

The sources and evolution of inequality in Mexican ejidos

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INTRODUCTION

This paper studies the roots of inequality in rural Mexico, and examines its evolution over time. It is concerned with identifying historical sources of inequality and their influence on the present distribution of income. In particular, it examines three different influences on current wealth distribution: pre-colonial population density, land reform policy, and geography.

There are two key measures of wealth used in this paper: historical land holdings determined at the time of post-Revolutionary agrarian reform, and measures of the number of cattle *per* household taken in 2002. It will be shown that both measures are highly correlated with other income indicators, and that the first is deterministic of the second, suggesting persistence in inequality across time. Using survey data from 406 ejidos and *comunidades* (common property villages), this paper documents how pre-colonial population density, the timing of the Agrarian Reform, and geographic characteristics determined the division of land at the time of the founding

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of each *ejido*, and how these influences carry through to the distribution of present-day wealth.

Understanding the roots of inequality is both a moral and an economic obligation. Even if one were unconcerned with principles of justice, the empirical evidence that inequality has important effects on the economy is mounting. In many studies, inequality is taken as given by researchers. At a macro-economic level, changes in inequality have been shown to have a non-linear relationship with economic growth and a positive relationship with civil wars and social unrest (Banerjee and Duflo 2003, Collier and Hoeffler 2004). Other work has established that the effectiveness of income growth in reducing poverty is compromised in high inequality countries (World Bank 2006). Household level studies have shown inequality to reduce productivity and civic participation, and to have mixed effects on common property resource management (Bardhan 2000; Banerjee *et al.* 2001; Cardenas 2003; Alix-Garcia 2007, 2008).

The present paper finds itself in the company of both across- and within-country studies of inequality. Sala-i-Martin (2006) reviews the former literature and shows decreases in world income inequality over time. Explanations for variation in income can be found in the classic cross-country growth literature which highlights the importance of saving rates, integration, geography, and institutions.¹ Within-country techniques examining variation in income have been proposed by the literature on inequality decomposition, both by subgroups, as in Cowell and Jenkins (1995), and by income source, as in Theil (1979), and inform the analysis in this paper.

This study discusses the potential role of pre-colonial population density, land reform policy, and geography in determining the wealth distribution. In particular, high densities of indigenous populations at the time of the Conquest may have had an important role in determining the settlement patterns of the Spanish and the persistence of particular institutions within *ejidos*. High densities may have limited the ability and willingness of the

¹ For representative papers from each of these veins of literature see Mankiw *et al.* (1992), Sachs and Warner (1995), Sachs and Warner (1997), and Acemoglu *et al.* (2001).

Spanish to establish good institutions, relying instead on exploitation of native populations to extract goods, and may simply have limited the ability of the Spanish to distribute large tracts of land. This echoes the reversal of fortune logic presented by Acemoglu *et al.* (2002) with regards to the distribution of income between countries. It is also possible that these high densities would have affected the way in which land was distributed within *ejidos*, as indigenous traditions are more likely to have endured where populations were dense.

The current land distribution in the *ejidos* was determined at the time of the Agrarian Reform, when villages applied for restitution or distribution of agricultural lands. The eligibility rules and administrative process changed throughout the reform, which lasted from 1915 until 1991, and this paper argues that these rules may have had a lasting influence on the amount of land distributed to each village as well as the distribution of private lands within these villages. On a very basic level, as the Reform progressed, less land was available. One would therefore expect to observe less land given out over time. In addition, in the earliest years of the Reform, distribution excluded workers on haciendas. Changes in eligibility rules to allow these workers to request land (after 1934) are expected to have an impact on the character of the communities which formed after this time, and hence on the distribution of land within particular *ejidos*. Finally, given that land productivity is highly variable across Mexico, one would expect greater variation in land distribution within *ejidos* where there is higher variation in land quality. It is also possible that variation in land quality across *ejidos* affected the total amount of land distributed to villages at particular periods in time.

The data shows that the allocation of private land undertaken at the time of the Agrarian Reform within and between the *ejidos* is highly correlated with other wealth measures, including presence of a vehicle, receipt of government anti-poverty subsidies, cattle holdings, and migration to the United States (U.S.). Decomposition of land inequality reveals that this inequality is much higher between *ejidos* than within them, and that the opposite is true of cattle inequality, although the measures of between *ejido* cattle inequality are very similar to those of land. Pre-colonial populations, the date of *ejido*

founding, and geographic characteristics are have important impacts on the distribution of land within and between *ejidos*. Specifically, more dense pre-colonial populations are positively correlated with lower allocations of land from the Agrarian Reform, and with smaller cattle herds. They are also negatively correlated with land inequality within the *ejidos*—probably because many of the *ejidos* in these regions are entirely managed as common property. On the contrary, presence in a Mayan region is positively correlated with inequality in current assets as measured by cattle. One possible explanation of this phenomenon is that this distribution is simply a reflection of a traditionally hierarchical society. The data also shows that *ejidos* formed early on in the Reform tend to have been allocated less land, although early formation does not appear to have affected the between-*ejido* distribution of cattle. Early-formed *ejidos*, on the other hand, tend to have highly unequal cattle distributions within their boundaries. Finally, geographic variables exhibit a strong influence on both within and between *ejidal* inequality, in the past and the present. Higher variation in quality tends to lead to great variation in within-*ejidal* distributions, and between *ejidal* inequality is strongly driven by the presence of temperate forests—a proxy for higher quality soils.

Although the data do not permit the establishment of causality, it does allow for the examination of differences in institutional outcomes across pre-colonial populations and year of *ejido* formation. It shows political concentration and absence of rules regulating commons use in the Mayan region, and instability of property rights in the Aztec region, relative to those *ejidos* found outside of these regions. Nonetheless, the correlations are suggestive of the deterministic nature of institutions and geography together shaping the distribution of both past and present wealth.

The paper begins by providing a framework to analyze the potential sources of inequality in rural Mexico. In that section, I detail the potential roles of pre-Colonial populations, the timing of land acquisition, and the geographic characteristics of the regions in which *ejidos* found themselves in determining the distribution of resources. Section 3 describes the data and presents simple summary statistics on assets and inequality in the study communities. Section 4 shows a decomposition of total land inequality

into within and between-village components, while section 5 analyzes the determinants of these, including the relationship between timing of ejido formation, pre-colonial population density, and institutional outcomes. The final section concludes.

SOURCES OF INEQUALITY

This section presents a brief history of land tenure in Mexico, as well as discussing potential geographical and historical sources of inequality. The focus of the analysis is the *ejidal* sector, which is unique to Mexico, but is of general interest as an example of the influence of history and geography on land tenure.² It is of particular interest to scholars of Mexico because of the quantity of resources controlled by *ejidos*, and the number of communities involved. The total number of *ejidos* is nearly 29 000. *Ejidos* presently hold over 90 million hectares of land (46% of the country) and contain 80% of the remaining forest in Mexico.

Pre-Colombian population and institutions

For the purpose of this paper, the key features of the pre-Colombian societies are those which could have influenced either the distribution of parcels of land across the entire country, or the propensity of groups of individuals to divide up land in a particular fashion. With regards to the first, it is clear that the presence of large indigenous populations, such as those of the central plateau and Yucatan peninsula, must have had an impact on the ability of the Spanish to establish settlements. It is therefore possible that the reversal of fortune documented across countries by Acemoglu *et al.* (2002) could potentially be at play in Mexico as well. The argument is that dense settlements of indigenous populations at the time of the Conquest could have substantially impacted the institutions established by the Spanish

² In this paper, the term *ejido* also includes communal properties known in Spanish as *comunidades*, indigenous communities mostly located in southern Mexico.

through two avenues. First, such densities could have made extractive institutions (*i.e.*, enslavement of native Mexicans) more convenient. Second, the presence of already-established populations would have made settlement more difficult.

In the face of such difficulties, the Spanish might have made greater inroads in developing infrastructure and institutions in places which were less densely populated. They may have spent less energy establishing true settlements, with attendant schools, health care, roads, etcetera, in places where they were a minority in the midst of a hostile majority. In particular, they would have had more success in promoting private property and the mechanisms to safeguard it in areas which were sparsely inhabited by indigenous populations. In densely populated areas, they would exploit existing structures to work the land and extract minerals, but invest little in infrastructure and institutions.

It is worth discussing differences between the Mayan and Aztec regions. At the time of the Conquest, the Aztecs had a significantly developed urban population, in stark contrast with the Mayans (Smith 2005). Because of the centralized nature of Aztec government, the subjugation of major urban centers facilitated the collapse of the entire chain of command, and hence a relatively easy victory for the Spanish. Around the same period, it is thought that the traditionally egalitarian societies of the central plateau of Mexico were in the midst of an evolution towards a more hierarchical system. In particular, it was just before the arrival of the Spanish that heads of Aztec villages came to have special lands larger than those of the majority of the village (Simpson 1934). As is true in present-day *ejidos*, some of the land was preserved as a commons, while other plots were farmed individually.

This process of unequal land division and the formalization of private property was deepened by the Spanish, who were often awarded lands encompassing several indigenous villages as reward for their efforts in the name of the crown. Mayan society, on the other hand, while extremely hierarchical, was also quite dispersed, using urban centers mostly for religious activities (Coe 1998). The dispersed nature of their governance structure led to difficulties for the invading Spanish; the conflict between

the colonists and the Mayans of the Yucatan Peninsula is legendary, culminating in the Yucatan's Caste War, which lasted from 1847 to 1901 (Reed 1964). It is therefore not clear that the exact predictions of the Reversal of Fortune should hold—the less dense population of Yucatan may have made it more complicated to establish a Spanish hierarchy than the highly concentrated population of the Aztecs. However, both areas should have been more difficult to invade than the sparsely populated north of the country. Nonetheless, it is certainly plausible that the pre-colonial populations influenced the settlement patterns of the Spanish, and that these patterns were echoed by the distribution of land by the Reform. This land distribution would subsequently have determined the income growth of households receiving it. In particular, one could argue that places with more dense populations were more likely to be able to take advantage of the opportunity inherent in the Agrarian Reform, and that they were better positioned to translate land into other forms of wealth at a later stage. However, one might also point out that the difficulty of distributing vast tracts of land as a result of the pre-existing populations may not have had direct institutional effects—it simply may have made land relatively scarce in indigenous regions.

Finally, the already-established populations came with a set of cultural norms governing behavior. While the indigenous civilizations may have been becoming more hierarchical, the Spanish at the time of conquest usurped the role of the traditional elites and subjugated the masses, perhaps more intensively in the plateau than in the south. It seems plausible that the traditional culture of common resource management would affect the distribution of land within particular *ejidos*. If this is the case, then one might expect indigenous regions to have greater equality within *ejidos*.

The Agrarian Reform

By 1910, it has been estimated that almost one-half of the total rural population of Mexico were resident laborers on haciendas or smaller private holdings (Sanderson 1984). The general disenfranchisement of this class was

rich fodder for revolutionaries. It is not surprising, therefore, that one of the first acts of the Revolutionary government headed by Carranza was to establish the legal machinery needed to carry out land reform with the Decree of 6 January, 1915. This act began the Agrarian Reform process in Mexico, which continued with a variety of modifications until 1991, when it was officially declared over and the government began the arduous “new agrarian reform” policies epitomized by *Programa de Certificación de Derechos Ejidales y Titulación de Solares Urbanos* (PROCEDE), a land certification program.

Lands were awarded to groups of farmers to manage and work as commons.³ The first feature of the *ejido* system that is important for our purposes is the unusual nature of their land tenure arrangement. *Ejididos* generally have two types of land –private parcels, to which *ejido* members have rights to a certain amount of hectares in a particular place, and common land, to which members have a right usually defined by a percentage of the commons. Private land is not transferable, and rights to parcels and the commons, by law, can only be passed down to one family member. The private *ejidal* land distribution was established at the founding of each *ejido* and serves as a measure of historical inequality for the purposes of this paper.⁴ Indigenous communities, however, tend to have maintained their entire land holdings as commons.

The timing of a community’s receipt of land plays a role in the analysis, as it may have affected both the total amount of land given to villages, as well as the character of the individuals to whom the land was allocated. The laws governing the distribution of land, and the characteristics of the land available, changed considerably over time. According to Sanderson (1984), the land reform got off to a slow start. In 1915-1934 period, despite the promises of the Revolution, very little land was given out, and most of that went to the states of Central Mexico, which had provided important support to the Revolution.

³ Land was also awarded to individuals, but as the Reform progressed, this became less common. In any case, our primary concern here is the development of the reform as it relates to the *ejidos*.

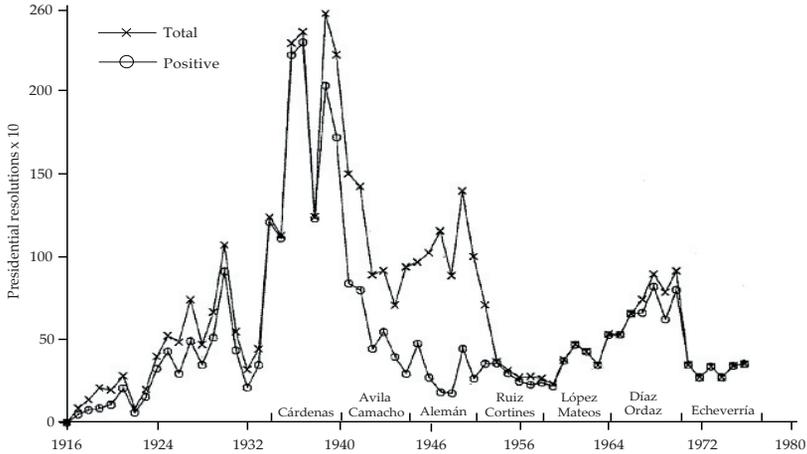
⁴ An *ejido* sector reform in 1992, called *Programa de Certificación de Derechos Ejidales y Titulación de Solares Urbanos*, allowed for a one-time expansion of *ejido* membership and redistribution of land. We use the measure of land holdings prior to the 1992 reform.

Although a variety of efforts were made to improve the efficiency of the process, it was plagued by administrative complications prohibitive to most potential land recipients. The Cárdenas administration of 1934-1940 marked a significant change in the attitude of the administration towards land reform. Its most important adjustment to the Reform was to allow hacienda workers to receive land. Prior to 1934, the Reform was limited to the restoration of land to agricultural villages and the distribution of land from abandoned haciendas. Over the 1934-1940 period, large amounts of land, generally of good quality, were expropriated and distributed. Almost all the irrigated land that was given out during the entire Reform was distributed before 1940.

The period between 1940 and 1970 represents the rapid industrialization of Mexico and a series of administrations bent on weakening the land reform. The majority of the land distributed after 1940 was classified as pasture. The more limited, lower quality land and unfavorable attitude of the government made receiving *ejidal* land more difficult during this time, with some increases in accessibility in the late 1960s in response to pressure from the countryside.

Figure 1 reprints Sanderson's (1984) graph of presidential resolutions over time. A positive resolution represents a distribution of land to an individual or community, and the total are all of the requests made for land. It seems likely that the timing of an *ejido's* petition would have various effects (not all of them exogenous) on the quantity of land given to it and on its distribution within the *ejido*. The most obvious impact of forming an *ejido* later in the Reform is that there would have been less land available for distribution. Hence one would expect to find small land allocations per capita in these *ejidos*. Within *ejidos*, the character of the recipients might have affected the within-distribution of land. In particular, the restoration of land to established villages, as occurred in the early part of the reform, may simply have codified the land distribution already present, which likely reflected the existing hierarchy. In later villages, formed from groups of workers and others who petitioned for land, one might anticipate a more egalitarian tendency.

FIGURE 1
Land distributions proposed and granted: 1915-1980



Fuente: Sanderson (1984).

Geography

Clearly, the distribution of land and resources is geographically dependent. There has been much written about geography and economic development in the cross-country literature (Sachs and Warner 1995, 1997). In the Mexican context, geography is intimately tied to the distribution of land because of the restrictions it imposes upon land use. Cattle are not productive in the steeply sloped and high altitude regions of the Sierras, nor are they particularly productive in the tropical flatlands of the Yucatan, although they can certainly be found in these areas. Agriculture too is limited by soil productivity and rainfall. Given that productive land requires smaller parcels to produce the same amount of output, it is easy to imagine that the distribution of land within the *ejidos* could have been designed to give larger allocations to individuals who found themselves on less productive land. Indeed, after 1922 the Agrarian Reform legislation contained provisions

dictating that allocations of rainfed land must be smaller than those of arid land, so it is also possible that land quality influenced the between-*ejido* distribution of land.

Predictions

The above sections argue for distinct roles for the timing of the Agrarian Reform, geography, and indigenous population density at the time of the Conquest as the roots of inequality in rural Mexico. In particular, this framework predicts that *ejidos* founded early on during the reform may have had an easier time acquiring land, as it became scarce with the passing of time. These early revolutionaries are therefore more likely to have larger *per capita* land holdings. For the distribution of land within these early *ejidos*, the prediction becomes more muddled. *Ejidos* formed before 1934 might be unique in that they were composed solely of already-established villages, rather than groups of hacienda workers.

Geographically speaking, greater variation in land quality within a given *ejido* should lead to greater observable inequality as individuals with poor land are compensated with larger allotments. One might expect to observe greater inequality between-*ejidos* driven by geography as well. In particular, the Reform may have allocated smaller parcels to *ejidos* with higher quality soils. Finally, the issue of the development of the land distribution is likely to be closely related to the density of indigenous populations at the time when the Spanish were dividing up land to reward settlers, as it was this land that was reallocated to villages during the Agrarian Reform. It seems clear that the allocation of large land allotments would be restricted by the presence of existing populations, and was likely to be easier where populations were scarce. This implies that *per capita* land-holdings should be larger in non-indigenous regions of the country. The impact of indigenous populations on within-*ejido* inequality is less clear—it depends upon the norms established in these communities after the displacement of their elites by the Spanish. The following sections will use data on land and cattle distribution in present-day *ejidos* to examine the roles of these three potential influences on inequality.

DATA DESCRIPTION

In the summer of 2002, Mexico's National Ecology Institute (INE in its Spanish acronym), together with the Iberoamericana University, the Center for Economic Education and Research (CIDE in its Spanish acronym), the University of California at Berkeley, and the World Bank, conducted a nationwide survey of Mexican forest-holding *ejidos*, which has come to be known as the *Encuesta Nacional de Núcleos Agrarios Forestales* (ENNAF). The purpose of the survey was to understand the deforestation process in these communities in order to inform the design of a Payments for Ecosystem Services (PES) program that the Mexican government was interested in introducing. The survey randomly sampled 410 *ejidos* larger than 100 hectares located in the forested regions of the country. The total universe of *ejidos* with forest over 100 hectares is 7 679 (out of a total of 29 000 *ejidos*).

The survey consisted of two sections, a community questionnaire and a household questionnaire. Respondents to the community questionnaire were three to four members of the community council, who are elected by popular vote. The community questionnaire collected basic characteristics of the community, including the year of the *ejido's* founding, as well as information regarding management of the commons. The household questionnaire, applied to 50 randomly chosen community members (individuals with rights to *ejidal* land), called *ejidatarios*, was an indirect survey where information was collected from a key informant. It includes data about participation in government programs, household size, migration, age, type of employment, land and cattle-holdings, and commons use. The methodology used to collect the indirect survey parallels that of Macours (2002).

I use two primary measures of inequality and assets created from this data. First, I use the measure of private land holdings for each individual interviewed in the indirect survey, adjusted for any changes in these numbers after the 1992 *Procede* reform which allowed reallocation and formalization of private lands. Given the rules on *ejidal* ownership, we consider this to be the measure of private land allocation at the time of the founding of the *ejido*. Table 1 shows a series of regressions corroborating the claim that land

is good measure of wealth. The dependent variables in these regressions are either measures of poverty (receiving payments through *Oportunidades*, an educational subsidy program for the poor), or wealth (animal holdings, migration to the U.S., and presence of a vehicle). The top panel of the table uses the individual-level data with fixed effects at the *ejido* level. In all cases, having larger parcel sizes increases measures of wealth (and decreases our measure of poverty). The bottom panel of the table shows *ejido*-means of both outcome and land variables. Average land holding shows similar correlations with wealth measures as does individual land holding, with the exception of small animals, where the effect is insignificant.

TABLE 1
Effect of private parcel size on wealth measures

	Individual measures				
	<i>Cattle</i>	<i>Small animals</i>	<i>Migrant in U.S.</i>	<i>Receives Oportunidades</i>	<i>Owns vehicle</i>
	(1)	(2)	(3)	(4)	(5)
Individual land (ha)	0.412 (0.014) ***	0.075 (0.011) ***	0.010 (0.002) ***	-0.004 (0.002) *	0.017 (0.002) ***
Observations	14 375	13 471	12 490	11 072	12 613
R-squared	0.056	0.004			
Log-likelihood			-5 544.3	-5 414.06	-5 468.97
	Ejidal averages				
Mean land holding	0.333 (0.041) ***	-0.013 (0.039)	0.042 (0.009) ***	-0.030 (0.012) **	0.035 (0.012) ***
Observations	406	404	429	342	406
R-squared	0.139	0.0002	0.042	0.015	0.02

Note: in the top panel, coefficients are from fixed effects ordinary least squares (OLS) regressions in columns (1)-(2) and fixed effects logits in columns (3)-(5). In the bottom panel, estimates come from OLS. Standard errors are robust and a constant is included, though not shown. (*), (**), and (***) represent significance at 10, 5, and 1 percent, respectively.

Although land is clearly one of the most important assets for an individual in rural Mexico, in this data set the measure of private land holding is an imperfect measure of actual land used. This is because in many of the indigenous *ejidos* of Southern Mexico, all of the land is officially managed as commons, and individuals are allocated parcels on a yearly basis for use in farming. These individuals have a private parcel size of zero, and the *ejidos* will necessarily be measured as perfectly equal, even if there are actual differences in assets within them. For this reason, and to have a measure of modern inequality, we also examine the number of cattle held by individuals within the *ejidos*.

The survey data is linked to spatial layers of the boundaries of each *ejido* property. This information allows for the overlay of these boundaries with digital elevation models and vegetation inventories, from which are created calculations of the average slope, elevation, and forest type within each community. The vegetation inventory used to determine forest type, which is generally a good reflection of soil quality, is the National Forest Inventory of 2000, from Mexico's National Institute of Geography and Statistics (INEGI in its Spanish acronym).

Finally, information for the distribution of pre-Colombian population is very challenging to find. Scholars have found it difficult to agree on the number of indigenous people in the entire country, let alone by region or state. However, there is broad agreement on where populations were most dense, that is, in the Aztec strongholds of Central Mexico, and in the Maya territories which cross over from Central American into the Southern Mexican States. Using maps of the Aztec and Mayan empires, states are classified as being in one empire, the other, or neither. In particular, the states of Mexico, Puebla, Hidalgo, Morelos, Oaxaca, and Queretaro find themselves in the area considered the "core" of the Aztec empire, and Chiapas, Quintana Roo, and Yucatan with the greatest development of the Mayan empire. This is not to say that there were not indigenous populations in other states—this is hardly the case—it is simply that the populations are thought to have been relatively more dense in these particular areas.

DECOMPOSITION OF INEQUALITY

This section applies the methodology of Shorrocks (1984) to decompose land inequality into inequality within and inequality between *ejidos*. The decomposition is applied to the three standard Generalized Entropy indices, $GE(a)$ where $a \in 0, 1, 2$, and $GE(A) = GE_w(a) + GE_B(a)$ where $GE_w(a)$ is within-*ejido* inequality and $GE(a)$ is between *ejido* inequality. Between-*ejido* inequality is calculated as if each *ejido* were a separate population and each person within it were allocated the mean land number of hectares of land within that *ejido*. The part of inequality explained by inequality within *ejidos* is given by:

$$GE_w(a) = \sum_{k=1}^K \left(\frac{N_k}{N} \right)^{1-a} \left(\frac{L_k}{L} \right)^a GE_k(a) \quad [1]$$

Where N is the total number of individuals, N_k the number of individuals in *ejido* (k, L_k) the amount of land held in *ejido* (k, L) the total amount of land in the sample and $GE_k(a)$ is $GE(a)$ calculated for *ejido* k .

Table 2 shows results of the decomposition analysis. The top panel includes all of the *ejidos* in the sample, while the bottom panel excludes those which do not have any parceled land (in which case each individual's private parcel size is registered as zero).⁵ In both cases, we observe that the vast majority of the overall inequality in the land distribution of the *ejidos* is due to variation in the mean parcel size between *ejidos*, rather than differences which occur because of the distribution of land within the *ejidos*. That said, however, the mean Gini coefficient within the *ejidos* is 0.26, and ranges up to 0.83.

⁵ Because of the difficulty in including zeros in the GE indices, calculations are done after adding 1 to all individuals' land and cattle holdings.

TABLE 2
Inequality decomposition

	<i>GE(0)</i>	<i>GE(1)</i>	<i>GE(2)</i>
<i>All ejidos</i>			
Overall	0.720	0.721	1.63
Within- <i>ejidos</i>	0.160	0.165	0.425
Between- <i>ejidos</i>	0.560	0.556	1.20
Percentage inequality from between	77.8	77.1	73.6
<i>Only ejidos with private land</i>			
Overall	0.598	0.634	1.403
Within- <i>ejidos</i>	0.182	0.167	0.380
Between- <i>ejidos</i>	0.416	0.467	1.023
Percentage inequality from between	69.6	73.7	72.9
<i>Cattle</i>			
Overall	1.035	1.044	3.108
Within- <i>ejidos</i>	0.622	0.675	2.635
Between- <i>ejidos</i>	0.404	0.369	0.473
Percentage inequality from between	39.0	35.3	15.2

Inequality in cattle holdings is significantly greater than inequality in land, although some of this is due to the fact that it is not possible to raise cattle in some *ejidos*.⁶ If one compares between-*ejido* inequality measures between cattle and land, the magnitudes are relatively similar. Within-*ejidos*, however, inequality in cattle holding is much greater than inequality in land holding. In cattle holding, it is within-*ejido* inequality that is the primary contributor to overall inequality. In addition, one can observe that these measures increase dramatically with the value of a of the *GE* indices. Increases in this parameter correspond to increasing sensitivity to the wealthier part of the population in the distribution. These increases therefore reflect increasing inequality among the wealthy—the implication of which is that cattle holdings are highly

⁶ Interestingly, however, the calculations do not change significantly when we leave out all *ejidos* with zero cattle in them.

skewed, with a relatively few individuals in the wealthiest quintiles holding the majority of the total herd in a community. If the measures are taken seriously as historical versus present, this suggests that regional inequalities have remained steady, while measured increases in inequality result from increases in inequality within communities. However, it is important to keep in mind that cattle are quite a distinct measure of wealth from land. Although the two are related, the productive potential of cattle is quite restricted by regions, which may be reflected in the between-*ejido* measures. The next section explores the potential sources of this inequality, both within and across *ejidos*, in the context of the hypotheses developed above.

EMPIRICAL ANALYSIS

This section analyzes the correlates of inequality within and between *ejidos*, using as the measure of the former the Gini coefficient of the private land or cattle distribution in each *ejido* (I), and for the latter the mean private parcel and herd sizes within each *ejido*. The basic specification is a simple regression where inequality is a function of geography (G_e) pre-Colombian population (P_e), and the time in which the *ejido* was formed (T):

$$I_e = \alpha_0 + \alpha_g' G_e + \alpha_p' P_e + \alpha_t' T_e + \varepsilon \quad [2]$$

A variety of geographical measures are used to proxy for G_e , including percentage of the *ejido* with a slope of less than 6 percent, average altitude of the land in the *ejido*, and a dummy variable indicating whether or not the *ejido* has temperate forest. For the regressions of mean parcel size, state averages are used rather than *ejidal* values for the geographic variables. Although fine scale information on soil quality is not available, forest type and altitude control broadly for soil type. Finally, proxies for the timing of the founding of the *ejido* are its age in 2000, and, alternatively, dummy variables for the periods 1914-1934 and 1934-1950, the peak years of the Reform. Pre-colonial populations are represented by dummy variables as described in the data description section. The equations are estimated using ordinary least squares (OLS) with robust standard errors.

Sources of inequality

Table 3 shows the results of a regression using the entire sample, where the dependent variable is the natural log of mean land holding of *ejido* members plus 1. This is therefore a measure of between *ejido* inequality. The hypotheses presented above are corroborated. *Ejid*os which were founded earlier in the reform have more land per capita, regardless of whether early is measured by dummy variables for 1915-1934 and 1934-1940, the age of the *ejido* in years, or a simple dummy for before 1940. The fact that there is no difference in the magnitude of the coefficients for the periods 1915-1934 and 1934-1940 suggests that the supply-side constraints on land did not differ much between these two periods.

Of the geographic variables the most robust result is that less land was awarded to *ejidos* with temperate forest. Given that temperate forest generally indicates higher quality soils than tropical forest, one might interpret this as support for the hypothesis that less land was given when that land was of higher quality. On the other hand, slightly more land was given in states with more low sloped land, although this effect is only marginally significant.

The presence of large pre-Colombian populations also appears to have a significant effect on land distribution. The coefficient on the Aztec and Mayan regions combined is negative and significant. When we separate out the two empires, only the Mayan region remains significant, and the effect is very large. The magnitude of this effect likely comes from the fact that *ejidos* in these regions are likely to be those that have chosen to keep all of their land as commons, and hence their private parcels enter the data set as zeros.

Within-*ejido* inequality is considered in table 4. Here we observe higher inequality in those *ejidos* formed in the early part of the Reform, although these results are only marginally significant. The results also show a large and significant impact of land quality on the internal distribution of land—those *ejidos* with more low sloped land tend to have lower inequality. This is evidence that quality-adjustments within *ejidos* were made at the time of land allocation, suggesting that the inequality observed in measures of land holdings overstates true inequality in terms of productive capacity. Finally,

TABLE 3
Correlates of inequality between ejidos

	Dependent variable: $\ln(1 + \text{mean parcel size})$					
	(1)	(2)	(3)	(4)	(5)	(6)
Founded 1915-1934	0.311 (0.132)**			0.295 (0.128)**		
Founded 1934-1940	0.331 (0.109)***			0.298 (0.109)***		
Age of <i>ejido</i>		0.006 (0.003)**			0.006 (0.003)**	
Founded before 1940			0.323 (0.102)***			0.297 (0.101)***
Proportion of state's <i>ejidos</i> in low slope	-0.039 (0.351)	-0.075 (0.352)	-0.037 (0.350)	0.732 (0.421)*	0.744 (0.416)*	0.733 (0.420)*
Altitude of <i>ejidos</i> in state	-8.03e-06 (0.00009)	-0.00003 (0.00009)	-8.85e-06 (0.00009)	-0.0001 (0.00009)	-0.0001 (0.00009)	-0.0001 (0.00009)
Proportion state <i>ejidos</i> with temperate forest	-0.776 (0.252)***	-0.737 (0.254)***	-0.774 (0.253)***	-0.820 (0.254)***	-0.795 (0.255)***	-0.820 (0.255)***
Aztec or Mayan	-0.838 (0.161)***	-0.843 (0.161)***	-0.840 (0.159)***			
Aztec				-0.203 (0.166)	-0.174 (0.164)	-0.203 (0.165)
Mayan				-1.663 (0.358)***	-1.712 (0.356)***	-1.664 (0.356)***
Observations	406	406	406	406	406	406
R-squared	0.138	0.129	0.138	0.17	0.164	0.17

Note: OLS estimates. Standard errors are robust and a constant is included, though not shown. (*), (**), and (***) represent significance at 10, 5, and 1 percent, respectively.

ejidos located in the Aztec and Mayan states have much lower measures of land inequality, particularly those in the Mayan regions. As before, this is probably due to the large amount of purely communal *ejidos* in these regions.

TABLE 4
Correlates of inequality within ejidos
Dependent variable: land Gini coefficient

	(1)	(2)	(3)	(4)	(5)	(6)
Founded 1915-1934	-0.219 (2.653)			-0.786 (2.585)		
Founded 1934-1940	3.558 (2.115)*			2.630 (2.110)		
Age of <i>ejido</i>		0.085 (0.051)*			0.077 (0.050)	
Founded before 1940			2.238 (1.957)			1.423 (1.941)
Percent <i>ejido</i> in low slope	-8.581 (3.047)***	-8.541 (3.028)***	-8.499 (3.045)***	-6.624 (3.027)**	-6.625 (3.004)**	-6.517 (3.030)**
Average altitude in <i>ejido</i>	0.0005 (0.001)	0.0004 (0.001)	0.0004 (0.001)	-0.0007 (0.001)	-0.0009 (0.001)	-0.0008 (0.001)
Temperate forest (0/1)	2.337 (2.571)	1.879 (2.585)	2.161 (2.579)	1.833 (2.568)	1.328 (2.574)	1.666 (2.575)
Aztec or Mayan	-6.255 (3.015)**	-6.703 (3.005)**	-6.588 (2.986)**			
Aztec				1.765 (4.381)	1.573 (4.357)	1.601 (4.339)
Mayan				-15.690 (3.851)***	-16.304 (3.853)***	-16.148 (3.834)***
Observations	406	406	406	406	406	406
R-squared	0.06	0.06	0.056	0.082	0.083	0.078

Note: ols estimates. Standard errors are robust and a constant is included, though not shown. (*), (**), and (***) represent significance at 10, 5, and 1 percent, respectively.

Finally, tables 5 and 6 consider the correlation between inequality between and within *ejidos* as measured by a current asset –cattle. Unlike the land data, where there is potential endogeneity between land size and the timing of *ejido* founding, it seems quite implausible that there is any reverse causality between the date of the founding of the *ejido* and cattle herd size in 2002. Between-*ejido* inequality is largely explained by the geographic and institutional variables. Larger herds are found where they are more productive –in states with low slope, low altitude, and temperate forests. Much larger herds are also found outside of the Aztec and Mayan regions, with presence in either region having similar effects. The point estimates of early formation of the *ejido* are positive – indicating larger herd size in early *ejidos*– but not statistically different from zero. The same is not true when we consider within-*ejido* inequality (the main source of inequality in cattle in the data). Early *ejidos* show much greater inequality in herd size. Within-*ejido* inequality is also higher in places where there is less variation in land quality –within *ejidos* at lower altitudes and with more low sloped land. Finally, inequality in cattle herd sizes is lower in the Aztec regions and higher in Mayan regions.

This section has examined the correlations of land and cattle distribution both between and within *ejidos*. This analysis gives us insight into how factors which determined the initial distribution of land have fed through to affect the current distribution of assets. In particular, geographic variables continue to be of substantial importance, but the timing of the land reform –interpreted as the impact of different eligibility rules over time– which was very important in determining between-*ejido* land allocation, has little impact on between-*ejido* allocation of present assets, while having an important influence on the current distribution of current assets within *ejidos*. Presence of dense pre-colonial populations continues to affect the current distribution of assets. The correlations shown here are suggestive support of the hypotheses presented earlier, although in some cases they do not correspond –for example, the observation of higher inequality in current assets among the Mayan *ejidos*. Because the data do not contain good instruments to predict institutions, it is impossible to separate the causal

effect of the institutions which have developed over time on the land and cattle endowments of individuals in our sample. However, examination of summary statistics on the institutional type information present in the dataset can give some insight into the dynamics within the different types of communities. The next section presents this analysis.

TABLE 5
Correlates of inequality between ejidos (cattle)
Dependent variable: $\ln(1 + \text{mean cattle herd size})$

	(1)	(2)	(3)	(4)	(5)	(6)
Founded 1915-1934	0.017 (0.126)			0.017 (0.126)		
Founded 1934-1940	0.118 (0.106)			0.119 (0.106)		
Age of <i>ejido</i>		0.003 (0.002)			0.003 (0.002)	
Founded before 1940			0.082 (0.095)			0.082 (0.095)
Proportion of state's <i>ejidos</i> in low slope	1.412 (0.320)*** -0.0004	1.425 (0.317)*** -0.0004	1.421 (0.319)*** -0.0004	1.402 (0.358)*** -0.0004	1.431 (0.355)*** -0.0004	1.415 (0.356)*** -0.0004
Altitude of state <i>ejidos</i>	(0.00008) ***	(0.00008) ***	(0.00008) ***	(0.00009) ***	(0.00009) ***	(0.00009) ***
Proportion state <i>ejidos</i> with temperate forest	1.414 (0.239)***	1.418 (0.238)***	1.423 (0.239)***	1.415 (0.240)***	1.417 (0.240)***	1.424 (0.240)***
Aztec or Mayan	-0.651 (0.126)***	-0.664 (0.126)***	-0.659 (0.125)***			
Aztec				-0.659 (0.187)***	-0.659 (0.185)***	-0.664 (0.185)***
Mayan				-0.641 (0.225)***	-0.671 (0.227)***	-0.653 (0.225)***
Observations	406	406	406	406	406	406
R-squared	0.151	0.151	0.15	0.151	0.151	0.15

Note: OLS estimates. Standard errors are robust and a constant is included, though not shown. (*), (**), and (***) represent significance at 10, 5, and 1 percent, respectively.

TABLE 6

Correlates of inequality within ejidos (cattle)

Dependent variable: cattle Gini coefficient

	(1)	(2)	(3)	(4)	(5)	(6)
Founded 1915-1934	7.778 (3.501)**			8.619 (3.461)**		
Founded 1934-1940	2.539 (2.814)			3.917 (2.883)		
Age of <i>ejido</i>		0.129 (0.065)**			0.139 (0.066)**	
Founded before 1940			4.370 (2.522)*			5.579 (2.571)**
Proportion of <i>ejido</i> in low slope	10.783 4.151***	10.734 (4.167)**	10.669 (4.154)**	7.882 (4.193)*	8.074 (4.214)*	7.734 (4.195)*
Average altitude	-0.008 (0.002)***	-0.008 (0.002)***	-0.007 (0.002)***	-0.006 (0.002)***	-0.006 (0.002)***	-0.006 (0.002)***
Temperate forest (0/1)	3.333 (3.369)	3.269 (3.335)	3.578 (3.318)	4.080 (3.364)	4.033 (3.338)	4.311 (3.314)
Aztec or Mayan	1.217 (4.176)	1.473 (4.144)	1.677 (4.163)			
Aztec				-10.680 (5.924)*	-10.019 (5.905)*	-10.453 (5.956)*
Mayan				15.210 (5.615)***	14.805 (5.440)**	15.841 (5.556)***
Observations	406	406	406	406	406	406
R-squared	0.085	0.084	0.081	0.111	0.107	0.107

Note: OLS estimates. Standard errors are robust and a constant is included, though not shown. (*), (**), and (***) represent significance at 10, 5, and 1 percent, respectively.

Leadership, rules, and uncertainty

This section examines the differences in the concentration of leadership, in rules and in uncertainty over resources which might change investment decisions within the *ejidos*. Of particular interest are the varying effects of pre-colonial population density and very early *ejido* foundation on the within-*ejido* distribution of cattle. Table 7 shows a summary of key institutionally-

related variables according to pre-colonial population. Relative to other regions, the percentage of *ejidatarios* who have been in leadership positions in the past 10 years is much lower in the Mayan region than in either of the other two.⁷ This suggests a certain level of concentration of power within these communities, and is consistent with the greater with-*ejido* inequality in assets that we observe in these communities. *Ejididos* in the Aztec region, on the other hand, exhibit a more egalitarian system of power-sharing within them. Participation in community assemblies, on the other hand, is highest in Mayan regions and lowest in other regions, with Aztec regions falling in the middle.

TABLE 7

Institutional outcomes by pre-colonial population
(average percentage)

	<i>Other</i>	<i>Aztec</i>	<i>Maya</i>
<i>Ejidatarios</i> in <i>ejido</i> leadership	42.1	52.2	34.4
<i>Ejidatarios</i> attending most recent assembly	71.6	74.1	76.2
<i>Ejididos</i> with <i>achurada</i> zone	15.1	17.2	4.3
Water conflict	9.3	32.3	3.8
Rules governing fire wood extraction	8.3	14.2	0
Rules governing housing wood extraction	17.5	33.3	0
Rules governing pasture use	26.3	8.7	14.3

The next measure is whether or not the *ejido* contains a *zona achurada*, or an area in the *ejido* which the *ejido* considers theirs but is not officially part of their land allocation. In other words, it measures whether or not the *ejido* has a land conflict. One might expect less investment in productive assets in *ejidos* which suffer from this uncertainty regarding their total land area. *Achurada* zones are most prevalent in the Aztec region, and there are surprisingly few in the Mayan regions. Water conflicts are also very high in

⁷ There are generally four leadership positions available at any given time in an *ejido*, with elections occurring every two years.

the Aztec region. This is likely because this is the area of highest population density in the country—central Mexico. The presence of conflicts over water and land could be interpreted as difficulty in developing the institutions needed to support investments in productive assets relative to the other regions. They also, of course, could simply be indicative of locations with significant water scarcity.

The last three variables in the table indicate whether or not the *ejidos* have developed rules regarding use of resources from their commons. In all cases the Mayan *ejidos* have considerably lower presence of rules over any resource than the regions outside the Mayan or Aztec empires. In the Aztec region, on the other hand, there are many more rules governing wood extraction and fewer governing pasture use. The development of rules is clearly endogenous to the presence of resources and multiple other factors. However, the conspicuous lack of rules and the higher political concentration in the Mayan *ejidos* does correlate with the presence of a hierarchical society where assets and power have concentrated in the hands of a relative few, and is not inconsistent with scholars' understanding of the post-classic Mayan civilization.

Table 8 examines the institutional variables as they relate to the timing of the *ejido* formation. In particular, it separates out the *ejidos* which were formed before hacienda workers were allowed to receive land. As was mentioned above, the Reform during this period was focused on the restitution of land to traditional agricultural villages rather than a redistribution of land to workers. The picture that emerges from the statistics is not particularly clear. Post-1934 *ejidos* have higher participation, less likelihood of a land dispute, and greater likelihood of rules governing pasture use. However, they have fewer rules governing forests and slightly higher political concentration. On the other hand, the greater inequality of cattle distribution that we observe within the earliest *ejidos* is concordant with a lack of rules governing pasture use.

CONCLUSION

This paper has presented varying hypotheses for the effects of history and geography in influencing the initial allocation of land in the *ejidos* of Mexico and the present allocation of assets. It has woven a narrative

TABLE 8
Institutional outcomes by year of ejido formation
 (average porcentaje)

	<i>Before 1934</i>	<i>After 1934</i>
<i>Ejidatarios</i> in <i>ejido</i> leadership	44.7	42.1
<i>Ejidatarios</i> attending most recent assembly	64.8	73.1
<i>Ejidos</i> with achurada zone	19.7	14.8
Water conflict	10.4	11.3
Rules governing fire wood extraction	11.6	8.5
Rules governing housing wood extraction	21.6	17.3
Rules governing pasture use	15.9	25.7

whereby the presence of pre-colonial populations affects the decisions of the Spanish regarding where to settle and develop institutions, and where to set up purely extractive mechanisms. It then examines how these early population densities influenced distribution of land during the reform, and how the timing of the formation of an *ejido* could have interacted with both historical population densities and geography. The earliest *ejidos* were different in character from later-formed communities as a result of both eligibility rules and the increasing scarcity of land to allocate.

Data from over 400 forest-holding *ejidos* is used to examine the effect of these factors on past and present wealth measures. It shows that where pre-colonial populations were dense, there was less private land allocated during the reform and greater equality in these allocations within *ejidos*. In terms of geography, greater variation in land quality resulted in greater inequality within *ejidos*, and the less land per person was given to *ejidos* in temperate zones, which could potentially be more productive than tropical ones. The earliest *ejidos* received more land, although there is no evident impact of early formation on the within-*ejido* distribution of land.

Cattle herd sizes proxy for the current distribution of wealth. Given the variation in productivity of cattle across Mexico, this proxy is imperfect. However, cattle tend to be an important asset throughout the country and are present in all of the zones contained in the sample. Consistent with the

variation of cattle productivity across space is that geographical variables are important determinants of both within and between *ejido* inequality. The timing of the Agrarian Reform does not have any effect on the distribution of cattle between *ejidos*, but *ejidos* formed before the 1934 revisions of the provisions for the Reform tend to have higher within-*ejido* inequality. Finally, *ejidos* located within the cores of the Aztec or Mayan empires have significantly smaller cattle herds, and those located within the Mayan zone have significantly greater inequality within these herds.

The last section of this paper examines the differences in institutional outcomes across pre-colonial populations and year of *ejido* formation. It shows political concentration and absence of rules regulating commons use in the Mayan region, and instability of property rights in the Aztec region, relative to those *ejidos* found outside of these regions. The analysis presented in this paper has been largely descriptive, with the data limiting its ability to establish causality. Nonetheless, the correlations are suggestive of the deterministic nature of both institutions and geography in shaping the distribution of wealth within Mexico. Efforts to understand current management of resources and projects aimed at improving the welfare of rural Mexico would do well to take into account the persistent impact of these factors.

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