72)***	(2.70)***	(2.70)***	(2.36)**	(2.35)**
Dmagdalena	-.0015749	-.0016535	-.0015736	-.0016471	-.0011407	-.0012142
	(2.86)***	(3.00)***	(2.89)***	(3.02)***	(2.06)**	(2.18)**
Dcauca	.0018724	.0019181	.0020387	.0020806	.001246	.0012749
	(3.56)***	(3.63)***	(3.90)***	(3.95)***	(2.41)**	(2.45)**
Dmarkets	-.0038054	-.0038354	-.0037917	-.0038212	-.0035778	-.0035924
	(7.03)***	(7.08)***	(7.08)***	(7.13)***	(6.48)***	(6.49)***
Lnpop99	.1921256	.1976381				
	(5.17)***	(5.31)***				
Lnpop85			.2639464	.2687785		
			(6.86)***	(6.95)***		
Density85					.0424983	.0439888
					(4.18)***	(4.22)***
R^2	0.1866	0.1817	0.2004	0.1955	0.1843	0.1797
No. of Obs.	896	896	896	896	896	896

*Notes: The absolute values of the t-statistics, calculated with robust standard errors, are in parentheses. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 2: Regressions without Institutions
Specification B.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	1.13885	1.642688	.4470159	.9558427	2.966069	3.561992
	(1.23)	(1.83)*	(0.48)	(1.07)	(3.56)***	(4.56)***
Temp	.0426651	.0231466	.0480627	.0290483	.0140217	-.0030555
	(0.56)	(0.30)	(0.63)	(0.38)	(0.18)	(0.04)
Temp2	-.0024701	-.0019642	-.0026674	-.0021736	-.0015428	-.0011007
	(1.32)	(1.03)	(1.42)	(1.14)	(0.83)	(0.59)
Rain	-.0002824	-.000292	-.0002914	-.0003009	-.0002849	-.0002925
	(1.82)*	(1.83)*	(1.85)*	(1.85)*	(1.98)**	(1.98)**
Temprain	.0000144	.0000149	.0000148	.0000152	.0000143	.0000147
	(1.98)**	(1.99)**	(2.02)**	(2.03)**	(2.08)**	(2.09)**
Plain	.4138996		.4139798		.4641981	
	(2.91)***		(2.94)***		(3.32)***	
Slope		-.01302		-.0131929		-.016044
		(2.10)**		(2.14)**		(2.65)***
Drivers	-.0061666	-.0062142	-.0062357	-.0062797	-.0057072	-.0057262
	(2.73)***	(2.74)***	(2.73)***	(2.73)***	(2.39)**	(2.38)**
Dmagdalena	-.001407	-.0014672	-.0014141	-.0014685	-.0009997	-.0010537
	(2.54)**	(2.65)***	(2.58)***	(2.68)***	(1.80)*	(1.89)*
Dcauca	.0016734	.0017228	.0018353	.0018804	.0011102	.0011405
	(3.15)***	(3.23)***	(3.47)***	(3.54)***	(2.12)**	(2.17)**
Dmarkets	-.004017	-.0040449	-.0040015	-.0040288	-.0037914	-.003805
	(7.38)***	(7.45)***	(7.42)***	(7.48)***	(6.86)***	(6.89)***
Lnpop99	.1795903	.1854321				
	(4.81)***	(4.97)***				
Lnpop85			.2504367	.2555189		
			(6.48)***	(6.59)***		
Density85					.0429805	.044246
					(4.17)***	(4.21)***
R^2	0.1731	0.1699	0.1861	0.1830	0.1741	0.1709
No. of Obs.	896	896	896	896	896	896

*Notes: The absolute values of the t-statistics, calculated with robust standard errors, are in parentheses. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 3: Regressions without Institutions
Specification C.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	.306338	.6755933	-.3724148	.0013935	2.104499	2.606949
	(0.73)	(1.53)	(0.85)	(0.00)	(10.98)***	(15.49)***
Alt	.0003484	.0003431	.0003623	.0003569	.0002996	.000295
	(4.58)***	(4.50)***	(4.74)***	(4.66)***	(3.90)***	(3.83)***
Rain	.0001192	.000121	.0001208	.0001224	.0001118	.0001136
	(1.90)*	(1.92)*	(1.95)*	(1.97)**	(1.81)*	(1.83)*
Altrain	-5.62e-08	-5.94e-08	-5.84e-08	-6.16e-08	-6.05e-08	-6.29e-08
	(1.66)*	(1.73)*	(1.74)*	(1.81)*	(1.83)*	(1.88)*
Plain	.4392379		.4359597		.511411	
	(3.38)***		(3.42)***		(4.05)***	
Slope		-.0147288		-.0147239		-.0186409
		(2.64)***		(2.67)***		(3.46)***
Drivers	-.0070119	-.0069816	-.0070975	-.0070657	-.0063865	-.0063367
	(2.98)***	(2.97)***	(2.98)***	(2.96)***	(2.59)***	(2.56)**
Dmagdalena	-.0014708	-.0015462	-.0014655	-.001535	-.0010628	-.0011329
	(2.65)***	(2.78)***	(2.67)***	(2.80)***	(1.90)*	(2.02)**
Dcauca	.0016885	.0017501	.0018441	.0019017	.0011008	.0011436
	(3.22)***	(3.32)***	(3.52)***	(3.62)***	(2.12)**	(2.20)**
Dmarkets	-.0039402	-.0039547	-.0039323	-.0039466	-.0036881	-.0036903
	(7.34)***	(7.37)***	(7.39)***	(7.43)***	(6.74)***	(6.74)***
Lnpop99	.1881829	.1938756				
	(5.09)***	(5.24)***				
Lnpop85			.2584608	.2635869		
			(6.72)***	(6.83)***		
Density85					.0432067	.04441
					(4.22)***	(4.25)***
R^2	0.1804	0.1769	0.1936	0.1903	0.1798	0.1763
No. of Obs.	896	896	896	896	896	896

*Notes: The absolute values of the t-statistics, calculated with robust standard errors, are in parentheses. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 4: Regressions without Institutions
Specification D.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	2.084939	2.336294	1.474907	1.728922	3.550219	3.945054
	(4.51)***	(4.81)***	(3.11)***	(3.50)***	(10.83)***	(12.06)***
Temp	-.0542892	-.0538384	-.0566112	-.0561173	-.0465881	-.0462317
	(3.98)***	(3.91)***	(4.14)***	(4.06)***	(3.38)***	(3.32)***
Rain	-.0002287	-.0002499	-.0002334	-.0002543	-.0002515	-.000269
	(1.66)*	(1.73)*	(1.70)*	(1.77)*	(1.85)*	(1.90)*
Temprain	.0000123	.0000132	.0000125	.0000134	.000013	.0000137
	(1.81)*	(1.88)*	(1.85)*	(1.92)*	(1.94)*	(2.00)**
Plain	.3457693		.3405772		.4201752	
	(2.63)***		(2.64)***		(3.31)***	
Slope		-.0106289		-.0105537		-.0146677
		(1.88)*		(1.89)*		(2.70)***
Drivers	-.0065274	-.006504	-.0066242	-.0065994	-.0059307	-.0058876
	(2.89)***	(2.88)***	(2.90)***	(2.88)***	(2.50)**	(2.47)**
Dmagdalena	-.0013476	-.0014136	-.0013495	-.0014088	-.000966	-.0010258
	(2.41)**	(2.53)**	(2.45)**	(2.56)**	(1.72)*	(1.83)*
Dcauca	.0016082	.0016695	.0017631	.0018199	.0010725	.0011127
	(3.04)***	(3.14)***	(3.34)***	(3.43)***	(2.05)**	(2.12)**
Dmarkets	-.0040823	-.0040984	-.0040722	-.0040881	-.0038289	-.003833
	(7.59)***	(7.64)***	(7.65)***	(7.68)***	(7.00)***	(7.02)***
Lnpop99	.1784018	.184511				
	(4.80)***	(4.96)***				
Lnpop85			.2484353	.2538764		
			(6.45)***	(6.57)***		
Density85					.0434695	.044549
					(4.20)***	(4.23)***
R^2	0.1716	0.1690	0.1845	0.1819	0.1735	0.1706
No. of Obs.	896	896	896	896	896	896

*Notes: The absolute values of the t-statistics, calculated with robust standard errors, are in parentheses. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 5: Regressions with Institutions
Specification A using Judicial Courts.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	19.63744	21.33399	18.27877	20.27787	21.53478	23.82164
	(3.44)***	(3.47)***	(3.53)***	(3.56)***	(4.37)***	(4.36)***
Lncourtspc	3.058242	3.135661	2.706975	2.793777	2.057187	2.14019
	(3.39)***	(3.34)***	(3.62)***	(3.56)***	(3.95)***	(3.88)***
Alt	-.000257	-.0003469	-.0001981	-.0002892	-.0003531	-.0004432
	(0.65)	(0.85)	(0.54)	(0.77)	(1.08)	(1.31)
Alt2	9.34e-08	1.22e-07	6.85e-08	9.71e-08	8.65e-08	1.14e-07
	(0.87)	(1.10)	(0.70)	(0.96)	(1.00)	(1.28)
Rain	-.0001792	-.0001832	-.0001853	-.0001912	-.000151	-.0001574
	(1.50)	(1.49)	(1.63)	(1.63)	(1.60)	(1.61)
Altrain	2.82e-10	9.96e-10	-1.08e-08	-8.97e-09	-1.82e-08	-1.51e-08
	(0.01)	(0.02)	(0.20)	(0.16)	(0.42)	(0.33)
Plain	1.211867		1.37756		1.437212	
	(3.65)***		(3.99)***		(4.45)***	
Slope		-.0472382		-.0555083		-.0595765
		(3.33)***		(3.70)***		(4.17)***
Drivers	-.0011612	-.0010512	-.0012463	-.0010937	-.0000856	.0001407
	(0.28)	(0.25)	(0.30)	(0.26)	(0.02)	(0.04)
Dmagdalena	.0002926	.0001872	.0009992	.0009162	.0015646	.0015104
	(0.30)	(0.19)	(0.97)	(0.87)	(1.54)	(1.46)
Dcauca	-.001793	-.001808	-.001999	-.0020459	-.0036862	-.0038062
	(1.55)	(1.51)	(1.75)*	(1.72)*	(2.98)***	(2.94)***
Dmarkets	-.0033631	-.0033723	-.0034272	-.0034255	-.0033391	-.003317
	(3.86)***	(3.78)***	(4.20)***	(4.08)***	(4.43)***	(4.27)***
Lnpop99	1.144336	1.173299				
	(3.78)***	(3.73)***				
Lnpop85			.9535261	.9794613		
			(4.51)***	(4.42)***		
Density85					.0765811	.0793901
					(3.20)***	(3.14)***
No. of Obs.	876	876	876	876	876	876
First-stage F	11.33	10.96	13.36	12.73	18.39	17.37

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 6: Regressions with Institutions
Specification B using Judicial Courts.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	20.27683	22.20303	18.52777	20.70619	21.88515	24.29029
	(3.78)***	(3.77)***	(3.89)***	(3.89)***	(4.79)***	(4.74)***
Lncourtspc	3.041685	3.119484	2.676929	2.762644	2.040787	2.120023
	(3.53)***	(3.46)***	(3.80)***	(3.70)***	(4.14)***	(4.05)***
Temp	-.0980124	-.1246068	-.0675641	-.091034	-.1106861	-.131528
	(0.73)	(0.91)	(0.54)	(0.71)	(0.95)	(1.11)
Temp2	.0023839	.0030677	.0016818	.0022879	.0032625	.0038153
	(0.70)	(0.88)	(0.53)	(0.71)	(1.10)	(1.27)
Rain	-.0001435	-.0001475	-.0001946	-.0001965	-.0001848	-.0001829
	(0.68)	(0.66)	(0.95)	(0.90)	(1.11)	(1.04)
Temprain	-1.24e-06	-1.13e-06	3.65e-07	3.42e-07	1.35e-06	1.18e-06
	(0.12)	(0.10)	(0.04)	(0.03)	(0.17)	(0.14)
Plain	1.261593		1.417841		1.461418	
	(3.42)***		(3.75)***		(4.16)***	
Slope		-.0498931		-.057915		-.0611689
		(3.14)***		(3.48)***		(3.90)***
Drivers	-.0012484	-.0011157	-.0013725	-.0011931	-.0002165	.0000362
	(0.31)	(0.27)	(0.33)	(0.28)	(0.06)	(0.01)
Dmagdalena	.0002378	.0001112	.0009415	.0008351	.0015673	.0014891
	(0.26)	(0.16)	(0.99)	(0.87)	(1.65)*	(1.54)
Dcauca	-.0017223	-.0017142	-.0019042	-.0019259	-.003574	-.0036679
	(1.60)	(1.54)	(1.83)*	(1.77)*	(3.14)***	(3.07)***
Dmarkets	-.0032846	-.0032722	-.0033734	-.0033464	-.0033467	-.0033006
	(3.68)***	(3.58)***	(4.07)***	(3.92)***	(4.41)***	(4.21)***
Lnpop99	1.143563	1.174164				
	(3.87)***	(3.80)***				
Lnpop85			.9498248	.9771591		
			(4.61)***	(4.50)***		
Density85					.0770104	.0799604
					(3.25)***	(3.19)***
No. of Obs.	876	876	876	876	876	876
First-stage F	12.24	11.69	14.55	13.72	20.03	18.73

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 7: Regressions with Institutions
Specification C using Judicial Courts.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	19.23169	20.99534	17.9805	20.00359	21.15047	23.49866
	(3.56)***	(3.53)***	(3.65)***	(3.62)***	(4.50)***	(4.46)***
Lncourtspc	3.031231	3.110807	2.689915	2.77677	2.036148	2.1193
	(3.45)***	(3.38)***	(3.68)***	(3.59)***	(4.01)***	(3.92)***
Alt	7.14e-06	-2.91e-06	-4.14e-06	-.0000151	-.000108	-.0001221
	(0.04)	(0.02)	(0.02)	(0.09)	(0.69)	(0.75)
Rain	-.0001752	-.0001785	-.0001824	-.0001876	-.0001473	-.0001531
	(1.50)	(1.48)	(1.63)	(1.62)	(1.60)	(1.60)
Altrain	-4.86e-09	-5.43e-09	-1.46e-08	-1.41e-08	-2.29e-08	-2.11e-08
	(0.09)	(0.09)	(0.27)	(0.25)	(0.51)	(0.44)
Plain	1.307283		1.446868		1.524679	
	(3.63)***		(3.90)***		(4.41)***	
Slope		-.0525619		-.0597171		-.0645119
		(3.38)***		(3.65)***		(4.15)***
Drivers	-.0007959	-.0005475	-.000979	-.000694	.0002478	.0006066
	(0.19)	(0.13)	(0.24)	(0.16)	(0.07)	(0.16)
Dmagdalena	.0002146	.0000757	.0009385	.0008245	.0014871	.0014031
	(0.23)	(0.08)	(0.94)	(0.82)	(1.52)	(1.41)
Dcauca	-.0016335	-.0016019	-.0018782	-.0018772	-.0035307	-.0036088
	(1.53)	(1.45)	(1.78)*	(1.70)*	(3.06)***	(2.97)***
Dmarkets	-.0032701	-.003246	-.0033581	-.003324	-.0032534	-.0031999
	(3.72)***	(3.60)***	(4.08)***	(3.92)***	(4.31)***	(4.11)***
Lnpop99	1.139305	1.170234				
	(3.82)***	(3.76)***				
Lnpop85			.9524786	.9800416		
			(4.53)***	(4.43)***		
Density85					.0762019	.0791072
					(3.26)***	(3.20)***
No. of Obs.	876	876	876	876	876	876
First-stage F	11.71	11.20	13.75	12.98	19.05	17.81

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 8: Regressions with Institutions
Specification D using Judicial Courts.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	19.08198	20.77871	17.69342	19.65028	20.22966	22.48821
	(4.15)***	(4.04)***	(4.30)***	(4.18)***	(5.20)***	(5.02)***
Lncourtspc	2.992262	3.063041	2.646806	2.726147	1.990525	2.067146
	(3.61)***	(3.52)***	(3.86)***	(3.76)***	(4.21)***	(4.11)***
Temp	-.0052718	-.0052814	-.0021992	-.0021165	.0158647	.0164946
	(0.19)	(0.19)	(0.08)	(0.08)	(0.62)	(0.62)
Rain	-.0001956	-.0002137	-.000231	-.0002455	-.0002551	-.0002642
	(0.87)	(0.88)	(1.07)	(1.05)	(1.36)	(1.30)
Temprain	9.89e-07	1.69e-06	1.93e-06	2.43e-06	4.34e-06	4.64e-06
	(0.09)	(0.15)	(0.19)	(0.23)	(0.51)	(0.51)
Plain	1.311668		1.451708		1.526225	
	(3.58)***		(1.85)*		(4.38)***	
Slope		-.0528554		-.0600355		-.0646471
		(3.32)***		(3.60)***		(4.12)***
Drivers	-.0009911	-.0007701	-.0011906	-.0009355	.000116	.0004442
	(0.25)	(0.19)	(0.29)	(0.22)	(0.03)	(0.12)
Dmagdalena	.0001555	1.93e-06	.0008759	.0007444	.0014326	.00133
	(0.18)	(0.00)	(0.94)	(0.79)	(1.57)	(1.43)
Dcauca	-.0016105	-.001575	-.0018204	-.0018156	-.0033899	-.0034617
	(1.58)	(1.49)	(1.87)*	(1.75)*	(3.16)***	3.06***
Dmarkets	-.0032367	-.0032057	-.003338	-.0032949	-.0032805	-.003218
	(3.65)***	(3.53)***	(4.04)***	3.87***	4.37***	4.15***
Lnpop99	1.129214	1.157876				
	(3.94)***	(3.87)***				
Lnpop85			.9434156	.9695928		
			(4.67)***	(4.56)***		
Density85					.0756611	.0785135
					(3.32)***	(3.26)***
No. of Obs.	876	876	876	876	876	876
First-stage F	12.84	12.23	15.17	14.26	21.19	19.71

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 9: Regressions with Institutions
Specification A using Communal Organizations.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	18.38372	19.05926	17.28353	18.34407	19.18274	20.57774
	(3.17)***	(3.23)***	(3.23)***	(3.28)***	(4.06)***	(4.10)***
Lncommpc	3.576089	3.625323	3.202862	3.272869	2.316218	2.387725
	(3.16)***	(3.15)***	(3.36)***	(3.33)***	(3.64)***	(3.59)***
Alt	-.0004878	-.0005147	-.0004018	-.0004411	-.0004208	-.0004699
	(1.07)	(1.14)	(0.97)	(1.06)	(1.23)	(1.37)
Alt2	1.52e-07	1.60e-07	1.22e-07	1.33e-07	1.13e-07	1.28e-07
	(1.32)	(1.41)	(1.16)	(1.28)	(1.34)	(1.51)
Rain	.0003067	.0003105	.0002482	.0002527	.000172	.0001764
	(2.76)***	(2.76)***	(2.56)**	(2.55)**	(2.54)**	(2.55)**
Altrain	-5.31e-08	-5.23e-08	-5.84e-08	-5.70e-08	-6.11e-08	-5.92e-08
	(0.86)	(0.84)	(1.08)	(1.03)	(1.56)	(1.48)
Plain	.4276368		.6691307		.8417684	
	(1.88)*		(2.86)***		(3.92)***	
Slope		-.0175974		-.0279697		-.0355198
		(1.70)*		(2.70)***		(3.67)***
Drivers	.0049875	.0051338	.0042303	.0044501	.0033037	.0035733
	(1.09)	(1.10)	(0.96)	(0.99)	(0.87)	(0.92)
Dmagdalena	.0004495	.0004304	.0010679	.0010529	.0013786	.0013677
	(0.42)	(0.39)	(0.93)	(0.89)	(1.31)	(1.26)
Dcauca	-.0015295	-.0015524	-.0017503	-.0017963	-.0030932	-.0031828
	(1.34)	(1.33)	(1.52)	(1.51)	(2.62)***	(2.59)***
Dmarkets	-.0027796	-.0027623	-.0029327	-.0029073	-.0030598	-.0030229
	(3.15)***	(3.07)***	(3.66)***	(3.54)***	(4.64)***	(4.48)***
Lnpop99	1.008454	1.02081				
	(3.63)***	(3.63)***				
Lnpop85			.8494099	.8639125		
			(4.35)***	(4.32)***		
Density85					.0631439	.0652369
					(3.97)***	(3.94)***
No. of Obs.	892	892	892	892	892	892
First-stage F statistic	9.93	9.83	11.78	11.48	16.82	16.23

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 10: Regressions with Institutions
Specification B using Communal Organizations.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	16.77889	17.74244	15.59367	16.87124	18.28363	19.80212
	(3.85)***	(3.88)***	(3.89)***	(3.91)***	(4.84)***	(4.84)***
Lncommpc	3.318503	3.384264	2.980006	3.059486	2.189689	2.261397
	(3.48)***	(3.43)***	(3.70)***	(3.62)***	(3.94)***	(3.85)***
Temp	-.0082477	-.0119285	.0118804	.0080814	-.048422	-.0544184
	(0.07)	(0.11)	(0.11)	(0.07)	(0.51)	(0.57)
Temp2	-.0000532	.0000401	-.0005065	-.0004084	.0013616	.0015235
	(0.02)	(0.01)	(0.20)	(0.16)	(0.58)	(0.65)
Rain	-.0001075	-.0001031	-.0001635	-.0001584	-.0002002	-.0001951
	(0.54)	(0.50)	(0.91)	(0.86)	(1.40)	(1.33)
Temprain	.0000159	.000016	.0000158	.0000159	.0000143	.0000144
	(1.65)*	(1.63)	(1.79)*	(1.76)*	(2.13)**	(2.08)**
Plain	.6220456		.831137		.9385796	
	(2.61)***		(3.29)***		(3.91)***	
Slope		-.0262248		-.0354633		-.040162
		(2.44)**		(3.06)***		(3.62)***
Drivers	.0046548	.0048771	.0039169	.0042013	.0031238	.0034326
	(1.11)	(1.13)	(0.96)	(1.00)	(0.86)	(0.92)
Dmagdalena	.0001207	.0000765	.0007345	.0006928	.0011945	.0011581
	(0.14)	(0.09)	(0.77)	(0.71)	(1.31)	(1.24)
Dcauca	-.0011378	-.0011556	-.0013501	-.0013851	-.0027581	-.0028326
	(1.23)	(1.21)	(1.45)	(1.43)	(2.77)***	(2.71)***
Dmarkets	-.0026443	-.0026038	-.0028148	-.0027639	-.0030289	-.0029708
	(3.03)***	(2.90)***	(3.55)***	(3.37)***	(4.63)***	(4.41)***
Lnpop99	.9614151	.9786082				
	(3.96)***	(3.92)***				
Lnpop85			.8198576	.8374422		
			(4.71)***	(4.63)***		
Density85					.0617096	.0639695
					(4.10)***	(4.05)***
No. of Obs.	892	892	892	892	892	892
First-stage F statistic	12.25	11.86	14.41	13.76	20.15	19.11

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 11: Regressions with Institutions Specification C using Communal Organizations.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	17.73502	18.64119	16.76265	17.98883	18.69123	20.23921
	(3.26)***	(3.26)***	(3.32)***	(3.31)***	(4.17)***	(4.14)***
Lncommpc	3.521474	3.586932	3.165011	3.245305	2.282352	2.359938
	(3.21)***	(3.16)***	(3.40)***	(3.34)***	(3.68)***	(3.61)***
Alt	-.0000567	-.0000621	-.0000561	-.0000635	-.0000985	-.0001084
	(0.29)	(0.31)	(0.30)	(0.33)	(0.62)	(0.67)
Rain	.0003063	.0003115	.0002486	.0002542	.0001721	.0001774
	(2.81)***	(2.81)***	(2.60)***	(2.60)***	(2.59)***	(2.61)***
Altrain	-6.10e-08	-6.04e-08	-6.47e-08	-6.37e-08	-6.68e-08	-6.56e-08
	(1.05)	(1.02)	(1.24)	(1.19)	(1.75)*	(1.67)*
Plain	.5924611		.7988663		.9636496	
	(2.62)***		(3.35)***		(4.24)***	
Slope		-.0248887		-.033985		-.0413287
		(2.43)**		(3.10)***		(3.93)***
Drivers	.0054892	.005734	.0046434	.0049581	.0036845	.0040527
	(1.18)	(1.21)	(1.05)	(1.08)	(0.97)	(1.03)
Dmagdalena	.0003162	.0002789	.0009553	.0009232	.0012744	.0012451
	(0.31)	(0.27)	(0.87)	(0.82)	(1.27)	(1.20)
Dcauca	-.0012625	-.0012744	-.001529	-.0015583	-.0028845	-.0029568
	(1.22)	(1.20)	(1.46)	(1.43)	(2.65)***	(2.58)***
Dmarkets	-.0026414	-.0026064	-.0028186	-.0027746	-.0029588	-.0029018
	(2.93)***	(2.82)***	(3.44)***	(3.29)***	(4.45)***	(4.24)***
Lnpop99	1.000593	1.017471				
	(3.68)***	(3.65)***				
Lnpop85			.8474619	.8648381		
			(4.38)***	(4.32)***		
Density85					.0621889	.0644914
					(4.01)***	(3.96)***
No. of Obs.	892	892	892	892	892	892
First-stage F statistic	10.39	10.09	12.25	11.74	17.56	16.68

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*

Table 12: Regressions with Institutions Specification D using Communal Organizations.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	16.80493	17.72444	15.84036	17.05445	17.61029	19.10818
	(4.09)***	(4.02)***	(4.16)***	(4.07)***	(5.07)***	(4.94)***
Lncommpc	3.31979	3.383417	2.990748	3.06707	2.165217	2.237138
	(3.49)***	(3.43)***	(3.70)***	(3.61)***	(3.95)***	(3.85)***
Temp	-.0103167	-.0103686	-.0078176	-.007801	.004471	.0047764
	(0.38)	(0.38)	(0.30)	(0.29)	(0.20)	(0.20)
Rain	-.0001063	-.000104	-.0001522	-.0001494	-.0002301	-.0002283
	(0.52)	(0.50)	(0.82)	(0.78)	(1.58)	(1.52)
Temprain	.0000159	.0000161	.0000154	.0000156	.0000154	.0000156
	(1.61)	(1.60)	(1.70)*	(1.68)*	(2.27)**	(2.23)**
Plain	.6206878		.8189231		.9710587	
	(2.78)***		(3.42)***		(4.23)***	
Slope		-.0262697		-.0350275		-.0417696
		(2.58)***		(3.17)***		(3.92)***
Drivers	.0046513	.0048802	.0038805	.004168	.0032233	.0035576
	(1.12)	(1.14)	(0.96)	(1.00)	(0.90)	(0.97)
Dmagdalena	.0001225	.000075	.0007545	.0007093	.0011392	.0010952
	(0.14)	(0.08)	(0.79)	(0.72)	(1.27)	(1.18)
Dcauca	-.0011403	-.0011538	-.0013749	-.0014045	-.0026843	-.0027535
	(1.24)	(1.21)	(1.48)	(1.45)	(2.75)***	(2.68)***
Dmarkets	-.0026451	-.0026031	-.0028236	-.0027718	-.0030065	-.0029429
	(3.04)***	(2.91)***	(3.56)***	(3.39)***	(4.62)***	(4.40)***
Lnpop99	.9616931	.9784286				
	(3.96)***	(3.92)***				
Lnpop85			.8215343	.8385735		
			(4.70)***	(4.62)***		
Density85					.0610728	.063341
					(4.11)***	(4.06)***
No. of Obs.	892	892	892	892	892	892
First-stage F	12.51	12.02	14.66	13.91	20.80	19.58

*Notes: Absolute values of the z-statistics with robust standard errors in parentheses. The first-stage F is the F statistic of PORSLAVE. ***Significant at the 99 percent level. **Significant at the 95 percent level. *Significant at the 90 percent level.*