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THE PERSISTENT EFFECTS OF PERU'S MINING *MITA*

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This study utilizes regression discontinuity to examine the long-run impacts of the *mita*, an extensive forced mining labor system in effect in Peru and Bolivia between 1573 and 1812. Results indicate that a *mita* effect lowers household consumption by around 25% and increases the prevalence of stunted growth in children by around 6 percentage points in subjected districts today. Using data from the Spanish Empire and Peruvian Republic to trace channels of institutional persistence, I show that the *mita*'s influence has persisted through its impacts on land tenure and public goods provision. *Mita* districts historically had fewer large landowners and lower educational attainment. Today, they are less integrated into road networks and their residents are substantially more likely to be subsistence farmers.

KEYWORDS: Forced labor, land tenure, public goods.

1. INTRODUCTION

THE ROLE OF HISTORICAL INSTITUTIONS in explaining contemporary underdevelopment has generated significant debate in recent years.[2] Studies find quantitative support for an impact of history on current economic outcomes (Nunn (2008), Glaeser and Shleifer (2002), Acemoglu, Johnson, and Robinson (2001, 2002), Hall and Jones (1999)), but have not focused on channels of persistence. Existing empirical evidence offers little guidance in distinguishing a variety of potential mechanisms, such as property rights enforcement, inequality, ethnic fractionalization, barriers to entry, and public goods. This paper uses variation in the assignment of an historical institution in Peru to identify land tenure and public goods as channels through which its effects persist.

Specifically, I examine the long-run impacts of the mining *mita*, a forced labor system instituted by the Spanish government in Peru and Bolivia in 1573 and abolished in 1812. The *mita* required over 200 indigenous communities to send one-seventh of their adult male population to work in the Potosí silver and Huancavelica mercury mines (Figure 1). The contribution of *mita* conscripts changed discretely at the boundary of the subjected region: on one side, all communities sent the same percentage of their population, while on the other side, all communities were exempt.

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[2]See, for example, Coatsworth (2005), Glaeser et al. (2004), Easterly and Levine (2003), Acemoglu, Johnson, and Robinson (2001, 2002), Sachs (2001), and Engerman and Sokoloff (1997).

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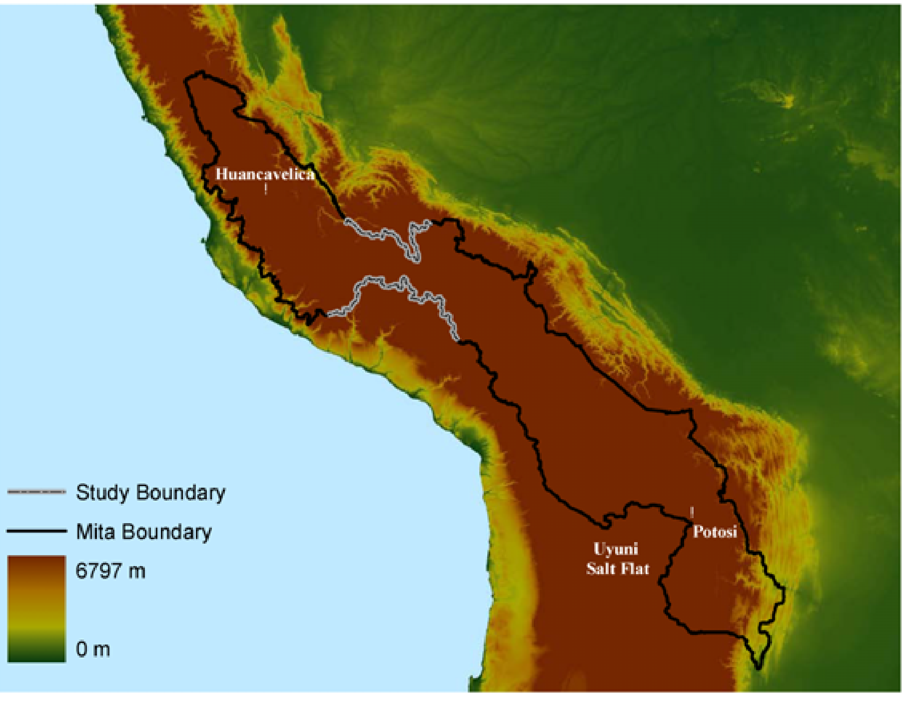


FIGURE 1.—The *mita* boundary is in black and the study boundary in light gray. Districts falling inside the contiguous area formed by the *mita* boundary contributed to the *mita*. Elevation is shown in the background.

This discrete change suggests a regression discontinuity (RD) approach for evaluating the long-term effects of the *mita*, with the *mita* boundary forming a multidimensional discontinuity in longitude–latitude space. Because validity of the RD design requires all relevant factors besides treatment to vary smoothly at the *mita* boundary, I focus exclusively on the portion that transects the Andean range in southern Peru. Much of the boundary tightly follows the steep Andean precipice, and hence has elevation and the ethnic distribution of the population changing discretely at the boundary. In contrast, elevation, the ethnic distribution, and other observables are statistically identical across the segment of the boundary on which this study focuses. Moreover, specification checks using detailed census data on local tribute (tax) rates, the allocation of tribute revenue, and demography—collected just prior to the *mita*'s institution in 1573—do not find differences across this segment. The multidimensional nature of the discontinuity raises interesting and important questions about how to specify the RD polynomial, which will be explored in detail.

Using the RD approach and household survey data, I estimate that a long-run *mita* effect lowers equivalent household consumption by around 25% in subjected districts today. Although the household survey provides little power for estimating relatively flexible models, the magnitude of the estimated *mita* effect is robust to a number of alternative specifications. Moreover, data from a national height census of school children provide robust evidence that the *mita*'s persistent impact increases childhood stunting by around 6 percentage points in subjected districts today. These baseline results support the well known hypothesis that extractive historical institutions influence long-run economic prosperity (Acemoglu, Johnson, and Robinson (2002)). More generally, they provide microeconomic evidence consistent with studies establishing a relationship between historical institutions and contemporary economic outcomes using aggregate data (Nunn (2008), Banerjee and Iyer (2005), Glaeser and Shleifer (2002)).

After examining contemporary living standards, I use data from the Spanish Empire and Peruvian Republic, combined with the RD approach, to investigate channels of persistence. Although a number of channels may be relevant, to provide a parsimonious yet informative picture, I focus on three that the historical literature and fieldwork highlight as important. First, using district-level data collected in 1689, I document that *haciendas*—rural estates with an attached labor force—developed primarily outside the *mita* catchment. At the time of the *mita*'s enactment, a landed elite had not yet formed. To minimize the competition the state faced in accessing scarce *mita* labor, colonial policy restricted the formation of *haciendas* in *mita* districts, promoting communal land tenure instead (Garrett (2005), Larson (1988)). The *mita*'s effect on *hacienda* concentration remained negative and significant in 1940. Second, econometric evidence indicates that a *mita* effect lowered education historically, and today *mita* districts remain less integrated into road networks. Finally, data from the most recent agricultural census provide evidence that a long-run *mita* impact increases the prevalence of subsistence farming.

Based on the quantitative and historical evidence, I hypothesize that the long-term presence of large landowners in non-*mita* districts provided a stable land tenure system that encouraged public goods provision. The property rights of large landowners remained secure from the 17th century onward. In contrast, the Peruvian government abolished the communal land tenure that had predominated in *mita* districts soon after the *mita* ended, but did not replace it with a system of enforceable peasant titling (Jacobsen (1993), Dancuart and Rodriguez (1902, Vol. 2, p. 136)). As a result, extensive confiscation of peasant lands, numerous responding peasant rebellions as well as banditry and livestock rustling were concentrated in *mita* districts during the late 19th and 20th centuries (Jacobsen (1993), Bustamante Otero (1987, pp. 126–130), Flores Galindo (1987, p. 240), Ramos Zambrano (1984, pp. 29–34)). Because established landowners in non-*mita* districts enjoyed more secure title to their property, it is probable that they received higher returns from investing in public goods. Moreover, historical evidence indicates that well established landowners possessed the political connections required to secure public goods

(Stein (1980)). For example, the *hacienda* elite lobbied successfully for roads, obtaining government funds for engineering expertise and equipment, and organizing labor provided by local citizens and *hacienda* peons (Stein (1980, p. 59)). These roads remain and allow small-scale agricultural producers to access markets today, although *haciendas* were subdivided in the 1970s.

The positive association between historical *haciendas* and contemporary economic development contrasts with the well known hypothesis that historically high land inequality is the fundamental cause of Latin America's poor long-run growth performance (Engerman and Sokoloff (1997)). Engerman and Sokoloff argued that high historical inequality *lowered* subsequent investments in public goods, leading to worse outcomes in areas of the Americas that developed high land inequality during the colonial period. This theory's implicit counterfactual to large landowners is secure, enfranchised smallholders of the sort that predominated in some parts of North America. This is not an appropriate counterfactual for Peru or many other places in Latin America, because institutional structures largely in place before the formation of the landed elite did not provide secure property rights, protection from exploitation, or a host of other guarantees to potential smallholders.[3] The evidence in this study indicates that large landowners—while they did not aim to promote economic prosperity for the masses—did shield individuals from exploitation by a highly extractive state and ensure public goods. Thus, it is unclear whether the Peruvian masses would have been better off if initial land inequality had been lower, and it is doubtful that initial land inequality is the most useful foundation for a theory of long-run growth. Rather, the Peruvian example suggests that exploring constraints on how the state can be used to shape economic interactions, for example, the extent to which elites can employ state machinery to coerce labor or citizens can use state guarantees to protect their property, could provide a particularly useful starting point for modeling Latin America's long-run growth trajectory.

In the next section, I provide an overview of the *mita*. Section 3 discusses identification and tests whether the *mita* affects contemporary living standards. Section 4 examines channels empirically. Finally, Section 5 offers concluding remarks.

2. THE MINING *MITA*

2.1. *Historical Introduction*

The Potosí mines, discovered in 1545, contained the largest deposits of silver in the Spanish Empire, and the state-owned Huancavelica mines provided the

[3]This argument is consistent with evidence on long-run inequality from other Latin American countries, notably Acemoglu et al. (2008) on Cundinamarca and Colombia and Coatsworth (2005) on Mexico.

mercury required to refine silver ore. Beginning in 1573, indigenous villages located within a contiguous region were required to provide one-seventh of their adult male population as rotating *mita* laborers to Potosí or Huancavelica, and the region subjected remained constant from 1578 onward.[4] The *mita* assigned 14,181 conscripts from southern Peru and Bolivia to Potosí and 3280 conscripts from central and southern Peru to Huancavelica (Bakewell (1984, p. 83)).[5] Using population estimates from the early 17th century (Cook (1981)), I calculate that around 3% of adult males living within the current boundaries of Peru were conscripted to the *mita* at a given point in time. The percentage of males who at some point participated was considerably higher, as men in subjected districts were supposed to serve once every 7 years.[6]

Local native elites were responsible for collecting conscripts, delivering them to the mines, and ensuring that they reported for mine duties (Cole (1985, p. 15), Bakewell (1984)). If community leaders were unable to provide their allotment of conscripts, they were required to pay in silver the sum needed to hire wage laborers instead. Historical evidence suggests that this rule was strictly enforced (Garrett (2005, p. 126), Cole (1985, p. 44), Zavala (1980), Sanchez-Albornoz (1978)). Some communities did commonly meet *mita* obligations through payment in silver, particularly those in present-day Bolivia who had relatively easy access to coinage due to their proximity to Potosí (Cole (1985)). Detailed records of *mita* contributions from the 17th, 18th, and early 19th centuries indicate that communities in the region that this paper examines contributed primarily in people (Tandeter (1993, pp. 56, 66), Zavala (1980, Vol. II, pp. 67–70)). This is corroborated by population data collected in a 1689 parish census (Villanueva Urteaga (1982)), described in the Supplemental Material (Dell (2010)), which shows that the male–female ratio was 22% lower in *mita* districts (a difference significant at the 1% level).[7]

[4]The term *mita* was first used by the Incas to describe the system of labor obligations, primarily in local agriculture, that supported the Inca state (D'Altoy (2002, p. 266), Rowe (1946, pp. 267–269)). While the Spanish coopted this phrase, historical evidence strongly supports independent assignment. Centrally, the Inca *m'ita* required every married adult male in the Inca Empire (besides leaders of large communities), spanning an area far more extensive than the region I examine, to provide several months of labor services for the state each year (D'Altoy (2002, p. 266), Cieza de León (1551)).

[5]Individuals could attempt to escape *mita* service by fleeing their communities, and a number pursued this strategy (Wightman (1990)). Yet fleeing had costs: giving up access to land, community, and family; facing severe punishment if caught; and either paying additional taxes in the destination location as a "foreigner" (*forastero*) or attaching oneself to a *hacienda*.

[6]*Mita* districts contain 17% of the Peruvian population today (Instituto Nacional de Estadística e Información de Perú (INEI) (1993)).

[7]While colonial observers highlighted the deleterious effects of the *mita* on demography and well-being in subjected communities, there are some features that could have promoted relatively better outcomes. For example, *mita* conscripts sold locally produced goods in Potosí, generating trade linkages.

With silver deposits depleted, the *mita* was abolished in 1812, after nearly 240 years of operation. Sections 3 and 4 discuss historical and empirical evidence showing divergent histories of *mita* and non-*mita* districts.

2.2. *The Mita's Assignment*

Why did Spanish authorities require only a portion of districts in Peru to contribute to the *mita* and how did they determine which districts to subject? The aim of the Crown was to revive silver production to levels attained using free labor in the 1550s, before epidemic disease had substantially reduced labor supply and increased wages. Yet coercing labor imposed costs: administrative and enforcement costs, compensation to conscripts for traveling as much as 1000 kilometers (km) each way to and from the mines, and the risk of decimating Peru's indigenous population, as had occurred in earlier Spanish mining ventures in the Caribbean (Tandeter (1993, p. 61), Cole (1985, pp. 3, 31), Cañete (1794), Levillier (1921, Vol. 4, p. 108)). To establish the minimum number of conscripts needed to revive production to 1550s levels, Viceroy Francisco Toledo commissioned a detailed inventory of mines and production processes in Potosí and elsewhere in 1571 (Bakewell (1984, pp. 76–78), Levillier (1921, Vol. 4)). These numbers were used, together with census data collected in the early 1570s, to enumerate the *mita* assignments. The limit that the *mita* subject no more than one-seventh of a community's adult male population at a given time was already an established rule that regulated local labor drafts in Peru (Glave (1989)). Together with estimates of the required number of conscripts, this rule roughly determined what fraction of Andean Peru's districts would need to be subjected to the *mita*.

Historical documents and scholarship reveal two criteria used to assign the *mita*: distance to the mines at Potosí and Huancavelica and elevation. Important costs of administering the *mita*, such as travel wages and enforcement costs, were increasing in distance to the mines (Tandeter (1993, p. 60), Cole (1985, p. 31)). Moreover, Spanish officials believed that only highland peoples could survive intensive physical labor in the mines, located at over 4000 meters (13,000 feet) (Golte (1980)). The geographic extent of the *mita* is consistent with the application of these two criteria, as can be seen in Figure 1.[8] This study focuses on the portion of the *mita* boundary that transects the Andean range, which this figure highlights in white, and the districts along this portion are termed the study region (see Supplemental Material Figure A1 for a detailed view). Here, exempt districts were those located farthest from

[8]An elevation constraint was binding along the eastern and western *mita* boundaries, which tightly follow the steep Andean precipice. The southern Potosí *mita* boundary was also constrained, by the border between Peru and the Viceroyalty of Rio de la Plata (Argentina), and by the geographic divide between agricultural lands and an uninhabitable salt flat.

the mining centers given road networks at the time (Hyslop (1984)).[9] While historical documents do not mention additional criteria, concerns remain that other underlying characteristics may have influenced *mita* assignment. This will be examined further in Section 3.2.

3. THE *MITA* AND LONG-RUN DEVELOPMENT

3.1. *Data*

I examine the *mita*'s long-run impact on economic development by testing whether it affects living standards today. A list of districts subjected to the *mita* is obtained from Saignes (1984) and Amat y Junient (1947) and matched to modern districts as detailed in the Supplemental Material, Table A.I. Peruvian districts are in most cases small political units that consist of a population center (the district capital) and its surrounding countryside. *Mita* assignment varies at the district level.

I measure living standards using two independent data sets, both georeferenced to the district. Household consumption data are taken from the 2001 Peruvian National Household Survey (Encuesta Nacional de Hogares (ENAHO)) collected by the National Institute of Statistics (INEI). To construct a measure of household consumption that reflects productive capacity, I subtract the transfers received by the household from total household consumption and normalize to Lima metropolitan prices using the deflation factor provided in ENAHO. I also utilize a microcensus data set, obtained from the Ministry of Education, that records the heights of all 6- to 9-year-old school children in the region. Following international standards, children whose heights are more than 2 standard deviations below their age-specific median are classified as stunted, with the medians and standard deviations calculated by the World Health Organization from an international reference population. Because stunting is related to malnutrition, to the extent that living standards are lower in *mita* districts, we would also expect stunting to be more common there. The height census has the advantage of providing substantially

[9]This discussion suggests that exempt districts were those located relatively far from both Potosí and Huancavelica. The correlation between distance to Potosí and distance to Huancavelica is −0.996, making it impossible to separately identify the effect of distance to each mine on the probability of receiving treatment. Thus, I divide the sample into two groups—municipalities to the east and those to the west of the dividing line between the Potosí and Huancavelica *mita* catchment areas. When considering districts to the west (Potosí side) of the dividing line, a flexible specification of *mita* treatment on a cubic in distance to Potosí, a cubic in elevation, and their linear interaction shows that being 100 additional kilometers from Potosí lowers the probability of treatment by 0.873, with a standard error of 0.244. Being 100 meters higher increases the probability of treatment by 0.061, with a standard error of 0.027. When looking at districts to the east (Huancavelica side) of the dividing line and using an analogous specification with a polynomial in distance to Huancavelica, the marginal effect of distance to Huancavelica is negative but not statistically significant.

more observations from about four times more districts than the household consumption sample. While the height census includes only children enrolled in school, 2005 data on primary school enrollment and completion rates do not show statistically significant differences across the *mita* boundary, with primary school enrollment rates exceeding 95% throughout the region examined (Ministro de Educación del Perú (MINEDU) (2005b)). Finally, to obtain controls for exogenous geographic characteristics, I calculate the mean area weighted elevation of each district by overlaying a map of Peruvian districts on 30 arc second (1 km) resolution elevation data produced by NASA's Shuttle Radar Topography Mission (SRTM (National Aeronautics and Space Administration and the National Geospatial-Intelligence Agency) (2000)), and I employ a similar procedure to obtain each district's mean area weighted slope. The Supplemental Material contains more detailed information about these data and the living standards data, as well as the data examined in Section 4.

3.2. *Estimation Framework*

Mita treatment is a deterministic and discontinuous function of known covariates, longitude and latitude, which suggests estimating the *mita*'s impacts using a regression discontinuity approach. The *mita* boundary forms a multidimensional discontinuity in longitude–latitude space, which differs from the single-dimensional thresholds typically examined in RD applications. While the identifying assumptions are identical to those in a single-dimensional RD, the multidimensional discontinuity raises interesting and important methodological issues about how to specify the RD polynomial, as discussed below. Before considering this and other identification issues in detail, let us introduce the basic regression form:

$$c_{idb} = \alpha + \gamma mita_d + X_{id}'\beta + f(\text{geographic location}_d) + \boldsymbol{\phi}_b + \varepsilon_{idb}, \tag{1}$$

where c_{idb} is the outcome variable of interest for observation i in district d along segment b of the *mita* boundary, and $mita_d$ is an indicator equal to 1 if district d contributed to the *mita* and equal to 0 otherwise; X_{id} is a vector of covariates that includes the mean area weighted elevation and slope for district d and (in regressions with equivalent household consumption on the left-hand side) demographic variables giving the number of infants, children, and adults in the household; $f(\text{geographic location}_d)$ is the RD polynomial, which controls for smooth functions of geographic location. Various forms will be explored. Finally, $\boldsymbol{\phi}_b$ is a set of boundary segment fixed effects that denote which of four equal length segments of the boundary is the closest to the observation's district capital.[10] To be conservative, all analysis excludes metropolitan Cusco. Metropolitan Cusco is composed of seven non-*mita* and two *mita*

[10] Results (available upon request) are robust to allowing the running variable to have heterogeneous effects by including a full set of interactions between the boundary segment fixed effects

districts located along the *mita* boundary and was the capital of the Inca Empire (Cook (1981, pp. 212–214), Cieza de León (1959, pp. 144–148)). I exclude Cusco because part of its relative prosperity today likely relates to its pre-*mita* heritage as the Inca capital. When Cusco is included, the impacts of the *mita* are estimated to be even larger.

The RD approach used in this paper requires two identifying assumptions. First, all relevant factors besides treatment must vary smoothly at the *mita* boundary. That is, letting c_1 and c_0 denote potential outcomes under treatment and control, x denote longitude, and y denote latitude, identification requires that $E[c_1|x, y]$ and $E[c_0|x, y]$ are continuous at the discontinuity threshold. This assumption is needed for individuals located just outside the *mita* catchment to be an appropriate counterfactual for those located just inside it. To assess the plausibility of this assumption, I examine the following potentially important characteristics: elevation, terrain ruggedness, soil fertility, rainfall, ethnicity, preexisting settlement patterns, local 1572 tribute (tax) rates, and allocation of 1572 tribute revenues.

To examine elevation—the principal determinant of climate and crop choice in Peru—as well as terrain ruggedness, I divide the study region into 20×20 km grid cells, approximately equal to the mean size of the districts in my sample, and calculate the mean elevation and slope within each grid cell using the SRTM data.[11] These geographic data are spatially correlated, and hence I report standard errors corrected for spatial correlation in square brackets. Following Conley (1999), I allow for spatial dependence of an unknown form. For comparison, I report robust standard errors in parentheses. The first set of columns of Table I restricts the sample to fall within 100 km of the *mita* boundary; the second, third, and fourth sets of columns restrict it to fall within 75, 50, and 25 km, respectively. The first row shows that elevation is statistically identical across the *mita* boundary.[12] I next look at terrain ruggedness, using the SRTM data to calculate the mean uphill slope in each grid cell. In contrast to elevation, there are some statistically significant, but relatively small, differences in slope, with *mita* districts being *less* rugged.[13]

and $f(\text{geographic location}_d)$. They are also robust to including soil type indicators, which I do not include in the main specification because they are highly collinear with the longitude–latitude polynomial used for one specification of $f(\text{geographic location}_d)$.

[11]All results are similar if the district is used as the unit of observation instead of using grid cells.

[12]Elevation remains identical across the *mita* boundary if I restrict the sample to inhabitable areas ($<$4800 m) or weight by population, rural population, or urban population data (Center for International Earth Science Information (2004, SEDAC)).

[13]I also examined data on district soil quality and rainfall (results available upon request; see the data appendix in the Supplemental Materials for more details). Data from the Peruvian Instituto Nacional de Recursos Naturales (INRENA (1997)) reveal *higher* soil quality in *mita* districts. I do not emphasize soil quality because it is endogenous to land usage. While climate is exogenous, high resolution data are not available and interpolated climate estimates are notoriously

TABLE I

SUMMARY STATISTICS[a]

	Sample Falls Within											
	<100 km of *Mita* Boundary			<75 km of *Mita* Boundary			<50 km of *Mita* Boundary			<25 km of *Mita* Boundary		
	Inside	Outside	s.e.	Inside	Outside	s.e.	Inside	Outside	s.e.	Inside	Outside	s.e.
GIS Measures												
Elevation	4042	4018	[188.77] (85.54)	4085	4103	[166.92] (82.75)	4117	4096	[169.45] (89.61)	4135	4060	[146.16] (115.15)
Slope	5.54	7.21	[0.88]* (0.49)***	5.75	7.02	[0.86] (0.52)**	5.87	6.95	[0.95] (0.58)*	5.77	7.21	[0.90] (0.79)*
Observations	177	95		144	86		104	73		48	52	
% Indigenous	63.59	58.84	[11.19] (9.76)	71.00	64.55	[8.04] (8.14)	71.01	64.54	[8.42] (8.43)	74.47	63.35	[10.87] (10.52)
Observations	1112	366		831	330		683	330		329	251	
Log 1572 tribute rate	1.57	1.60	[0.04] (0.03)	1.57	1.60	[0.04] (0.03)	1.58	1.61	[0.05] (0.04)	1.65	1.61	[0.02]* (0.03)

(*Continues*)

TABLE I—*Continued*

	Sample Falls Within											
	<100 km of *Mita* Boundary			<75 km of *Mita* Boundary			<50 km of *Mita* Boundary			<25 km of *Mita* Boundary		
	Inside	Outside	s.e.	Inside	Outside	s.e.	Inside	Outside	s.e.	Inside	Outside	s.e.
% 1572 tribute to												
Spanish Nobility	59.80	63.82	[1.39]*** (1.36)***	59.98	63.69	[1.56]** (1.53)**	62.01	63.07	[1.12] (1.34)	61.01	63.17	[1.58] (2.21)
Spanish Priests	21.05	19.10	[0.90]** (0.94)**	21.90	19.45	[1.02]** (1.02)**	20.59	19.93	[0.76] (0.92)	21.45	19.98	[1.01] (1.33)
Spanish Justices	13.36	12.58	[0.53] (0.48)*	13.31	12.46	[0.65] (0.60)	12.81	12.48	[0.43] (0.55)	13.06	12.37	[0.56] (0.79)
Indigenous Mayors	5.67	4.40	[0.78] (0.85)	4.55	4.29	[0.26] (0.29)	4.42	4.47	[0.34] (0.33)	4.48	4.42	[0.29] (0.39)
Observations	63	41		47	37		35	30		18	24	

[a]The unit of observation is 20 × 20 km grid cells for the geospatial measures, the household for % indigenous, and the district for the 1572 tribute data. Conley standard errors for the difference in means between *mita* and non-*mita* observations are in brackets. Robust standard errors for the difference in means are in parentheses. For % indigenous, the robust standard errors are corrected for clustering at the district level. The geospatial measures are calculated using elevation data at 30 arc second (1 km) resolution (SRTM (2000)). The unit of measure for elevation is 1000 meters and for slope is degrees. A household is indigenous if its members primarily speak an indigenous language in the home (ENAHO (2001)). The tribute data are taken from Miranda (1583). In the first three columns, the sample includes only observations located less than 100 km from the *mita* boundary, and this threshold is reduced to 75, 50, and finally 25 km in the succeeding columns. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

The third row examines ethnicity using data from the 2001 Peruvian National Household Survey (ENAHO). A household is defined as indigenous if the primary language spoken in the household is an indigenous language (usually Quechua). Results show no statistically significant differences in ethnic identification across the *mita* boundary.

Spanish authorities could have based *mita* assignment on settlement patterns, instituting the *mita* in densely populated areas and claiming land for themselves in sparsely inhabited regions where it was easier to usurp. A detailed review by Bauer and Covey (2002) of all archaeological surveys in the region surrounding the Cusco basin, covering much of the study region, indicates no large differences in settlement density at the date of Spanish Conquest. Moreover, there is no evidence suggesting differential rates of population decline in the 40 years between conquest and enactment of the *mita* (Cook (1981, pp. 108–114)).

Spanish officials blamed demographic collapse on excessive, unregulated rates of tribute extraction by local Hispanic elites (*encomenderos*), who received the right to collect tribute from the indigenous population in return for their role in Peru's military conquests. Thus Viceroy Francisco Toledo coordinated an in-depth inspection of Peru, Bolivia, and Ecuador in the early 1570s to evaluate the maximum tribute that could be demanded from local groups without threatening subsistence. Based on their assessment of ability to pay, authorities assigned varying tribute obligations at the level of the district socioeconomic group, with each district containing one or two socioeconomic groups. (See the Supplemental Material for more details on the tribute assessment.) These per capita contributions, preserved for all districts in the study region, provide a measure of Spanish authorities' best estimates of local prosperity. The forth row of Table I shows average tribute contributions per adult male (women, children, and those over age 50 were not taxed). Simple means comparisons across the *mita* boundary do not find statistically significant differences. The fifth through eight examine district level data on how Spanish authorities allocated these tribute revenues, divided between rents for Spanish nobility (*encomenderos*, fith row), salaries for Spanish priests (sixth row), salaries for local Spanish administrators (*justicias*, seventh row), and salaries for indigenous mayors (*caciques*, eigth row). The data on tribute revenue allocation are informative about the financing of local government, about the

inaccurate for the mountainous region examined in this study (Hijmans et al. (2005)). Temperature is primarily determined by altitude (Golte (1980), Pulgar-Vidal (1950)), and thus is unlikely to differ substantially across the *mita* boundary. To examine precipitation, I use station data from the Global Historical Climatology Network, Version 2 (Peterson and Vose (1997)). Using all available data (from stations in 50 districts located within 100 km of the *mita* boundary), *mita* districts appear to receive somewhat *higher* average annual precipitation, and these differences disappear when comparing districts closer to the *mita* boundary. When using only stations with at least 20 years of data (to ensure a long-run average), which provides observations from 20 different stations (11 outside the *mita* catchment and 9 inside), the difference declines somewhat in magnitude and is not statistically significant.

extent to which Spain extracted local revenues, and about the relative power of competing local administrators to obtain tribute revenues. Table I reveals some modest differences: when the sample is limited to fall within 100 km or 75 km from the *mita* boundary, we see that Spanish nobility received a slightly lower share of tribute revenue inside the *mita* catchment than outside (60% versus 64%), whereas Spanish priests received a slightly higher share (21% versus 19%). All differences disappear as the sample is limited to fall closer to the *mita* boundary.

In the ideal RD setup, the treatment effect is identified using only the variation at the discontinuity. Nonparametric RD techniques can be applied to approximate this setup in contexts with a large number of observations very near the treatment threshold (Imbens and Lemieux (2008)). While nonparametric techniques have the advantage of not relying on functional form assumptions, the data requirements that they pose are particularly high in the geographic RD context, as a convincing nonparametric RD would probably require precise georeferencing: for example, each observation's longitude–latitude coordinates or address.[14] This information is rarely made available due to confidentiality restrictions, and none of the available Peruvian micro data sets contains it. Moreover, many of the data sets required to investigate the *mita*'s potential long-run effects do not provide sufficiently large sample sizes to employ nonparametric techniques. Thus, I use a semiparametric RD approach that limits the sample to districts within 50 km of the *mita* boundary. This approach identifies causal effects by using a regression model to distinguish the treatment indicator, which is a nonlinear and discontinuous function of longitude (x) and latitude (y), from the smooth effects of geographic location. It is important for the regression model to approximate these effects well, so that a nonlinearity in the counterfactual conditional mean function $E[c_0|x, y]$ is not mistaken for a discontinuity, or vice versa (Angrist and Pischke (2009)). To the best of my knowledge, this is the first study to utilize a multidimensional, semiparametric RD approach.

Because approaches to specifying a multidimensional RD polynomial have not been widely explored, I report estimates from three baseline specifications of $f(\text{geographic location}_d)$. The first approach uses a cubic polynomial in latitude and longitude.[15] This parametrization is relatively flexible; it is analogous to the standard single-dimensional RD approach; and the RD plots, drawn in "x–y outcome" space, allow a transparent visual assessment of the data.

[14]A notable example of a multidimensional nonparametric RD is Black's (1999) study of the value that parents place on school quality. Black compared housing prices on either side of school attendance district boundaries in Massachusetts. Because she employs a large and precisely georeferenced data set, Black was able to include many boundary segment fixed effects and limit the sample to observations located within 0.15 miles of the boundary, ensuring comparison of observations in extremely close proximity.

[15]Letting x denote longitude and y denote latitude, this polynomial is $x + y + x^2 + y^2 + xy + x^3 + y^3 + x^2y + xy^2$.

For these reasons, this approach appears preferable to projecting the running variable into a lower-dimensional space—as I do in the other two baseline specifications—when power permits its precise estimation. One drawback is that some of the necessary datasets do not provide enough power to precisely estimate this flexible specification. The multidimensional RD polynomial also increases concerns about overfitting at the discontinuity, as a given order of a multidimensional polynomial has more degrees of freedom than the same order one-dimensional polynomial. This point is discussed using a concrete example in Section 4.3. Finally, there is no a priori reason why a polynomial form will do a good job of modeling the interactions between longitude and latitude. I partially address this concern by examining robustness to different orders of RD polynomials.

Given these concerns, I also report two baseline specifications that project geographic location into a single dimension. These single-dimensional specifications can be precisely estimated across the paper's data sets and provide useful checks on the multidimensional RD. One controls for a cubic polynomial in Euclidean distance to Potosí, a dimension which historical evidence identifies as particularly important. During much of the colonial period, Potosí was the largest city in the Western Hemisphere and one of the largest in the world, with a population exceeding 200,000. Historical studies document distance to Potosí as an important determinant of local production and trading activities, and access to coinage (Tandeter (1993, p. 56), Glave (1989), Cole (1985)).[16] Thus, a polynomial in distance to Potosí is likely to capture variation in relevant unobservables. However, this approach does not map well into the traditional RD setup, although it is similar in controlling for smooth variation and requiring all factors to change smoothly at the boundary. Thus I also examine a specification that controls for a cubic polynomial in distance to the *mita* boundary. I report this specification because it is similar to traditional one-dimensional RD designs, but to the best of my knowledge neither historical nor qualitative evidence suggests that distance to the *mita* boundary is economically important. Thus, this specification is most informative when examined in conjunction with the other two.

In addition to the two identifying assumptions already discussed, an additional assumption often employed in RD is no selective sorting across the treatment threshold. This would be violated if a direct *mita* effect provoked substantial out-migration of relatively productive individuals, leading to a larger indirect effect. Because this assumption may not be fully reasonable, I do not emphasize it. Rather I explore the possibility of migration as an interesting channel of persistence, to the extent that the data permit. During the past 130 years, migration appears to have been low. Data from the 1876, 1940,

[16]Potosí traded extensively with the surrounding region, given that it was located in a desert 14,000 feet above sea level and that it supported one of the world's largest urban populations during the colonial period.

and 1993 population censuses show a district level population correlation of 0.87 between 1940 and 1993 for both *mita* and non-*mita* districts.[17] Similarly, the population correlation between 1876 and 1940 is 0.80 in *mita* districts and 0.85 in non-*mita* districts. While a constant aggregate population distribution does not preclude extensive sorting, this is unlikely given the relatively closed nature of indigenous communities and the stable linkages between *haciendas* and their attached peasantry (Morner (1978)). Moreover, the 1993 Population Census (INEI (1993)) does not show statistically significant differences in rates of out-migration between *mita* and non-*mita* districts, although the rate of in-migration is 4.8% higher outside the *mita* catchment. In considering why individuals do not arbitrage income differences between *mita* and non-*mita* districts, it is useful to note that over half of the population in the region I examine lives in formally recognized indigenous communities. It tends to be difficult to gain membership and land in a different indigenous community, making large cities—which have various disamenities—the primary feasible destination for most migrants (INEI (1993)).

In contrast, out-migration from *mita* districts during the period that the *mita* was in force may have been substantial. Both Spanish authorities and indigenous leaders of *mita* communities had incentives to prevent migration, which made it harder for local leaders to meet *mita* quotas that were fixed in the medium run and threatened the *mita*'s feasibility in the longer run. Spanish authorities required individuals to reside in the communities to which the colonial state had assigned their ancestors soon after Peru's conquest to receive citizenship and access to agricultural land. Indigenous community leaders attempted to forcibly restrict migration. Despite these efforts, the state's capacity to restrict migration was limited, and 17th century population data—available for 15 *mita* and 14 non-*mita* districts—provide evidence consistent with the hypothesis that individuals migrated disproportionately from *mita* to non-*mita* districts.[18] To the extent that flight was selective and certain cognitive skills, physical strength, or other relevant characteristics are highly heritable, so that initial differences could persist over several hundred years, historical migration could contribute to the estimated *mita* effect. The paucity of data and complex patterns of heritability that would link historically selective migration to the present unfortunately place further investigation substantially beyond the scope of the current paper.

I begin by estimating the *mita*'s impact on living standards today; see Table II. First, I test for a *mita* effect on household consumption, using the log of equivalent household consumption, net transfers, in 2001 as the dependent variable. Following Deaton (1997), I assume that children aged 0 to 4 are equal

[17]The 2005 Population Census was methodologically flawed and thus I use 1993.

[18]According to data from the 1689 Cusco parish reports (see the Supplemental Material), in the 14 non-*mita* districts, 52.5% of individuals had ancestors who had not been assigned to their current district of residence, as compared to 35% in the 15 *mita* districts.

TABLE II

LIVING STANDARDS[a]

	Dependent Variable						
	Log Equiv. Hausehold Consumption (2001)			Stunted Growth, Children 6–9 (2005)			
Sample Within:	<100 km of Bound.	<75 km of Bound.	<50 km of Bound.	<100 km of Bound.	<75 km of Bound.	<50 km of Bound.	Border District
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A. Cubic Polynomial in Latitude and Longitude						
Mita	−0.284	−0.216	−0.331	0.070	0.084*	0.087*	0.114**
	(0.198)	(0.207)	(0.219)	(0.043)	(0.046)	(0.048)	(0.049)
R^2	0.060	0.060	0.069	0.051	0.020	0.017	0.050
	Panel B. Cubic Polynomial in Distance to Potosí						
Mita	−0.337***	−0.307***	−0.329***	0.080***	0.078***	0.078***	0.063*
	(0.087)	(0.101)	(0.096)	(0.021)	(0.022)	(0.024)	(0.032)
R^2	0.046	0.036	0.047	0.049	0.017	0.013	0.047
	Panel C. Cubic Polynomial in Distance to *Mita* Boundary						
Mita	−0.277***	−0.230**	−0.224**	0.073***	0.061***	0.064***	0.055*
	(0.078)	(0.089)	(0.092)	(0.023)	(0.022)	(0.023)	(0.030)
R^2	0.044	0.042	0.040	0.040	0.015	0.013	0.043
Geo. controls	yes	yes	yes	yes	yes	yes	yes
Boundary F.E.s	yes	yes	yes	yes	yes	yes	yes
Clusters	71	60	52	289	239	185	63
Observations	1478	1161	1013	158,848	115,761	100,446	37,421

[a]The unit of observation is the household in columns 1–3 and the individual in columns 4–7. Robust standard errors, adjusted for clustering by district, are in parentheses. The dependent variable is log equivalent household consumption (ENAHO (2001)) in columns 1–3, and a dummy equal to 1 if the child has stunted growth and equal to 0 otherwise in columns 4–7 (Ministro de Educación (2005a)). *Mita* is an indicator equal to 1 if the household's district contributed to the *mita* and equal to 0 otherwise (Saignes (1984), Amat y Juniet (1947, pp. 249, 284)). Panel A includes a cubic polynomial in the latitude and longitude of the observation's district capital, panel B includes a cubic polynomial in Euclidean distance from the observation's district capital to Potosí, and panel C includes a cubic polynomial in Euclidean distance to the nearest point on the *mita* boundary. All regressions include controls for elevation and slope, as well as boundary segment fixed effects (F.E.s). Columns 1–3 include demographic controls for the number of infants, children, and adults in the household. In columns 1 and 4, the sample includes observations whose district capitals are located within 100 km of the *mita* boundary, and this threshold is reduced to 75 and 50 km in the succeeding columns. Column 7 includes only observations whose districts border the *mita* boundary. 78% of the observations are in *mita* districts in column 1, 71% in column 2, 68% in column 3, 78% in column 4, 71% in column 5, 68% in column 6, and 58% in column 7. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

to 0.4 adults and children aged 5 to 14 are equal to 0.5 adults. Panel A reports the specification that includes a cubic polynomial in latitude and longitude, panel B reports the specification that uses a cubic polynomial in distance to Potosí, and panel C reports the specification that includes a cubic polynomial in distance to the *mita* boundary. Column 1 of Table II limits the sample to districts within 100 km of the *mita* boundary, and columns 2 and 3 restrict it to fall within 75 and 50 km, respectively.[19] Columns 4–7 repeat this exercise, using as the dependent variable a dummy equal to 1 if the child's growth is stunted and equal to 0 otherwise. Column 4 limits the sample to districts within 100 km of the *mita* boundary, and columns 5 and 6 restrict it to fall within 75 and 50 km, respectively. Column 7 limits the sample to only those districts bordering the *mita* boundary. In combination with the inclusion of boundary segment fixed effects, this ensures that I am comparing observations in close geographic proximity.

3.3. *Estimation Results*

Columns 1–3 of Table II estimate that a long-run *mita* effect lowers household consumption in 2001 by around 25% in subjected districts. The point estimates remain fairly stable as the sample is restricted to fall within narrower bands of the *mita* boundary. Moreover, the *mita* coefficients are economically similar across the three specifications of the RD polynomial, and I am unable to reject that they are statistically identical. All of the *mita* coefficients in panels B and C, which report the single-dimensional RD estimates, are statistically significant at the 1% or 5% level. In contrast, the point estimates using a cubic polynomial in latitude and longitude (panel A) are not statistically significant. This imprecision likely results from the relative flexibility of the specification, the small number of observations and clusters (the household survey samples only around one-quarter of districts), and measurement error in the dependent variable (Deaton (1997)).

Columns 4–7 of Table II examine census data on stunting in children, an alternative measure of living standards which offers a substantially larger sample. When using only observations in districts that border the *mita* boundary, point estimates of the *mita* effect on stunting range from 0.055 (s.e. = 0.030) to 0.114 (s.e. = 0.049) percentage points. This compares to a mean prevalence of stunting of 40% throughout the region examined.[20] Of the 12 point estimates reported in Table II, 11 are statistically significant, and I cannot reject at the 10% level that the estimates are the same across specifications.

[19]The single-dimensional specifications produce similar estimates when the sample is limited to fall within 25 km of the *mita* boundary. The multidimensional specification produces a very large and imprecisely estimated *mita* coefficient because of the small sample size.

[20]A similar picture emerges when I use height in centimeters as the dependent variable and include quarter × year of birth dummies, a gender dummy, and their interactions on the right-hand side.

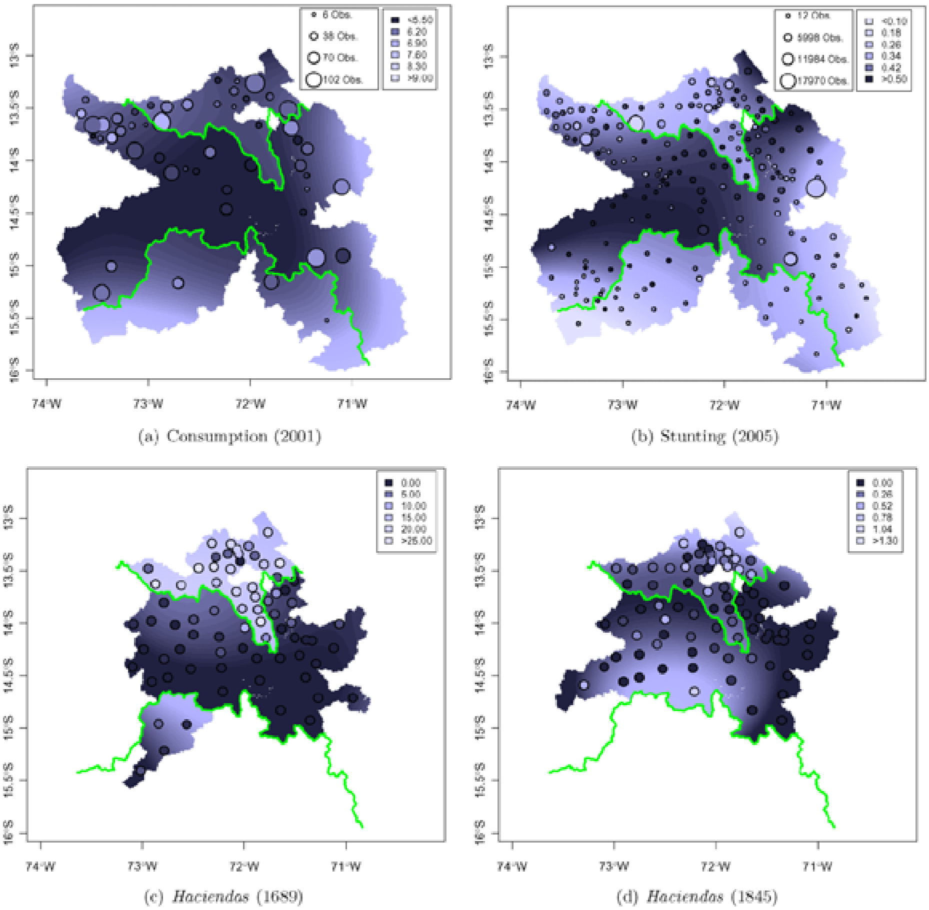
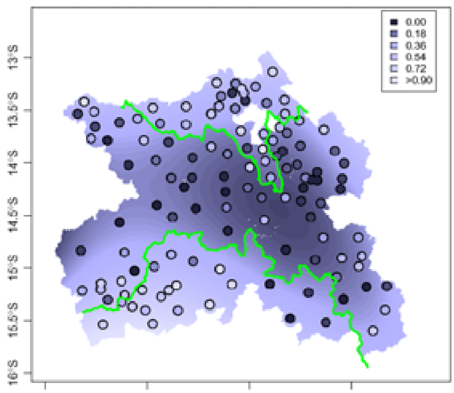
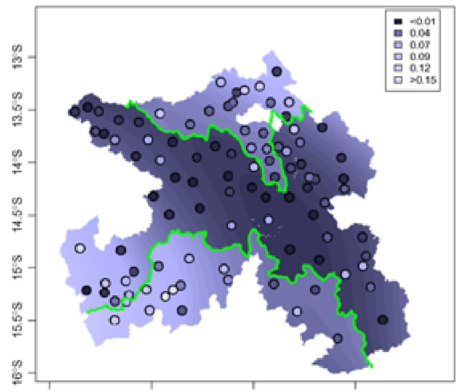


FIGURE 2.—Plots of various outcomes against longitude and latitude. See the text for a detailed description.

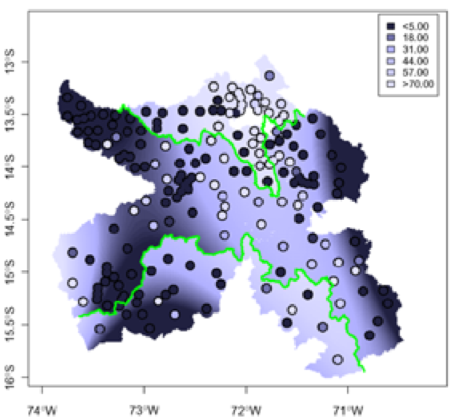
The results can be seen graphically in Figure 2. Each subfigure shows a district-level scatter plot for one of the paper's main outcome variables. These plots are the three-dimensional analogues to standard two-dimensional RD plots, with each district capital's longitude on the x axis, its latitude on the y axis, and the data value for that district shown using an evenly spaced monochromatic color scale, as described in the legends. When the underlying data are at the microlevel, I take district-level averages, and the size of the dot indicates the number of observations in each district. Importantly, the scaling on these dots, which is specified in the legend, is nonlinear, as otherwise some would be microscopic and others too large to display. The background in each plot shows predicted values, for a finely spaced grid of longitude–latitude co-



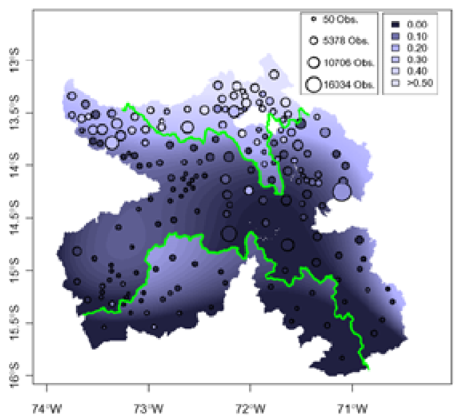
(e) *Haciendas* (1940)



(f) Education (1876)



(g) Road Density (2006)



(h) Ag. Market Participation (1994)

FIGURE 2.—*Continued*.

ordinates, from a regression of the outcome variable under consideration on a cubic polynomial in longitude–latitude and the *mita* dummy. In the typical RD context, the predicted value plot is a two-dimensional curve, whereas here it is a three-dimensional surface, with the third dimension indicated by the color gradient.[21] The shades of the data points can be compared to the shades of the predicted values behind them to judge whether the RD has done an adequate job of averaging the data across space. The majority of the population in the region is clustered along the upper segment of the *mita* boundary, giving these

[21]Three-dimensional surface plots of the predicted values are shown in Figure A2 in the Supplemental Material, and contour plots are available upon request.

TABLE III

SPECIFICATION TESTS[a]

	Dependent Variable						
	Log Equiv. Hausehold Consumption (2001)			Stunted Growth, Children 6–9 (2005)			
Sample Within:	<100 km of Bound. (1)	<75 km of Bound. (2)	<50 km of Bound. (3)	<100 km of Bound. (4)	<75 km of Bound. (5)	<50 km of Bound. (6)	Border District (7)
Alternative Functional Forms for RD Polynomial: Baseline I							
Linear polynomial in latitude and longitude							
Mita	−0.294***	−0.199	−0.143	0.064***	0.054**	0.062**	0.068**
	(0.092)	(0.126)	(0.128)	(0.021)	(0.022)	(0.026)	(0.031)
Quadratic polynomial in latitude and longitude							
Mita	−0.151	−0.247	−0.361	0.073*	0.091**	0.106**	0.087**
	(0.189)	(0.209)	(0.216)	(0.040)	(0.043)	(0.047)	(0.041)
Quartic polynomial in latitude and longitude							
Mita	−0.392*	−0.324	−0.342	0.073	0.072	0.057	0.104**
	(0.225)	(0.231)	(0.260)	(0.056)	(0.050)	(0.048)	(0.042)
Alternative Functional Forms for RD Polynomial: Baseline II							
Linear polynomial in distance to Potosí							
Mita	−0.297***	−0.273***	−0.220**	0.050**	0.048**	0.049**	0.071**
	(0.079)	(0.093)	(0.092)	(0.022)	(0.022)	(0.024)	(0.031)
Quadratic polynomial in distance to Potosí							
Mita	−0.345***	−0.262***	−0.309***	0.072***	0.064***	0.072***	0.060*
	(0.086)	(0.095)	(0.100)	(0.023)	(0.022)	(0.023)	(0.032)
Quartic polynomial in distance to Potosí							
Mita	−0.331***	−0.310***	−0.330***	0.078***	0.075***	0.071***	0.053*
	(0.086)	(0.100)	(0.097)	(0.021)	(0.020)	(0.021)	(0.031)
Interacted linear polynomial in distance to Potosí							
Mita	−0.307***	−0.280***	−0.227**	0.051**	0.048**	0.043*	0.076***
	(0.092)	(0.094)	(0.095)	(0.022)	(0.021)	(0.022)	(0.029)
Interacted quadratic polynomial in distance to Potosí							
Mita	−0.264***	−0.177*	−0.285**	0.033	0.027	0.039*	0.036
	(0.087)	(0.096)	(0.111)	(0.024)	(0.023)	(0.023)	(0.024)

(*Continues*)

districts substantially more weight in figures showing predicted values from microlevel regressions.

Table III examines robustness to 14 different specifications of the RD polynomial, documenting *mita* effects on household consumption and stunting that are generally similar across specifications. The first three rows report results from alternative specifications of the RD polynomial in longitude–latitude: linear, quadratic, and quartic. The next five rows report alternative specifications using distance to Potosí: linear, quadratic, quartic, and the *mita* dummy inter-

TABLE III—*Continued*

	Dependent Variable						
	Log Equiv. Hausehold Consumption (2001)			Stunted Growth, Children 6–9 (2005)			
Sample Within:	<100 km of Bound. (1)	<75 km of Bound. (2)	<50 km of Bound. (3)	<100 km of Bound. (4)	<75 km of Bound. (5)	<50 km of Bound. (6)	Border District (7)
Alternative Functional Forms for RD Polynomial: Baseline III							
Linear polynomial in distance to *mita* boundary							
Mita	−0.299***	−0.227**	−0.223**	0.072***	0.060***	0.058**	0.056*
	(0.082)	(0.089)	(0.091)	(0.024)	(0.022)	(0.023)	(0.032)
Quadratic polynomial in distance to *mita* boundary							
Mita	−0.277***	−0.227**	−0.224**	0.072***	0.060***	0.061***	0.056*
	(0.078)	(0.089)	(0.092)	(0.023)	(0.022)	(0.023)	(0.030)
Quartic polynomial in distance to *mita* boundary							
Mita	−0.251***	−0.229**	−0.246***	0.073***	0.064***	0.063***	0.055*
	(0.078)	(0.089)	(0.088)	(0.023)	(0.022)	(0.023)	(0.030)
Interacted linear polynomial in distance to *mita* boundary							
Mita	−0.301*	−0.277	−0.385*	0.082	0.087	0.095	0.132**
	(0.174)	(0.190)	(0.210)	(0.054)	(0.055)	(0.065)	(0.053)
Interacted quadratic polynomial in distance to *mita* boundary							
Mita	−0.351	−0.505	−0.295	0.140*	0.132	0.136	0.121*
	(0.260)	(0.319)	(0.366)	(0.082)	(0.084)	(0.086)	(0.064)
Ordinary Least Squares							
Mita	−0.294***	−0.288***	−0.227**	0.057**	0.048*	0.049*	0.055*
	(0.083)	(0.089)	(0.090)	(0.025)	(0.024)	(0.026)	(0.031)
Geo. controls	yes	yes	yes	yes	yes	yes	yes
Boundary F.E.s	yes	yes	yes	yes	yes	yes	yes
Clusters	71	60	52	289	239	185	63
Observations	1478	1161	1013	158,848	115,761	100,446	37,421

[a] Robust standard errors, adjusted for clustering by district, are in parentheses. All regressions include geographic controls and boundary segment fixed effects (F.E.s). Columns 1–3 include demographic controls for the number of infants, children, and adults in the household. Coefficients significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

acted with a linear or quadratic polynomial in distance to Potosí.[22] Next, the ninth trough thirteenth rows examine robustness to the same set of specifications, using distance to the *mita* boundary as the running variable. Finally, the fourteenth row reports estimates from a specification using ordinary least squares. The *mita* effect on consumption is always statistically significant in

[22]The *mita* effect is evaluated at the mean distance to Potosí for observations very near (<10 km from) the *mita* boundary. Results are broadly robust to evaluating the *mita* effect at different average distances to Potosí, that is, for districts <25 km from the boundary, for bordering districts, or for all districts.

the relatively parsimonious specifications: those that use noninteracted, single-dimensional RD polynomials and ordinary least squares. In the more flexible specifications—the longitude–latitude regressions and those that interact the RD polynomial with the *mita* dummy—the *mita* coefficients in the consumption regression tend to be imprecisely estimated. As in Table II, the household survey does not provide enough power to precisely estimate relatively flexible specifications, but the coefficients are similar in magnitude to those estimated using a more parsimonious approach. Estimates of the *mita*'s impact on stunting are statistically significant across most specifications and samples.[23]

Given broad robustness to functional form assumptions, Table IV reports a number of additional robustness checks using the three baseline specifications of the RD polynomial. To conserve space, I report estimates only from the sample that contains districts within 50 km of the *mita* boundary. Columns 1–7 examine the household consumption data and columns 8–12 examine the stunting data. For comparison purposes, columns 1 and 8 present the baseline estimates from Table II. Column 2 adds a control for ethnicity, equal to 1 if an indigenous language is spoken in the household and 0 otherwise. Next, columns 3 and 9 include metropolitan Cusco. In response to the potential endogeneity of the *mita* to Inca landholding patterns, columns 4 and 10 exclude districts that contained Inca royal estates, which served sacred as opposed to productive purposes (Niles (1987, p. 13)). Similarly, columns 5 and 11 exclude districts falling along portions of the *mita* boundary formed by rivers to account for one way in which the boundary could be endogenous to geography. Column 6 estimates consumption equivalence flexibly, using log household consumption as the dependent variable, and controlling for the ratio of children to adults and the log of household size. In all cases, point estimates and significance levels tend to be similar to those in Table II. As expected, the point estimates are somewhat larger when metropolitan Cusco is included.

Table IV investigates whether differential rates of migration today may be responsible for living standards differences between *mita* and non-*mita* districts. Given that in-migration in non-*mita* districts is about 4.8% higher than in *mita* districts (whereas rates of out-migration are statistically and economically similar), I omit the 4.8% of the non-*mita* sample with the highest equivalent household consumption and least stunting, respectively. Estimates in columns 7 and 12 remain of similar magnitude and statistical significance, documenting that migration today is not the primary force responsible for the *mita* effect.

If the RD specification is estimating the *mita*'s long-run effect as opposed to some other underlying difference, being inside the *mita* catchment should not affect economic prosperity, institutions, or demographics prior to the *mita*'s enactment. In a series of specification checks, I first regress the log of the

[23]Results (not shown) are also robust to including higher order polynomials in elevation and slope.

TABLE IV

ADDITIONAL SPECIFICATION TESTS[a]

	Log Equivalent Household Consumption (2001)							Stunted Growth, Children 6–9 (2005)				
	Baseline	Control for Ethnicity	Includes Cusco	Excludes Districts With Inca Estates	Excludes Portions of Boundary Formed by Rivers	Flexible Estimation of Consump. Equivalence	Migration	Baseline	Includes Cusco	Excludes Districts With Inca Estates	Excludes Portions of Boundary Formed by Rivers	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. Cubic Polynomial in Latitude and Longitude												
Mita	−0.331	−0.202	−0.465**	−0.281	−0.322	−0.326	−0.223	0.087*	0.147***	0.093*	0.090*	0.069
	(0.219)	(0.157)	(0.207)	(0.265)	(0.215)	(0.230)	(0.198)	(0.048)	(0.048)	(0.048)	(0.048)	(0.049)
R^2	0.069	0.154	0.104	0.065	0.070	0.292	0.067	0.017	0.046	0.019	0.018	0.016
Panel B. Cubic Polynomial in Distance to Potosí												
Mita	−0.329***	−0.282***	−0.450***	−0.354***	−0.376***	−0.328***	−0.263***	0.078***	0.146***	0.077***	0.081***	0.060**
	(0.096)	(0.073)	(0.096)	(0.101)	(0.114)	(0.099)	(0.095)	(0.024)	(0.030)	(0.026)	(0.024)	(0.025)
R^2	0.047	0.140	0.087	0.036	0.049	0.275	0.042	0.013	0.039	0.014	0.013	0.012
Panel C. Cubic Polynomial in Distance to *Mita* Boundary												
Mita	−0.224**	−0.195***	−0.333***	−0.255**	−0.217**	−0.224**	−0.161*	0.064***	0.132***	0.066***	0.065***	0.046*
	(0.092)	(0.070)	(0.087)	(0.110)	(0.098)	(0.095)	(0.088)	(0.023)	(0.027)	(0.025)	(0.023)	(0.024)
R^2	0.040	0.135	0.088	0.047	0.039	0.270	0.037	0.013	0.042	0.014	0.013	0.012
Geo. controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bound. F.E.s	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clusters	52	52	57	47	51	52	52	185	195	180	183	185
Observations	1013	1013	1173	930	992	1013	997	100,446	127,259	96,440	99,940	98,922

[a] Robust standard errors, adjusted for clustering by district, are in parentheses. All regressions include soil type indicators and boundary segment fixed effects (F.E.s). Columns 1–5 and 7 include demographic controls for the number of infants, children, and adults in the household. Column (6) includes controls for the log of household size and the ratio of children to household members, using the log of household consumption as the dependent variable. The samples include observations whose district capitals are less than 50 km from the *mita* boundary. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

mean district 1572 tribute contribution per adult male on the variables used in the stunting regressions in Table II. I then examine the shares of 1572 tribute revenues allocated to rents for Spanish nobility, salaries for Spanish priests, salaries for local Spanish administrators, and salaries for indigenous mayors. Finally, also using data from the 1572 census, I investigate demographics, with the population shares of tribute paying males (those aged 18–50), boys, and women as the dependent variables. These regressions, reported in Table V, do not show statistically significant differences across the *mita* boundary, and the estimated *mita* coefficients are small.

TABLE V

1572 TRIBUTE AND POPULATION[a]

	Dependent Variable							
		Share of Tribute Revenues				Percent		
	Log Mean Tribute (1)	Spanish Nobility (2)	Spanish Priests (3)	Spanish Justices (4)	Indig. Mayors (5)	Men (6)	Boys (7)	Females (8)
	Panel A. Cubic Polynomial in Latitude and Longitude							
Mita	0.020	−0.010	0.004	0.004	0.003	−0.006	0.011	−0.009
	(0.031)	(0.030)	(0.019)	(0.010)	(0.005)	(0.009)	(0.012)	(0.016)
R^2	0.762	0.109	0.090	0.228	0.266	0.596	0.377	0.599
	Panel B. Cubic Polynomial in Distance to Potosí							
Mita	0.019	−0.013	0.008	0.006	−0.001	−0.012	0.005	−0.011
	(0.029)	(0.025)	(0.015)	(0.009)	(0.004)	(0.008)	(0.010)	(0.012)
R^2	0.597	0.058	0.073	0.151	0.132	0.315	0.139	0.401
	Panel C. Cubic Polynomial in Distance to *Mita* Boundary							
Mita	0.040	−0.009	0.005	0.003	−0.001	−0.011	0.001	−0.008
	(0.030)	(0.018)	(0.012)	(0.006)	(0.004)	(0.007)	(0.008)	(0.010)
R^2	0.406	0.062	0.096	0.118	0.162	0.267	0.190	0.361
Geo. controls	yes	yes	yes	yes	yes	yes	yes	yes
Boundary F.E.s	yes	yes	yes	yes	yes	yes	yes	yes
Mean dep. var.	1.591	0.625	0.203	0.127	0.044	0.193	0.204	0.544
Observations	65	65	65	65	65	65	65	65

[a]The dependent variable in column 1 is the log of the district's mean 1572 tribute rate (Miranda (1583)). In columns 2–5, it is the share of tribute revenue allocated to Spanish nobility (*encomenderos*), Spanish priests, Spanish justices, and indigenous mayors (*caciques*), respectively. In columns 6–8, it is the share of 1572 district population composed of males (aged 18–50), boys, and females (of all ages), respectively. Panel A includes a cubic polynomial in longitude and latitude, panel B includes a cubic polynomial in Euclidean distance from the observation's district capital to Potosí, and panel C includes a cubic polynomial in Euclidean distance to the nearest point on the *mita* boundary. All regressions include geographic controls and boundary segment fixed effects. The samples include districts whose capitals are less than 50 km from the *mita* boundary. Column 1 weights by the square root of the district's tributary population and columns 6–8 weight by the square root of the district's total population. 66% of the observations are from *mita* districts. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

To achieve credible identification, I exploit variation across observations located near the *mita* boundary. If the boundary is an unusual place, these estimates may have little external validity. To examine this issue further, I use ordinary least squares to estimate the correlation between the *mita* and the main outcome variables (including those that will be examined in Section 4), limiting the sample to districts located *between* 25 and 100 km from the *mita* boundary. The estimates are quite similar to those obtained from the RD specifications (results available upon request). Moreover, correlations between the *mita* and living standards (measured by both consumption and stunting) calculated along the entire *mita* boundary within Peru are consistent in magnitude with the effects documented above.[24] In summary, the RD evidence appears informative about the *mita*'s overall impacts.

Why would the *mita* affect economic prosperity nearly 200 years after its abolition? To open this black box, I turn to an investigation of channels of persistence.

4. CHANNELS OF PERSISTENCE

This section uses data from the Spanish Empire and Peruvian Republic to test channels of persistence. There exist many potential channels, but to provide a picture that is both parsimonious and informative, I focus on three that the historical literature and fieldwork suggest are important: land tenure, public goods, and market participation. The results document that the *mita* limited the establishment of large landowners inside the *mita* catchment and, combined with historical evidence, suggest that land tenure has in turn affected public goods provision and smallholder participation in agricultural markets.

The tables in the main text report three specifications, which use a cubic polynomial in latitude and longitude, a cubic polynomial in distance to Potosí, or a cubic polynomial in distance to the *mita* boundary. Table A.III in the Supplemental Material reports results from the 14 additional specifications examined in Table III. In most cases, the point estimates across these specifications are similar. When not, I note it explicitly.[25]

4.1. *Land Tenure and Labor Systems*

This section examines the impact of the *mita* on the formation of *haciendas*—rural estates with an attached labor force permanently settled on the estate (Keith (1971, p. 437)). Critically, when authorities instituted the *mita*

[24]When considering observations in Peru within 50 km of any point on the *mita* boundary, being inside the *mita* catchment is associated with 28.4 percent lower equivalent household consumption and an increase of 16.4 percentage points in the prevalence of stunting.

[25]As in Table III, the more flexible specifications in Table A.III are less likely than the parsimonious ones to estimate statistically significant effects.

in 1573 (40 years after the Spanish conquest of Peru), a landed elite had not yet formed. At the time, Peru was parceled into *encomiendas*, pieces of territory in which appointed Spaniards exercised the right to collect tribute and labor services from the indigenous population but did not hold title to land (Keith (1971, p. 433)). Rivalries between *encomenderos* provoked civil wars in the years following Peru's conquest, and thus the Crown began to dismantle the *encomienda* system during the 1570s. This opened the possibility for manipulating land tenure to promote other policy goals, in particular, the *mita*.[26]

Specifically, Spanish land tenure policy aimed to minimize the establishment of landed elites in *mita* districts, as large landowners—who unsurprisingly opposed yielding their attached labor for a year of *mita* service—formed the state's principal labor market competition (Larson (1988), Sanchez-Albornoz (1978)).[27] Centrally, as Bolivian historian Larson (1988, p. 171) concisely articulated, "*Haciendas* secluded peasants from the extractive institutions of colonial society." Moreover, by protecting native access to agricultural lands, the state promoted the ability of the indigenous community to subsidize *mita* conscripts, who were paid substantially below subsistence wages (Garrett (2005, p. 120), Tandeter (1993, pp. 58–60), Cole (1985, p. 31)). Similarly, authorities believed that protecting access to land could be an effective means of staving off demographic collapse (Larson (1982, p. 11), Cook (1981, pp. 108–114, 250), Morner (1978)). Finally, in return for ensuring the delivery of conscripts, local authorities were permitted to extract surplus that would have otherwise been claimed by large landowners (Garrett (2005, p. 115)).

I now examine the concentration of *haciendas* in 1689, 1845, and 1940. The 1689 data are contained in parish reports commissioned by Bishop Manuel de Mollinedo and submitted by all parishes in the bishopric of Cusco, which encompassed most of the study region. The reports list the number of *haciendas* and the population within each subdivision of the parish, and were compiled by Horacio Villanueva Urteaga (1982). For *haciendas* in 1845, I employ data collected by the Cusco regional government, which had jurisdiction over a substantial fraction of the study region, on the percentage of the rural tributary population residing in *haciendas* (Peralta Ruiz (1991)). Data from 1845, 1846, and 1850 are combined to form the circa 1845 data set.[28] Finally, data from the 1940 Peruvian Population Census are aggregated to the district level to calculate the percentage of the rural population residing in *haciendas*.

[26]Throughout the colonial period, royal policy aimed to minimize the power of the (potentially revolutionary) landed class: landowners did not acquired the same political clout as mine owners, the most powerful colonial interest group (Tandeter (1993), Cole (1985)).

[27]For example, land sales under Philip VI between 1634 and 1648 and by royal charter in 1654 played a central role in *hacienda* formation and were almost exclusively concentrated in non-*mita* districts (Brisseau (1981, p. 146), Glave and Remy (1978, p. 1)).

[28]When data are available for more than one year, figures change little, and I use the earliest observation.

TABLE VI

LAND TENURE AND LABOR SYSTEMS[a]

	Dependent Variable				
	Haciendas per District in 1689 (1)	*Haciendas* per 1000 District Residents in 1689 (2)	Percent of Rural Tributary Population in *Haciendas* in ca. 1845 (3)	Percent of Rural Population in *Haciendas* in 1940 (4)	Land Gini in 1994 (5)
	Panel A. Cubic Polynomial in Latitude and Longitude				
Mita	−12.683***	−6.453**	−0.127*	−0.066	0.078
	(3.221)	(2.490)	(0.067)	(0.086)	(0.053)
R^2	0.538	0.582	0.410	0.421	0.245
	Panel B. Cubic Polynomial in Distance to Potosí				
Mita	−10.316***	−7.570***	−0.204**	−0.143***	0.107***
	(2.057)	(1.478)	(0.082)	(0.051)	(0.036)
R^2	0.494	0.514	0.308	0.346	0.194
	Panel C. Cubic Polynomial in Distance to *Mita* Boundary				
Mita	−11.336***	−8.516***	−0.212***	−0.120***	0.124***
	(2.074)	(1.665)	(0.060)	(0.045)	(0.033)
R^2	0.494	0.497	0.316	0.336	0.226
Geo. controls	yes	yes	yes	yes	yes
Boundary F.E.s	yes	yes	yes	yes	yes
Mean dep. var.	6.500	5.336	0.135	0.263	0.783
Observations	74	74	81	119	181

[a]The unit of observation is the district. Robust standard errors are in parentheses. The dependent variable in column 1 is *haciendas* per district in 1689 and in column 2 is *haciendas* per 1000 district residents in 1689 (Villanueva Urteaga (1982)). In column 3 it is the percentage of the district's tributary population residing in *haciendas* ca. 1845 (Peralta Ruiz (1991)), in column 4 it is the percentage of the district's rural population residing in *haciendas* in 1940 (Dirección de Estadística del Perú (1944)), and in column 5 it is the district land gini (INEI (1994)). Panel A includes a cubic polynomial in the latitude and longitude of the observation's district capital, panel B includes a cubic polynomial in Euclidean distance from the observation's district capital to Potosí, and panel C includes a cubic polynomial in Euclidean distance to the nearest point on the *mita* boundary. All regressions include geographic controls and boundary segment fixed effects. The samples include districts whose capitals are less than 50 km from the *mita* boundary. Column 3 is weighted by the square root of the district's rural tributary population and column 4 is weighted by the square root of the district's rural population. 58% of the observations are in *mita* districts in columns 1 and 2, 59% in column 3, 62% in column 4, and 66% in column 5. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

In Table VI, column 1 (number of *haciendas* per district) and column 2 (number of *haciendas* per 1000 district residents) show a very large *mita* effect on the concentration of *haciendas* in the 17th century, of similar magnitude and highly significant across specifications.[29] The median coefficient from column 1, con-

[29]Given the *mita*'s role in provoking population collapse (Wightman (1990, p. 72)), the latter measure is likely endogenous, but nevertheless provides a useful robustness check.

tained in panel C, estimates that the *mita* lowered the number of *haciendas* in subjected districts by 11.3 (s.e. = 2.1), a sizeable effect given that on average *mita* districts contained only one *hacienda*. Figure 2, panel (c) clearly demonstrates the discontinuity. Moreover, Table VI provides reasonably robust support for a persistent impact. Column 3 estimates that the *mita* lowered the percentage of the rural tributary population in *haciendas* in 1845 by around 20 percentage points (with estimates ranging from 0.13 to 0.21), an effect that is statistically significant across specifications. Column 4 suggests that disparities persisted into the 20th century, with an estimated effect on the percentage of the rural labor force in *haciendas* that is somewhat smaller for 1940 than for 1845—as can be seen by comparing panels (d) and (e) of Figure 2—and not quite as robust. The median point estimate is -0.12 (s.e. = 0.045) in panel C; the point estimates are statistically significant at the 1% level in panels B and C, but the longitude–latitude specification estimates an effect that is smaller, at -0.07, and imprecise.

Table VI also documents that the percentage of the rural population in *haciendas* nearly doubled between 1845 and 1940, paralleling historical evidence for a rapid expansion of *haciendas* in the late 19th and early 20th centuries. This expansion was spurred by a large increase in land values due to globalization and seems to have been particularly coercive inside the *mita* catchment (Jacobsen (1993, pp. 226–237), Favre (1967, p. 243), Nuñez (1913, p. 11)). No longer needing to ensure *mita* conscripts, Peru abolished the communal land tenure predominant in *mita* districts in 1821, but did not replace it with enforceable peasant titling (Jacobsen (1993), Dancuart and Rodriguez (1902, Vol. 2, p. 136)). This opened the door to tactics such as the *interdicto de adquirir*, a judicial procedure which allowed aspiring landowners to legally claim "abandoned" lands that in reality belonged to peasants. *Hacienda* expansion also occurred through violence, with cattle nustling, grazing estate cattle on peasant lands, looting, and physical abuse used as strategies to intimidate peasants into signing bills of sale (Avila (1952, p. 22), Roca-Sanchez (1935, pp. 242–243)). Numerous peasant rebellions engulfed *mita* districts during the 1910s and 1920s, and indiscriminate banditry and livestock rustling remained prevalent in some *mita* districts for decades (Jacobsen (1993), Ramos Zambrano (1984), Tamayo Herrera (1982), Hazen (1974, pp. 170–178)). In contrast, large landowners had been established since the early 17th century in non-*mita* districts, which remained relatively stable (Flores Galindo (1987, p. 240)).

In 1969, the Peruvian government enacted an agrarian reform bill mandating the complete dissolution of *haciendas*. As a result, the *hacienda* elite were deposed and lands formerly belonging to *haciendas* were divided into Agricultural Societies of Social Interest (SAIS) during the early 1970s (Flores Galindo (1987)). In SAIS, neighboring indigenous communities and the producers acted as collective owners. By the late 1970s, attempts to impose collective ownership through SAIS had failed, and many SAIS were divided and allocated to individuals (Mar and Mejia (1980)). The 1994 Agricultural Census

(INEI (1994)) documents that when considering districts within 50 km of the *mita* boundary, 20% of household heads outside the *mita* catchment received their land in the 1970s through the agrarian reform, versus only 9% inside the *mita* catchment. Column 5, using data from the 1994 Agricultural Census, documents somewhat lower land inequality in non-*mita* districts. This finding is consistent with those in columns 1–4, given that non-*mita* districts had more large properties that could be distributed to smallholders during the agrarian reform.[30]

4.2. *Public Goods*

Table VII examines the *mita*'s impact on education in 1876, 1940, and 2001, providing two sets of interesting results.[31] First, there is some evidence that the *mita* lowered access to education historically, although point estimates are imprecisely estimated by the longitude–latitude RD polynomial. In column 1, the dependent variable is the district's mean literacy rate, obtained from the 1876 Population Census (Dirección de Estadística del Perú (1878)). Individuals are defined as literate if they could read, write, or both. Panels B and C show a highly significant *mita* effect of around 2 percentage points, as compared to an average literacy rate of 3.6% in the region I examine. The estimated effect is smaller, at around one percentage point, and not statistically significant, when estimated using the more flexible longitude–latitude specification.[32] In column 2, the dependent variable is mean years of schooling by district, from the 1940 Population Census (Dirección de Estadística del Perú 1944). The specifications reported in panels A–C suggest a long-run negative *mita* effect of around 0.2 years, as compared to a mean schooling attainment of 0.47 years throughout the study region, which again is statistically significant in panels B and C. While this provides support for a *mita* effect on education historically, the evidence for an effect today is weak. In column 3, the dependent variable is individual years of schooling, obtained from ENAHO (2001). The *mita* coefficient is negative in all panels, but is of substantial magnitude and marginally significant only in panel A.[33] It is also statistically insignificant in most specifications in Table A.III. This evidence is consistent with studies of the Peruvian educational

[30]The 1994 Agricultural Census also documents that a similar percentage of households across the *mita* boundary held formal titles to their land.

[31]Education, roads, and irrigation are the three public goods traditionally provided in Peru (Portocarrero, Beltran, and Zimmerman (1988)). Irrigation has been almost exclusively concentrated along the coast.

[32]In some of the specifications in Table A.III in the Supplemental Material that interact the RD polynomial with the *mita* dummy, the estimated *mita* effect is near 0. This discrepancy is explained by two *mita* districts with relatively high literacy located near the *mita* boundary, to which these specifications are sensitive. When these two observations are dropped, the magnitude of the effect is similar across specifications.

[33]Data from the 1981 Population Census (INEI (1981)) likewise do not show a *mita* effect on years of schooling. Moreover, data collected by the Ministro de Educación in 2005 reveal no sys-

TABLE VII

EDUCATION[a]

	Dependent Variable		
	Literacy 1876 (1)	Mean Years of Schooling 1940 (2)	Mean Years of Schooling 2001 (3)
	Panel A. Cubic Polynomial in Latitude and Longitude		
Mita	−0.015	−0.265	−1.479*
	(0.012)	(0.177)	(0.872)
R^2	0.401	0.280	0.020
	Panel B. Cubic Polynomial in Distance to Potosí		
Mita	−0.020***	−0.181**	−0.341
	(0.007)	(0.078)	(0.451)
R^2	0.345	0.187	0.007
	Panel C. Cubic Polynomial in Distance to *Mita* Boundary		
Mita	−0.022***	−0.209***	−0.111
	(0.006)	(0.076)	(0.429)
R^2	0.301	0.234	0.004
Geo. controls	yes	yes	yes
Boundary F.E.s	yes	yes	yes
Mean dep. var.	0.036	0.470	4.457
Clusters	95	118	52
Observations	95	118	4038

[a]The unit of observation is the district in columns 1 and 2 and the individual in column 3. Robust standard errors, adjusted for clustering by district, are in parentheses. The dependent variable is mean literacy in 1876 in column 1 (Dirección de Estadística del Perú (1878)), mean years of schooling in 1940 in column 2 (Dirección de Estadística del Perú (1944)), and individual years of schooling in 2001 in column 3 (ENAHO (2001)). Panel A includes a cubic polynomial in the latitude and longitude of the observation's district capital, panel B includes a cubic polynomial in Euclidean distance from the observation's district capital to Potosí, and panel C includes a cubic polynomial in Euclidean distance to the nearest point on the *mita* boundary. All regressions include geographic controls and boundary segment fixed effects. The samples include districts whose capitals are less than 50 km from the *mita* boundary. Columns 1 and 2 are weighted by the square root of the district's population. 64% of the observations are in *mita* districts in column 1, 63% in column 2, and 67% in column 3. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

sector, which emphasize near-universal access (Saavedra and Suárez (2002), Portocarrero and Oliart (1989)).

What about roads, the other principal public good in Peru? I estimate the *mita*'s impact using a GIS road map of Peru produced by the Ministro de Transporte (2006). The map classifies roads as paved, gravel, nongravel, and *trocha*

tematic differences in primary or secondary school enrollment or completion rates. Examination of data from a 2006 census of schools likewise showed little evidence for a causal impact of the *mita* on school infrastructure or the student-to-teacher ratio.

TABLE VIII

ROADS[a]

	Dependent Variable		
	Density of Local Road Networks (1)	Density of Regional Road Networks (2)	Density of Paved/Gravel Regional Roads (3)
	Panel A. Cubic Polynomial in Latitude and Longitude		
Mita	0.464	−29.276*	−22.426*
	(18.575)	(16.038)	(12.178)
R^2	0.232	0.293	0.271
	Panel B. Cubic Polynomial in Distance to Potosí		
Mita	−1.522	−32.644***	−30.698***
	(12.101)	(8.988)	(8.155)
R^2	0.217	0.271	0.256
	Panel C. Cubic Polynomial in Distance to *Mita* Boundary		
Mita	0.535	−35.831***	−32.458***
	(12.227)	(9.386)	(8.638)
R^2	0.213	0.226	0.208
Geo. controls	yes	yes	yes
Boundary F.E.s	yes	yes	yes
Mean dep. var.	85.34	33.55	22.51
Observations	185	185	185

[a]The unit of observation is the district. Robust standard errors are in parentheses. The road densities are defined as total length in meters of the respective road type in each district divided by the district's surface area, in kilometers squared. They are calculated using a GIS map of Peru's road networks (Ministro de Transporte (2006)). Panel A includes a cubic polynomial in the latitude and longitude of the observation's district capital, panel B includes a cubic polynomial in Euclidean distance from the observation's district capital to Potosí, and panel C includes a cubic polynomial in Euclidean distance to the nearest point on the *mita* boundary. All regressions include geographic controls and boundary segment fixed effects. The samples include districts whose capitals are less than 50 km from the *mita* boundary. 66% of the observations are in *mita* districts. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

carrozable, which translates as "narrow path, often through wild vegetation ... that a vehicle can be driven on with great difficulty" (Real Academia Española (2006)). The total length (in meters) of district roads is divided by the district surface area (in kilometers squared) to obtain a road network density.

Column 1 of Table VIII suggests that the *mita* does not impact local road networks, which consist primarily of nongravel and *trocha* roads. Care is required in interpreting this result, as the World Bank's Rural Roads program, operating since 1997, has worked to reduce disparities in local road networks in marginalized areas of Peru. In contrast, there are significant disparities in regional road networks, which connect population centers to each other. Column 2 in panel A estimates that a *mita* effect lowers the density of regional roads by a statistically significant −29.3 meters of roadway for every square kilometer of district surface area (s.e. = 16.0). In panels B and C, the coefficients are similar, at −32.6 and −35.8, respectively, and are significant at the 1% level. This large effect compares to an average road density in *mita* districts of 20. Column 3 breaks down the result by looking only at the two highest quality road types—paved and gravel—and a similar picture emerges.[34]

If substantial population and economic activity endogenously clustered along roads, the relative poverty of *mita* districts would not be that surprising. While many of Peru's roads were built or paved in the interlude between 1940 and 1990, aggregate population responses appear minimal. The correlation between 1940 district population density and the density of paved and gravel roads, measured in 2006, is 0.58; when looking at this correlation using 1993 population density, it remains at 0.58.

In summary, while I find little evidence that a *mita* effect persists through access to schooling, there are pronounced disparities in road networks across the *mita* boundary. Consistent with this evidence, I hypothesize that the long-term presence of large landowners provided a stable land tenure system that encouraged public goods provision.[35] Because established landowners in non-*mita* districts controlled a large percentage of the productive factors and because their property rights were secure, it is probable that they received higher returns to investing in public goods than those inside the *mita* catchment. Moreover, historical evidence indicates that these landowners were better able to secure roads, through lobbying for government resources and organizing local labor, and these roads remain today (Stein (1980, p. 59)).[36]

4.3. *Proximate Determinants of Household Consumption*

This section examines the *mita*'s long-run effects on the proximate determinants of consumption. The limited available evidence does not suggest differences in investment, so I focus on the labor force and market participation.[37] Agriculture is an important economic activity, providing primary employment for around 70% of the population in the region examined. Thus, Table IX begins by looking at the percentage of the district labor force whose primary occupation is agriculture, taken from the 1993 Population Census. The median

[34]18% of *mita* districts can be accessed by paved roads versus 40% of non-*mita* districts (INEI (2004)).

[35]The elasticity of equivalent consumption in 2001 with respect to *haciendas* per capita in 1689, in non-*mita* districts, is 0.036 (s.e. = 0.022).

[36]The first modern road building campaigns occurred in the 1920s and many of the region's roads were constructed in the 1950s (Stein (1980), Capuñay (1951, pp. 197–199)).

[37]Data from the 1994 Agricultural Census on utilization of 15 types of capital goods and 12 types of infrastructure for agricultural production do not show differences across the *mita* boundary, nor is the length of fallowing different. I am not aware of data on private investment outside of agriculture.

TABLE IX

CONSUMPTION CHANNELS[a]

	Dependent Variable		
	Percent of District Labor Force in Agriculture—1993 (1)	Agricultural Household Sells Part of Produce in Markets—1994 (2)	Household Member Employed Outside the Agricultural Unit—1994 (3)
	Panel A. Cubic Polynomial in Latitude and Longitude		
Mita	0.211	−0.074**	−0.013
	(0.140)	(0.036)	(0.032)
R^2	0.177	0.176	0.010
	Panel B. Cubic Polynomial in Distance to Potosí		
Mita	0.101	−0.208***	−0.033
	(0.061)	(0.030)	(0.020)
R^2	0.112	0.144	0.008
	Panel C. Cubic Polynomial in Distance to *Mita* Boundary		
Mita	0.092*	−0.225***	−0.038**
	(0.054)	(0.032)	(0.018)
R^2	0.213	0.136	0.006
Geo. controls	yes	yes	yes
Boundary F.E.s	yes	yes	yes
Mean dep. var.	0.697	0.173	0.245
Clusters	179	178	182
Observations	179	160,990	183,596

[a] Robust standard errors, adjusted for clustering by district in columns 2 and 3, are in parentheses. The dependent variable in column 1 is the percentage of the district's labor force engaged in agriculture as a primary occupation (INEI (1993)), in column 2 it is an indicator equal to 1 if the agricultural unit sells at least part of its produce in markets, and in column 3 it is an indicator equal to 1 if at least one member of the household pursues secondary employment outside the agricultural unit (INEI (1994)). Panel A includes a cubic polynomial in the latitude and longitude of the observation's district capital, panel B includes a cubic polynomial in Euclidean distance from the observation's district capital to Potosí, and panel C includes a cubic polynomial in Euclidean distance to the nearest point on the *mita* boundary. All regressions include geographic controls and boundary segment fixed effects. Column 1 is weighted by the square root of the district's population. 66% of the observations in column 1 are in *mita* districts, 68% in column 2, and 69% in column 3. Coefficients that are significantly different from zero are denoted by the following system: *10%, **5%, and ***1%.

point estimate on $mita_d$ is equal to 0.10 and marginally significant only in panel C, providing some weak evidence for a *mita* effect on employment in agriculture. Further results (not shown) do not find an effect on male and female labor force participation and hours worked.

The dependent variable in column 2, from the 1994 Agricultural Census, is a dummy equal to 1 if the agricultural household sells at least part of its produce in market. The corpus of evidence suggests we can be confident that the *mita*'s effects persist in part through an economically meaningful impact on agricultural market participation, although the precise magnitude of this effect is difficult to convincingly establish given the properties of the data and the mechanics of RD. The cubic longitude–latitude regression estimates a long-run *mita* effect of -0.074 (s.e. $= 0.036$), which is significant at the 5% level and compares to a mean market participation rate in the study region of 0.17. The magnitude of this estimate differs substantially from estimates that use a cubic polynomial in distance to Potosí (panel B, -0.208, s.e. $= 0.030$) and a cubic polynomial in distance to the *mita* boundary (panel C, -0.225, s.e. $= 0.032$). It also contrasts to the estimate from ordinary least squares limiting the sample to districts bordering the boundary (-0.178, s.e. $= 0.050$).

The surface plots in Figure 3 shed some light on why the cubic longitude–latitude point estimate is smaller. They show predicted values in "longitude–latitude–market participation rate" space from regressing the market participation dummy on the *mita* dummy (upper left), the *mita* dummy and a linear polynomial in longitude–latitude (upper right), the *mita* dummy and a quadratic polynomial in longitude–latitude (lower left), or the *mita* dummy and a cubic polynomial in longitude–latitude (lower right).[38] The *mita* region is seen from the side, appearing as a "canyon" with lower market participation values. In the surface plot with the cubic polynomial, which is analogous to the regression in panel A, the function increases smoothly and steeply, by orders of magnitude, near the *mita* boundary. In contrast, the other plots model less of the steep variation near the boundary as smooth and thus estimate a larger discontinuity. The single-dimensional RDs likewise have fewer degrees of freedom to model the variation near the boundary as smooth. It is not obvious which specification produces the most accurate results, as a more flexible specification will not necessarily yield a more reliable estimate. For example, consider the stylized case of an equation that includes the *mita* dummy and a polynomial with as many terms as observations. This has a solution that perfectly fits the data with a discontinuity term of zero, regardless of how large the true *mita* effect is. On the other hand, flexibility is important if parsimonious specifications do not have enough degrees of freedom to accurately model smoothly changing unobservables. While there is not, for example, a large urban area at the peak of the cubic polynomial causing market participation to increase steeply in this region, it is difficult to conclusively argue that the variation is attributable to the discontinuity and not to unobservables, or vice versa.[39] The estimates in Tables IX and A.III are most useful for determining a range of

[38]I show three-dimensional surface plots, instead of shaded plots as in Figure 2, because the predicted values can be seen more clearly and it is not necessary to plot the data points.

[39]Note, however, that the relatively large (*mita*) urban area of Ayacucho, while outside the study region, is near the cluster of *mita* districts with high market participation in the upper left corner of the *mita* area.

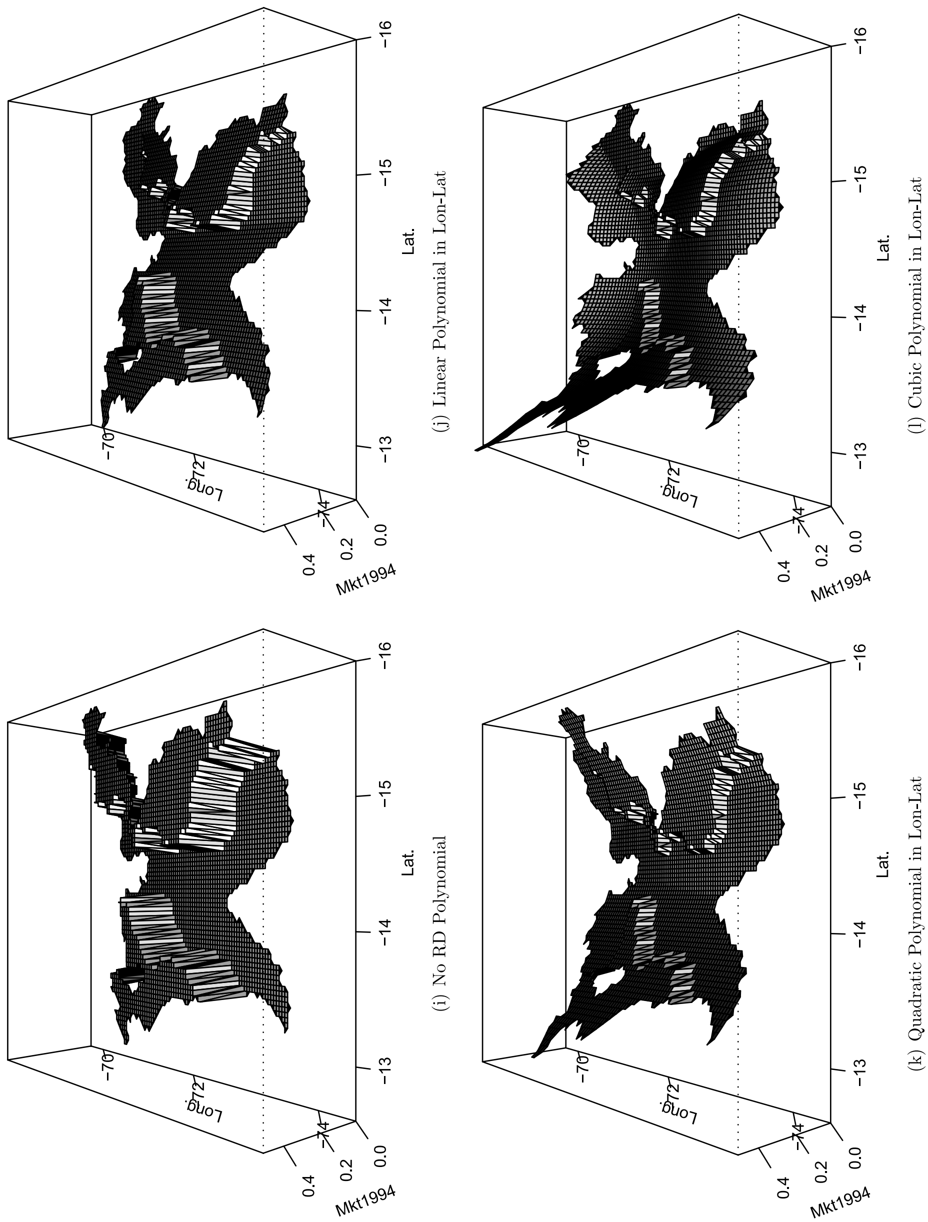


FIGURE 3.—Plots of predicted values from regressing a market participation dummy on the *mita* dummy and various degrees of polynomials in longitude and latitude. See the text for a detailed description.

possible *mita* effects consistent with the data, and this range supports an economically meaningful *mita* effect on market participation.[40]

A *mita* effect on market participation is consistent with the findings on road networks, particularly given that recent studies on Andean Peru empirically connect poor road infrastructure to higher transaction costs, lower market participation, and reduced household income (Escobal and Ponce (2002), Escobal (2001), Agreda and Escobal (1998)).[41] An alternative hypothesis is that agricultural producers in *mita* districts supplement their income by working as wage laborers rather than by producing for markets. In column 3, the dependent variable is an indicator equal to 1 if a member of the agricultural household participates in secondary employment outside the agricultural unit, also taken from the 1994 Agricultural Census. Estimates suggest that, if anything, the *mita* effect on participation in secondary employment is negative.

Could residents in *mita* districts have less desire to participate in the market economy, rather than being constrained by poor road infrastructure? While Shining Path, a Maoist guerilla movement, gained a strong foothold in the region during the 1980s, this hypothesis seems unlikely.[42] Shining Path's rise to power occurred against a backdrop of limited support for Maoist ideology, and the movement's attempts to reduce participation in markets were unpopular and unsuccessful where attempted (McClintock (1998), Palmer (1994)).

Recent qualitative evidence also underscores roads and market access. The citizens I spoke with while visiting eight primarily *mita* and six primarily non-*mita* provinces were acutely aware that some areas are more prosperous than

[40]The specifications interacting the *mita* dummy with a linear or quadratic polynomial in distance to the *mita* boundary, reported in Table A.III, do not estimate a significant *mita* effect. Graphical evidence suggests that these specifications are sensitive to outliers near the boundary.

[41]In my sample, 33% of agricultural households in districts with paved road density above the median participate in markets, as compared to 13% in districts with paved road density below the median. Of course, there may also exist other channels through which a *mita* effect lowers market participation. Data from the 1994 Agricultural Census reveal that the median size of household landholdings is somewhat lower inside the *mita* catchment (at 1.2 hectares) than outside (at 1.4 hectares). If marketing agricultural produce involves fixed costs, a broader group of small farmers in non-*mita* districts may find it profitable.

[42]Many of the factors linked to the *mita* (poor infrastructure, limited access to markets, poorly defined property rights, and poverty) are heavily emphasized as the leading factors promoting Shining Path (Comisión de la Verdad y Reconciliación (2003, Vol. 1, p. 94), McClintock (1998), Palmer (1994)). Thus, I tested whether there was a *mita* effect on Shining Path (results available upon request). To measure the intensity of Shining Path, I exploit a loophole in the Peruvian constitution that stipulates that when more than two-thirds of votes cast are blank or null, authorities cannot be renewed (Pareja and Gatti (1990)). In an attempt to sabotage the 1989 municipal elections, Shining Path operatives encouraged citizens to cast blank or null (secret) ballots (McClintock (1998, p. 79)). I find that a *mita* effect increased blank/null votes by 10.7 percentage points (s.e. $= 0.031$), suggesting greater support for and intimidation by Shining Path in *mita* districts. Moreover, estimates show that a *mita* effect increased the probability that authorities were not renewed by a highly significant 43.5 percentage points. I also look at blank/null votes in 2002, 10 years after Shining Path's defeat, and there is no longer an effect.

others. When discussing the factors leading to the observed income differences, a common theme was that it is difficult to transport crops to markets. Thus, most residents in *mita* districts are engaged in subsistence farming. Agrarian scientist Gonzales Castro (2006) argued, “Some provinces have been favored, with the government—particularly during the large road building campaign in the early 1950s—choosing to construct roads in some provinces and completely ignore others.” At the forefront of the local government’s mission in the (primarily *mita*) province of Espinar is “to advocate effectively for a system of modern roads to regional markets” Espinar Municipal Government (2008). Popular demands have also centered on roads and markets. In 2004, (the *mita* district) Ilave made international headlines when demonstrations involving over 10,000 protestors culminated with the lynching of Ilave’s mayor, whom protestors accused of failing to deliver on promises to pave the town’s access road and build a local market (Shifter (2004)).

5. CONCLUDING REMARKS

This paper documents and exploits plausible exogenous variation in the assignment of the *mita* to identify channels through which it influences contemporary economic development. I estimate that its long-run effects lower household consumption by around 25% and increase stunting in children by around 6 percentage points. I then document land tenure, public goods, and market participation as channels through which its impacts persist.

In existing theories about land inequality and long-run growth, the implicit counterfactual to large landowners in Latin America is secure, enfranchised smallholders (Engerman and Sokoloff (1997)). This is not an appropriate counterfactual for Peru, or many other places in Latin America, because institutional structures largely in place before the formation of the landed elite did not provide secure property rights, protection from exploitation, or a host of other guarantees to potential smallholders. Large landowners—while they did not aim to promote economic prosperity for the masses—did shield individuals from exploitation by a highly extractive state and did ensure public goods. This evidence suggests that exploring constraints on how the state can be used to shape economic interactions—for example, the extent to which elites can employ state machinery to coerce labor or citizens can use state guarantees to protect their property—is a more useful starting point than land inequality for modeling Latin America’s long-run growth trajectory. The development of general models of institutional evolution and empirical investigation of how these constraints are influenced by forces promoting change are particularly central areas for future research.

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