Tordesillas, Slavery and the Origins of Brazilian Inequality*

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February 25, 2020

Abstract

This article shows the long-term effect of slavery on inequality on the receiving end of the spectrum. We focus on Brazil, the largest importer of African slaves, and the last country to abolish this institution in the Western Hemisphere, in 1888. To deal with the endogeneity of slavery placement, we use a spatial Regression Discontinuity (RD) framework, exploiting the colonial boundaries between the Portuguese and Spanish empires within Brazil. We find that the number of slaves in 1872 is discontinuously higher in the Portuguese side of the border, consistent with this power's comparative advantage in Transatlantic slavery. We then show how this differential slave rate led to higher income inequality of 0.103 points (of the Gini coefficient), approximately 20% of average income inequality in Brazil. To further investigate the mechanisms at play, we use the division of the former Portuguese colony into Donatary Captaincies as well as the Dutch colonization experience. Aside from the effect on income inequality, we find that more slave intensive areas have higher income and educational racial imbalances, and lower state capacity today.

JEL codes: O10, N36, O54, O43, I24
Keywords: Slavery, Inequality, Brazil, Regression Discontinuity Design, Colonization, Institutions, Racial Income Gap, Education

*We would like to thank Stanley Engerman, Nathan Nunn, Paola Giuliano, Melissa Dell, Oded Galor, David Weil, Stelios Michalopoulos, Luigi Pascali, Moritz Schularick, Leonard Wantchekon, Camilo Garcia Jimeno, Joana Naritomi, Giacomo Ponzetto, Ruben Enikolopov, Andrea Ichino, Matteo Cervellati, Jean-Louis Arcand, Ugo Panizza, Matias Cattaneo, Laura Chioda, Gani Aldashev, John Friedman, Glenn Loury, Claudio Ferrraz, Eduardo Montero, Rodrigo Soares, Leonado Weller, Francisco Costa, Claudia Rei, Francisco Vidal Luna, Jorge Pimentel Cintra, and seminar participants at Brown, Stanford, UBC, Toronto, SFU, UC Davis, the LSE, Pompeu Fabra, Bonn, ASREC Bologna, LACEA Sao Paulo, RIDGE Montevideo, FGV-EESP, INSPER, WEHC Boston, Madrid, Odense and Los Andes for helpful comments. We thank Marcelo Sacchi for excellent research assistance. All remaining errors are ours.

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1 Introduction

The Transatlantic slave trade constituted a defining demographic, social and economic event in world history. It is now estimated that between the fifteenth and the nineteenth centuries, more than 12 million slaves were taken from Africa (Eltis and Richardson, 2010). Although the negative impact of this human trafficking has been documented for exporting African nations (Nunn 2008; Nunn and Wantchekon, 2010), less is known about the long-term impact of slavery as an institution on the receiving end of the spectrum. The analysis is complicated due to the endogenous placement of slaves, as well as the lack of disaggregated historical data.

To make progress with question, in this paper we focus on Brazil. This country is particularly well suited to study the aftermath of slavery, as the largest recipient of African slaves. Brazil was also the last country in the Western hemisphere to abolish this institution in 1888. This allows us to use the 1872 Census to estimate the intensity of slavery at the municipal level. At the same time, Brazil remains one of the most unequal countries in the world (Milanovic, 2011). Notably, according to the 2010 Census, the majority of Brazilians defined themselves as non-white. Hence our motivation here is twofold. We are interested in evaluating the impact of slavery on income inequality at the sub-national level. Conversely, we want to explore the historical roots of inequality in one of the most unequal countries in the world.

Conceptually, we perform a quantitative re-examination of the famous Engerman and Sokoloff hypothesis (1997). According to this thesis, the development trajectories in the Americas can be explained by initial factor endowments and subsequent colonial productive structures. Here we focus on the link between Transatlantic slavery and economic inequality. Even though this hypothesis has been examined at the cross-country level (Nunn, 2007; Soares et al. 2012), a careful sub-national analysis would help to isolate the confounding effect of other national-level institutional, historical and cultural legacies.[1] We are further interested in the underlying mechanisms of transmission leading to inequality and potential underdevelopment in the long term.

In our empirical analysis, we conduct a Regression Discontinuity Design (RDD). We exploit the historical discontinuity provided by the Treaty of Tordesillas (1494), dividing the Spanish and Portuguese empires in the New World. Interestingly, the drawing of the Tordesillas line pre-dated the discovery of South America, during the third voyage of Christopher Columbus (1498). Still, the Tordesillas Treaty provided the foundation for the eventual Portuguese colonization of the continent (Seed, 1995; Herzog, 2014). Crucially, Portugal had a comparative advantage in slave trade relative to Spain, due to its previous exploration of the African coast as well as its plantation experience in the Azores Islands.

To quantify the effect of slavery, we use a municipality's distance to the

[1]Different from Lagerlöf (2005) and Fenske and Kala (2015) we do not focus here on evaluating the impact of geography or climate on slavery, since these are continuous variables in our analysis, but on the impact of slavery on inequality and income

Tordesillas line. For estimation we use the non-parametric method proposed by Calonico, Cattaneo and Titiniuk (2016) combined with the donut RDD of Barreca et al. (2011). Empirically, we find that the number of slaves in 1872 is discontinuously higher on the Portuguese relative to the Spanish side of the Brazilian colonial border, consistent with the historical narrative. In modern times, we also observe a discontinuous jump in income inequality in 2010. The estimates range from 0.104 Gini coefficient points, or 20.76% of Brazilian income inequality, to a more conservative bound of 0.0384 points or 7.6% of the sample average, using a local randomization approach (Cattaneo, Frandsen and Titiniuk, 2015). We do not find a substantial effect on the level income, as hypothesized by Engerman and Sokoloff, suggesting that the effect of slavery works predominantly on the second moment of the income distribution.

To better understand the effect of slavery on income inequality, we focus on the racial income gap. There we find again a large and significant discontinuity, on the former Portuguese side of the border, where more slaves inhabited. Further income decompositions reveal important differences among the white and black populations. The income inequality between groups, using a Theil index, appears less pronounced. The racial income gaps parallel the racial gaps in education. We find around 10% lower education for black relative to white households at the discontinuity. Additional tests reveal negligible effects on land inequality, higher expenditures in education, but lower institutional capacity (Naritomi et al, 2012).

We also explore regional differences within Portuguese Brazil, to study the effect of slavery at the intensive margin. To this end, we focus on the Donatary Captancy (DC) system, which the Portuguese Crown established during the early colonization of Brazil. This system is tightly linked to slavery and land inequality in Brazilian historiography (Mattos et al., 2013). The empirical results for Donatary Captaincies mimic those for the Tordesillas line, whereby higher slavery during colonial times results in higher income inequality. The results for land inequality are marginally significant and those for the education racial gap are more muted.

To examine the potential role of colonial identity, we look at the case of Dutch Brazil. The Dutch had an important early colonial presence in the Brazilian Northeast. Even though they might have been more different culturally from the Portuguese than the Spaniards, they were also major slave traders. Hence with this case we can distinguish between colonial cultural legacies and slavery policies. Empirically, we find no significant differences in the number of slaves imported, relative to the Portuguese and no corresponding differences in terms of inequality later on. The results suggest that slavery and not colonizer identity mattered for inequality in this case.

Lastly, we explore other mechanisms of persistence that have been suggested in the literature. We mostly follow Engerman and Sokoloff (1997), finding no significant effects on historic or modern voting. We do find significant results for structural transformation as early as 1920, suggesting a more advanced economy on the Portuguese side of the border, consistent with the findings for modern income. There are no significant differences on a variety of measures of institutional

presence, but important ones in self-organized racial equality councils, suggesting the importance of this channel. In terms of health, a complementary component of the human capital function, there are no significant differences except for violent deaths. Demographically, there are no large jumps for white, pardo, black or international populations in modern times (cf. Fogel and Engerman, 1974; Bertocchi and Dimico, 2019). The effect on trust is observable, though muted, with the exception of trust in the judiciary (as in Nunn and Wantchekon, 2010).

1.1 Literature

Recent research has quantified the negative economic impact of slave trade on origin African countries. Nunn (2008) explains part of Africa's current underdevelopment with slave intensity, relying on data from shipping records and matching them to ethnicities today. Focusing on mechanisms of transmission, Nunn and Wantchekon (2010) show a negative relationship between an individual's reported trust in others and the number of slaves taken from the individual's ethnic group during the slave trades. These studies have gone beyond correlations, to establish causality in various ways. Follow up papers have continued this tradition. For instance, Fenske and Kala (2017) have related slavery to conflict, Bertocchi and Dimico (2015) to the prevalence of HIV/AIDS, Bertocchi and Dimico (2019) to family size, and Teso (2019) to modern female labor force participation.[2]

The effect of slavery on receiving nations is relatively less well understood. Nunn (2007) examines the Engerman and Sokoloff hypothesis empirically, using data at the national level. He finds again that slavery is related to underdevelopment, but little impact on economic inequality. Soares et al. (2012) document a strong relationship between slavery and modern levels of inequality in a cross section of countries. Derenoncourt (2018) documents a positive effect of slavery on European ports involved in this trade, though few slaves arrived to the continent.

Focusing on the US, Fogel and Engerman's watershed 'Time on the Cross' (1974) provided a critical historic and quantitative re-examination of the American slavery experience. In this book they document the relatively low levels of slave imports, the higher than average reproduction rates and quantify the productivity of the slave economy. This seminal piece led to many other contributions including Smith (1984), Margo (1990), Coatsworth et. al. (1998) and Mitchener and McLean (2003). More recently, Lagerlöf (2005) looked at the role of geography, Naidu (2012) of suffrage and Bertocchi and Dimico (2014) of education. Gouda and Rigterink (2013) and Buonano and Vargas (2017) link slavery to higher crime, while Acharya, Blackwell and Sen (2014 and 2018) analyze its impact on southern politics.

Our knowledge of the long-term economic impact of slavery remains relatively precarious going south of the border. Naritomi et al. (2012) stress the importance of colonial booms for Brazilian economic development. Dell (2010) documents the negative long-term effect of the mita labor system in Peru and Bolivia. Though

[2]Pierce and Snyder (2017) and Levine, Lin, Xie (2017) document the impact of slavery on lower credit and access to finance.

this forced labor institution was not equivalent to slavery, this is perhaps the closest article conceptually. In a lone exception, Acemoglu, Robinson and Garcia Jimeno (2012), document the negative impact of slavery in Colombia, using variation in gold mines. Still, to the best of our knowledge, no study in economics has attempted to quantify the impact of slavery in Brazil, the largest recipient of African slaves in world. We contribute to this literature with new data and a novel econometric identification strategy, based on former colonial boundaries.

The rest of the paper is organized as follows. In the next section, we provide the historical background in terms of the Tordesillas Treaty, as well as slavery in South America and Brazil. Section 3 presents the identification strategy and estimation framework, and Section 4 describes the data. Section 5 contains the main empirical results of the paper. Section 6 presents mechanisms of transmission and Section 7 robustness tests. Section 8 concludes.

2 Historical Context

2.1 Tordesillas Treaty: Spanish and Portuguese South America

The Treaty of Tordesillas followed soon after the discovery of the New World. After Columbus arrival from the Americas, in 1493, King Ferdinand II of Aragon, Queen Isabella I of Castile and King John II of Portugal secured two papal bulls - called *Inter Caetera*. The bulls entrusted the European monarchs with the duty to convert indigenous people in return for rights in territories discovered west of the meridian passing one hundred leagues off the Cabo Verde and Azores Islands (Herzog, 2015). In 1494, the Spanish and Portuguese monarchs formally signed the Treaty of Tordesillas, in the province of Valladolid.[3] The treaty effectively separated the globe by a meridian located 370 leagues to the west of the Cape Verde Islands. Lands to the east of the meridian would be Portuguese, while those to the west would be Spanish.

The demarcation of the Tordesillas Line pre-dated the discovery of Brazil. The northern tip of South America was only sighted until Columbus third voyage in 1498-1500. The actual discovery of Brazil by Pedro Álvares Cabral occurred on April 22, 1500. The Tordesillas Treaty dictated the borders of the New World and provided the foundation for the Portuguese colonization of South America (Seed 1995; Herzog, 2015). The actual implementation of the Treaty was not without controversy. Teams of experts, often supporting one of the two sides, debated the location of the actual meridian in relation to the Cape Verde Islands. Spain preferred to measure the meridian from the center of the Islands, while Portugal intended to measure it from the most westward point, resulting in the difference of $2^o42'$ (Cintra, 2012; Herzog, 2015). The contesting parties met in Badajoz and Elvas in 1524 and signed later in 1529 the Treaty of Zaragoza. This treaty

[3]The Tordesillas Treaty replaced the 1479 Alcáçovas Treaty between Spain and Portugal. Pope Julius II confirmed the Treaty in 1506.

demarcated the antimeridian of the Tordesillas Line, defining the Spanish and Portuguese claims in Asia, and settling the claims for the Moluccas Islands.

Implementation on the ground was also contested throughout the colonial period. In the 1530s, Spain and Portugal disagreed on the territory of the River Plate, in modern-day Argentina and Uruguay. From 1580 to 1640, Spain and Portugal were under the same kingdom, largely ignoring the Tordesillas Treaty. As soon as 1641, Portuguese troops invaded the Spanish territory of Omaguas, in present-day Peru. An important flashpoint was the settlement of Colonia de Sacramento, in present-day Uruguay, on the River Plate delta, right in front of Buenos Aires. Disputes were settled by the Lisbon Treaty of 1681. During the eighteenth century, disputes included territories that are currently located in Brazil, Paraguay, Uruguay, Argentina, Venezuela, Colombia, Ecuador, Peru and Bolivia. Again tensions were resolved with the The Treaty of Utrecht in 1715, in the context of the War of Spanish Succession. But it was not until the Treaty of Madrid in 1750, that the modern Brazilian boundaries were established. The treaty was annulled in 1761, integrated into the Treaty of Paris (1763) and finally ratified in San Idelfonso, in 1777. Still, despite the complications, for most of the Brazilian colonial era, the Tordesillas Treaty demarcated the Spanish and Portuguese boundaries in South America.

2.2 Slavery in South America

Modern historical scholarship estimates that between the fifteenth and the nineteenth centuries more than 12 million slaves were taken from Africa, of which 10.7 million disembarked in their destinations (Eltis and Richardson, 2010). 45.6% of that total number of slaves disembarked in Brazil from 1501 to 1867.[4] 21.5% of the total slaves landed in southeast Brazil, 14.7%, in Bahia, 8.1%, in Recife and 1.3% Amazonia, as detailed later. By 1790, slaves in Brazil outnumbered US slaves by two to one and it is estimated that as many as 4 million slaves were imported to the country, four times the US total. Overall, Brazil was the destination for almost half of the African slaves who were shipped across the Atlantic.

Portugal had a comparative advantage in slave trading for several reasons. Since the times of Henry the Navigator in the fifteenth century, Portuguese sailors had been exploring the African coast. In 1488, Bartolomeu Dias rounded the Cape of Good Hope and in 1498 Vasco da Gama reached India. The Portuguese established a seaborne empire reaching the Moluccas islands (Boxer, 1969). In Africa, as in India and Asia, they set up a series of factories or trading posts along the coasts. Additionally, they set up plantation economies in Madeira, Sao Tomé, the Azores and Cape Verde Islands, which served as a pilot projects for the eventual colonization of Brazil.

Slavery was one of the main pillars of the Portuguese colonial model established in Brazil after 1500. Slaves played an important role in agriculture and

[4]The Yale Transatlantic project takes this date, though slavery was abolished two decades later in 1888.

local societies, reflecting a key difference from previous systems. Several reasons led to the importing of African slaves into Brazil starting in 1570. One was the relative scarcity of Indian labor. Brazilian Indians were not used to agriculture or taxation, unlike the Amerindians located in Mexico or Peru. Second, Portuguese were eager to populate Brazil to avoid potential invasions from other European countries increasingly interested in the Americas. As detailed later, the funds to cover the import of African slaves would come mostly from increasing revenues of sugar exported to Europe.

The Spanish trans-Atlantic trade was mostly focused on Central America and the Caribbean.[5] The Spaniards transported 8,000 slaves to Rio de la Plata, while the majority of the slaves went to Cuba (600,000 out of 885,000). The British, French, North American and northern European countries brought about 47,000 slaves in Rio de la Plata. The Dutch transported 28,000 slaves to Recife between 1630 and 1654. In the rest of South America, 0.6% of the slaves landed in Rio de la Plata, 0.3% French Guiana, 2.8% in Dutch Guiana and 0.7% British Guiana.

Slavery was further developed in the Spanish Americas at the beginning of the sixteenth century. In countries such as Mexico, Peru and Central America, African slaves were employed in mining activities. But already in 1600, the number of slaves arriving in Brazil surpassed the number observed in the Spanish America. Over time, the Brazilian slave plantation model became a reference for English, French and Dutch colonies in America.

Brazil was the last country in the Americas to end slavery in 1888. Haiti was the first country to abolish slavery in 1804, followed by Chile in 1823 and Mexico in 1829 (Bergad, 2007) . These countries followed a similar processes starting with the end of the slave trade, followed by a free birth or free womb law for newborns, finishing with the final abolition of the slavery labor regime (Table 12).

2.3 Slavery in Brazil

Brazil received subsequent waves of African slaves as early as the sixteenth century, closely following colonial economic booms (Bethel, 1987; Klein and Luna, 2010). The initial wave of slavery was channeled towards the production of sugar cane, and was mostly concentrated in the Northeast of the country (Schwartz, 1973). By 1640, the number of slaves in Portuguese America was larger than in any other American colony. The Dutch also played an important role in the early development of Brazilian slavery with the invasion of Pernambuco from 1630 to 1651.

The discovery of gold in current region of Minas Gerais (general mines) at the end of the seventeenth century started a new type of slave economy in Brazil. The number of slaves dramatically increased in the country. From 1716 to 1730, gold production was about 14,000 kilograms per year in Minas Gerais and the neighboring state of Goias. The gold period was followed by a precious stones

[5]The New Laws of 1542 limited - at least in principle - the enslavement of indigenous people.

export boom as Minas Gerais became the world's largest supplier of diamonds. By 1800, Brazil had one million African slaves in 1800, more than any other country in the world (Klein and Luna, 2010). The slave population growth resulted in an important native-born slave population by the end of the eighteenth century.

Another important economic product for slavery was cotton. In the North of Brazil, the General Trade Company of Grao-Para and Maranhao had a monopoly over cotton plantations in the region using slave workforce. The company exported raw cotton to England to produce textiles. By 1850, when England forcibly halted the maritime slave trade, internal slave trade grew substantially. The American Civil War (1861-1865) benefited Maranhao because the South of the United States was the largest producer of cotton at the time. At the end of the eighteenth century, the production of cotton in the Brazilian north-east started to decay and some plantations reverted into sugar.

The last major boom was the production of coffee in Rio de Janeiro and eventually Sao Paulo states. These regions had already been connected with the slave trade of the mining areas, mostly through the production of of beef jerky. By 1872, the area of Rio de Janeiro and the neighboring region in Sao Paulo (Vale do Paraiba) had mastered the techniques of mass coffee production. Brazil soon became the largest coffee producer in the world. The production relied on slave labor at this stage, albeit not exclusively (Mello, 1977). It was only around the 1880s that coffee expanded to the west of Sao Paulo and the southern region of Minas Gerais. To summarize, 53% slaves were located in the northeast of the country producing sugar as late as the 1820s, moving to 67% of slaves in the southeast producing coffee (Engerman, 2015). Table 13 shows the relative importance of the different colonial booms in relation to slavery.

3 Identification Strategy

The key problem in conducting an empirical analysis of the long-term impact of slavery is the endogenous placement of slaves. For instance, it is well known that slaves were sent to mines (Acemoglu et al. 2012) and employed in highly productive activities, such as cotton harvesting in the Southern United States (Fogel and Engerman, 1974) and sugar production in Brazil (Naritomi et al. 2012). Therefore, without isolating the independent roles of these activities, one can naively conclude that slavery resulted in higher economic activity. To tackle this issue, we propose a new econometric strategy based upon early colonial territorial boundaries. The idea is to combine the latest research on the historiography of colonial boundaries with standard econometric techniques. Technically, to isolate the impact of slavery from other confounders, we use a regression discontinuity framework (Imbens and Lemieux, 2008; Angrist and Pischke, 2009; and Lee and Lemieux, 2010; Cattaneo et al., 2015).

Historically, we will focus on what Tamar Herzog (2014) calls the "Frontiers of Possession" of the Spanish and Portuguese empires in the Americas. As can be seen in Figure 1, the Tordesillas Treaty Line of 1494 delimited the Spanish and

Portuguese empires in the New World. The territory to the right of the line was then colonized by the Portuguese, which had a comparative advantage in slave trading, as described before.

The key insight for the identification is to exploit econometrically this colonial discontinuity between the Portuguese and Spanish empires, while holding geographic, weather and other local factors constant. Moreover, as can be seen in Figure 1, the Portuguese territories themselves were divided into Donatary Captaincies that also followed differential colonization patterns (Mattos et al. 2012). Again, the idea would be to exploit these almost geometric discontinuities econometrically to capture the causal effect of slavery on modern development outcomes. One additional difference was the colonization by the Dutch of the north-east state of Pernambuco (Mello, 2010), which we also explore empirically, using a geographic RDD.

3.1 Estimation Framework

We use the regression discontinuity (RD) design, which identifies the effect of slavery at the Tordesillas line. The geodesic distance of the Tordesillas line functions as an assignment variable to measure the long-term impact of slavery. In this case, the Tordesillas line is exogenous and pre-dated the European discovery of Brazil, representing a discontinuity between the Spanish and Portuguese Americas. We use official census data from 1872, when slavery existed in Brazil. At that time, slavery was already abolished in the neighboring Latin American countries.

We can also relax the linearity assumption and include polynomial functions in the regression model. A polynomial model generates global estimates of the regression function over all values of the assignment variable. It can be a disadvantage because the RD design depends on local estimates of the regression function at the cut-off point (Lee and Lemieux, 2010; Angrist and Pischke, 2008). Gelman and Imbens (2014) argued that estimators for causal effects based upon high-order (third, fourth or higher) polynomials of the assignment variable can be misleading. The authors recommend using estimators based upon smoother functions such as local linear and quadratic polynomials.

We mainly work with the sharp RD given the reasons mentioned above, which have the basic regression form:

$$Y_i = \alpha + D_i\tau + X_i\beta + \varepsilon \tag{1}$$

where Y_i is the outcome variable of interest for a municipality, D_i is the side on which the municipality is located with respect to the Tordesillas line (D_i=1 when the municipality is east of the Tordesillas line and D_i=0 if it is located west of this meridian), τ can be viewed as the estimate of the causal effect and X_i is a vector of covariates.

We apply the methodological framework developed by Cattaneo et al. (2015), which analyzes RD designs as local randomized experiments, employing a randomization inference setup. This method assumes exact finite-sample inference

procedures, given that there might be few observations available close to the threshold where local randomization is more probable. This is a two-step procedure: first, we choose the window around the cut-off where the treatment is assumed to be as good as randomly assigned; and second, we apply the conventional randomization inference tools.

We also implement the Donut RD approach used by Barreca et al. (2011). The heaped distribution of slaves around the Tordesillas line led us to consider a smoother approach. The authors argue that heaping can generate significant biases, including when the data heap does not fall close to the treatment threshold. The Donut RD estimates equation 1 dropping observations at data heaps. Barreca et al. (2011) argue that Donut RD always results in unbiased estimates of the treatment effect on continuous data. At the same time, the conventional RD design for heaped data can be unbiased, although it tends to reduce the bandwidth.

4 Data

We study the long-term impact of slavery on economic development by testing whether it affects today's standards of living. Therefore, our data combines historical records with modern outcomes. We use municipality-level data for historic and recent sources. The Brazilian Imperial Census of 1872 is already matched to modern municipalities (IBGE, 2011)[6]. The census records the age, sex, civil status, religion and crucially the race and status (slave or free) of the respondent. We use the ratio of slaves over the total population as a variable to capture slavery at the municipality level. We also use data about quilombos (runaway slave communities)[7]. We include geographical variables that we created using ArcGIS tools, such as the distances of municipalities from the Tordesillas lines and Donatary Captaincies. We also use variables such as distance to Portugal, distance to the Ecuador meridian as well as sugar, coffee and gold economic cycles explored by Naritomi et al. (2012).

For the modern outcomes such as income inequality and the income and education racial imbalance, we use data available from the Brazilian IBGE and the Datasus (Ministry of Health) portals. To run the regressions proposed, we include a set of geographic and weather controls at a highly disaggregated level, which are also available from the Brazilian statistic portals. All variables are detailed in the Annex.

[6]We measure slavery using the ratio number of slaves over the total population in 1872. According to the IBGE, there were 624 current municipalities that had slaves in 1872. In our estimations, we attributed zero to the other 4,881 municipalities that did not have black slaves to really capture the current effect of slavery in inequality.

[7]Data produced by INCRA (National Institute of Colonization and Land Reform) and available at the portal acervofundiario.incra.gov.br/

4.1 Summary Statistics

The data contains the totality of municipalities (5,505). The first municipalities of Brazil are Ilheus and Porto Seguro (1534) in the current state of Bahia, while 518 municipalities were created in 1997. We use the 1872 data already converted to 624 current municipalities (IBGE, 2011). On average, 14% of the municipal population in 1872 comprised black slaves. For all Brazilians municipalities, we list economic, demographic and social data. The geographic variables that we generate using GIS are also summarized in Table 1.

Table 1: Summary Statistics

	N	Mean	SD	Min	Max
Year of Foundation	5235	1944.659	57.48361	1534	1997
Year of the Municipality's Foundation	5,235	1,945	57.48	1,534	1,997
Population (1872)	624	15,802	17,239	876	274,972
Slave Population (1872)	624	2,399	3,727	4	48,939
Number of slaves over total population (1872)	624	0.140	0.107	0.000687	0.939
Population (2012)	5,503	34,666	203,879	807	11,380,000
GDP per capita	5,503	14,778	16,556	2,720	511,967
Income Inequality (Gini coefficient - 2010)	5,505	0.503	0.0663	0.284	0.808
Income Racial Imbalance (2010)	5,501	0.701	0.236	0.0424	8.110
Education Racial Imbalance (2010)	5,394	2.233	1.248	0.217	31.25
Distance to Tordesillas Line ($48^o42'$ west)	5,493	569.9	430.8	0.239	2,760
Distance to Dutch Brazil's border	5,493	1,147	778.3	0.546	3,089
Distance to Dutch Brazil's shore	1,135	140.1	120.1	0.149	581.2
Donatary Captaincy (DC)	5,493	5.770	5.674	0	17
DC Maranhao 1	5,493	0.0113	0.106	0	1
DC Maranhao 2	5,493	0.00801	0.0891	0	1
DC Piaui	5,493	0.0238	0.153	0	1
DC Ceara	5,493	0.0211	0.144	0	1
DC Rio Grande Norte 1	5,493	0.0202	0.141	0	1
DC Rio Grande Norte 2	5,493	0.0202	0.141	0	1
DC Itamaraca	5,493	0.0637	0.244	0	1
DC Pernambuco	5,493	0.0717	0.258	0	1
DC Bahia	5,493	0.0535	0.225	0	1
DC Ilheus	5,493	0.0350	0.184	0	1
DC Porto Seguro	5,493	0.0401	0.196	0	1
DC Espirito Santo	5,493	0.0978	0.297	0	1
DC Sao Tome	5,493	0.00947	0.0968	0	1
DC Sao Vicente 1	5,493	0.0825	0.275	0	1
DC Sao Vicente 2	5,493	0.00783	0.0881	0	1
DC Santo Amaro	5,493	0.0188	0.136	0	1
DC Santana	5,493	0.00346	0.0587	0	1

The table shows the summary statistics of the main variables that we used in the paper. The description of the variables is further detailed. The income racial imbalance reflects the ratio of the average income of black households over the average income of white households in 2010. The education racial imbalance represents the ratio of the average illiteracy rate of black households over the average illiteracy rate of white households in 2010. Quilombos are hinterland settlements that escaped slaves in Brazil founded.

4.2 Tordesillas Line

We use the meridian $48^o42'$ west for the Tordesillas line (Cintra, 2013). Figure 7 show the distribution of the municipalities around the Tordesillas line in 1872. At that time, 15.9% of the municipalities were located west of the Tordesillas and 84.1% to the east.

Figure 7 shows the distribution of slaves as a ratio of the total population in relation to the municipalities' distance to the Tordesillas line. There is a "hole" around the cutoff. The municipalities where the coffee, sugar cane and gold economic cycles took place in Brazil are highlighted in different colors. The Tordesillas line passes through the municipalities where the coffee cycle (until 1886) took place. The graphs 8b and 8a show the absolute values in the number of black slaves and free people before the abolition of slavery, confirming - as expected - the results of figure 1. Figure 7 shows that the majority of the municipalities that had slaves in 1872 close to the Tordesillas line are located in the states of Sao Paulo and Minas Gerais.

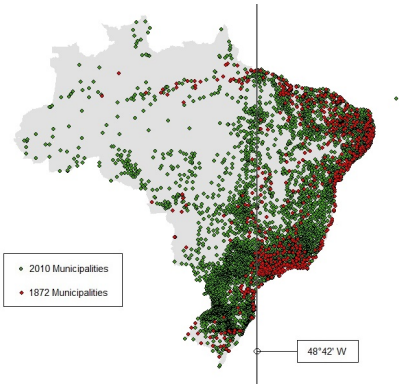
Portuguese South America received considerably more black slaves than Spanish South America (Bergad, 2007). The abolition of slavery in Brazil happened in 1888. We use the 1872 census to measure the number of slaves by current Brazilian municipality. We use the Tordesillas line as an exogenous instrument in the identification strategy. The effects are not symmetrical for both sides of the Tordesillas line.

In this section, we present the summary statistics and preliminary regressions of both the Portuguese and Spanish parts of Brazil theoretically divided by the Tordesillas line. From now onwards, we refer to these two parts of the country as Portuguese (east of the Tordesillas line) and Spanish (west of the Tordesillas line) Brazil. The first city founded in Portuguese Brazil dates from 1534, while in Spanish Brazil it dates from 1635. The number of slaves over the total population of Portuguese Brazil in 1872 was 14.7% on average and slavery was present in 525 current municipalities (out of 3,367) This ratio for Spanish Brazil was 10.6% and the area involved 99 current municipalities (out of 2,136). The average number of black slaves by municipality in Portuguese Brazil was 2,628, while it was 1,184 in Spanish Brazil.

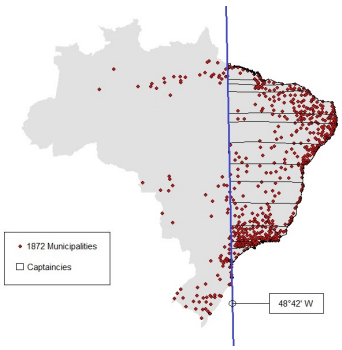
The greater incidence of black slavery east of the Tordesillas line resulted in the higher number of quilombos. While the area corresponding to Portuguese Brazil has 410 quilombos, Spanish Brazil counts 100. The current income inequality - measured by the Gini coefficient - in Portuguese Brazil is on average 5.8% higher than Spanish Brazil, while the latter is 62.2% richer on average in GDP per capita terms.

Table 2 also shows that the income of black households in relation to white households (income racial imbalance) is on average 29% higher in Spanish rather than Portuguese Brazil. Black households tend to have half of a white household's average income in Portuguese Brazil. On the other hand, the table also shows that for each white illiterate household there are on average two black illiterate households in Portuguese Brazil. This ratio increases to 2.7 in Spanish Brazil.

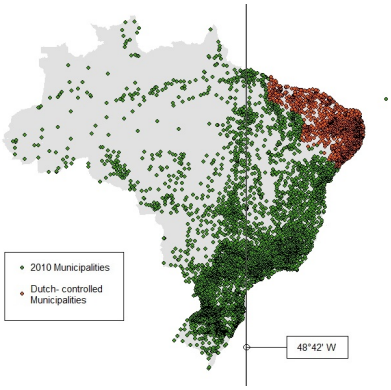
Figure 1: Tordesillas Line and Donatary Captaincies



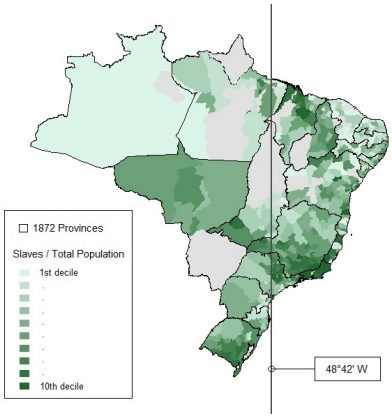
(a) Tordesillas Line



(b) Donatary Captaincies: traditional



(c) Dutch Brazil



(d) Intensity of slavery per municipality in 1872

Map (a) shows the Tordesillas line and the distribution of current municipalities that existed in 1872 in red and current municipalities in green. Map (b) represents the traditional representation of the Donatary Captaincies and map (c) exhibits in orange the area colonized by the Dutch (Hettema Jr., 1920). Map (d) shows the intensity of the black slaves' representation in each municipality in 1872.

Table 2: Summary Statistics: Portuguese and Spanish Brazil

	N	Mean	SD	Min	Max
Portuguese Brazil					
Year of Foundation	3,172	1936	64.62	1534	1997
Population (1872)	525	16,892	18,271	1,331	274,972
Number of black slaves (1872)	525	2,628	3,982	63	48,939
Number of slaves over total population (1872)	525	0.147	0.112	0.0118	0.939
Quilombo[8]	3367	0.122	0.327	0	1
Population (2012)	3,367	41,367	252,042	807	11,380,000
GDP per capita (2012)	3,367	11,903	17,853	2,727	511,967
Gini coefficient (2010)	3,367	0.514	0.0577	0.329	0.797
Income Racial Imbalance (2010)	3,367	0.725	0.214	0.0959	2.364
Educational Racial Imbalance (2010)	3,361	1.968	0.730	0.348	11.45
Spanish Brazil					
Year of Foundation	2,063	1958	40.81	1635	1997
Population (1872)	99	10,020	8,008	876	43,998
Number of black slaves (1872)	99	1,184	1,327	4	8,155
Number of slaves over total population (1872)	99	0.106	0.0665	0.000687	0.254
Quilombo[9]	2138	0.046	0.211	0	1
Population (2012)	2,136	24,104	82,365	807	1,862,000
GDP per capita (2012)	2,136	19,311	13,049	2,720	230,484
Gini coefficient (2010)	2,138	0.486	0.0747	0.284	0.808
Income Racial Imbalance (2010)	2,134	0.664	0.264	0.0424	8.110
Educational Racial Imbalance (2010)	2,033	2.671	1.716	0.217	31.25

The table shows Portuguese (east) and Spanish (west) Brazil divided by the Tordesillas line. The historiographical literature suggests that Portuguese South America received many more slaves than Spanish South America, which is confirmed by the table above.

4.3 Donatary Captaincies

Figure 1 shows the Donatary Captaincies (DCs) map, highlighting the current municipalities that existed in 1872. We replicated the map creating dummies for each DC by using ArcGIS tools.

The DC Espirito Santo employed the largest number of slaves in the colony (30% of the total) in 1872.. [10] The majority of black slaves were located in the mining region of the current Minas Gerais. Sao Tome and Santo Amaro - currently part of Rio de Janeiro and Sao Paulo states - had 23% of the black slaves reported by the census. At the end of the nineteenth century, this region had a flourishing coffee plantation. While the sugar cane region of Bahia and

[10] According to Klein and Luna (2010), there was internal slave trade in Brazil. Therefore, the 1872 census captures the picture at this point in time.

Pernambuco had 11% of the slaves, Maranhao (1 and 2) accounted for 12% of the black slaves [11].

Using seemingly unrelated regressions (SUR), Mattos et al. (2013) found that municipalities belonging to the area of the Donatary Captaincies are associated with higher land concentration - measured by the Gini coefficient - lower public expenditures in education and culture and lower political persistence. The identification strategy does not seem to take care of the endogeneity problem.

4.4 Dutch Brazil

The Dutch sent their first fleet to Brazil as early as 1599 (de Mello, 2010). In 1604 and again in 1624 they attacked the city of Salvador, the capital of colonial Brazil until 1763, under the auspices of the recently founded Dutch West India Company (WIC). Dutch merchants were interested in the commerce of Brazil wood and sugarcane. They were also important players in the slave trade, moving a total of more than half a million people from 1501 to 1866, mostly to the Caribbean and the Guianas (van Welie, 2008). Dutch Brazil or New Holland, was established officially in 1630 in the former captaincy of Pernambuco, one of the most important areas for sugar production in the world. The Dutch West India Company, set up its headquarters in the Brazilian city of Recife. The Dutch expanded their area of influence to the states of Ceará and Maranhao, and the Sao Francisco River. Dutch Brazil flourished during the governorship of Johan Maurits van Nassau, who founded several sugar mills and other infrastructure projects (Schwarcz, 2015). To set this industry in motion, the Dutch brought approximately 28,000 African slaves to Brazil. The number of slaves over the total population in Dutch Brazil was as high as 20 to 30% percent. Portuguese planters, who remained uneasy with Dutch rule, rebelled and finally captured Salvador in 1654. In the Treaty of The Hague (1661) the Dutch recognized the Portuguese imperial sovereignty over New Holland, officially putting an end to Dutch Brazil. Despite their relatively short presence, the Dutch deeply shaped ethos of Northeast Brazil.

Table 3 presents summary statistics for Dutch Brazil and its closer neighbors.

[11] See detailed table in the Annex.

Table 3: Dutch Brazil and Portuguese Brazil: Summary Statistics

	Dutch Brazil				
	N	Mean	SD	Min	Max
Year of Foundation	1025	1,934.8	63.7	1,537.0	1,997.0
Population (1872)	210	14,867.7	11,293.7	2,843.0	116,671.0
Number of Black Slaves (1872)	210	1,383.6	1,541.6	120.0	15,136.0
Number of Black Slaves over the total population (1872)	210	0.100	0.1	0	0.4
Income Inequality (2010)	1135	0.528	0	0.4	0.7
GDP per capita (2012)	1135	6,847.0	6,776.3	2,727.1	138,273.0
Population (2012)	1135	31,741.0	111,867.3	1,633.0	2,500,194.0
	Portuguese Brazil: 600 Km distance to the Dutch Brazil border				
	N	Mean	SD	Min	Max
Year of Foundation	741	1,945.3	65.3	1,534.0	1,997.0
Population (1872)	100	16,445.4	18,579.0	1,331.0	129,109.0
Number of Black Slaves (1872)	100	2,035.4	2,753.5	41.0	16,468.0
Number of Black Slaves over the total population (1872)	100	0.129	0.1	0	0.9
Income Inequality (2010)	799	0.546	0.1	0.4	0.8
GDP per capita (2012)	799	7,317.4	8,320.6	2,720.3	107,164.4
Population (2012)	799	28,188.0	103,624.3	1,236.0	2,710,968.0

5 Results

We present the results in three sections, regarding the Tordesillas line, Donatary Captaincies and Dutch Brazil, respectively.

Before detailing the specific identification strategy, we estimate OLS and state fixed effects for the overall dataset to capture broader correlations (see Annex). The results show a correlation of slavery - measured by the ratio of the number of slaves in 1872 over the total population - with current development outcomes (income inequality, GPD per capita, the income racial imbalance and education racial imbalance).

We find that a 1% increase in slaves by municipality in 1872 raises the Gini coefficient - which measures income inequality – by 0.130, estimated with state fixed effects, clustered by region and geographical controls. [12]

Slavery also negatively affects the income and education imbalances between black and white people. For each 1% increase in the number of black slaves, the

[12]The geographic variables used are longitude, latitude, rain, distance to the coast, altitude, distance to the federal capital, sunlight, average monthly temperature and types of soils.

average income of a black household in relation to a white household declines by 39.5%, while the average illiteracy rate of black households relative to white households can increase by 36.7%. Table 14 reports the OLS and municipality fixed effects results for the whole sample.

While the results show that inequality persists between the two groups, slavery is still positively associated with current GDP per capita, reflecting more aggregate data.

Table 4 shows the state fixed effects estimates for both Portuguese and Spanish Brazil. The first conclusion is that current income inequality is positively correlated to the proportion of slaves in the municipalities back in 1872 for both sides of the Tordesillas line. On the Portuguese side, the current income and education racial imbalance are also associated with slavery in the nineteenth century. For instance, with a 1% increase in the number of slaves in a given municipality in Portuguese Brazil, the income imbalance declines by 24.3% and the illiteracy rate (education imbalance) increases by 35.1%.

Table 4: Slavery and Development Outcomes: State Fixed Effects estimates for the Portuguese and the Spanish Brazil

Portuguese Brazil								
	GDP per capita		Income Inequality		Income Racial Imbalance		Education Racial Imbalance	
Number of slaves								
over total population (1872)	6,271	6,271	0.0663***	0.0663***	-0.243***	-0.243***	0.351*	0.351***
	(4,676)	(4,098)	(0.0134)	(0.0202)	(0.0535)	(0.0745)	(0.196)	(0.116)
Observations	2,819	2,819	2,819	2,819	2,819	2,819	2,813	2,813
R-squared	0.190	0.190	0.343	0.343	0.151	0.151	0.165	0.165
Region Cluster		✓		✓		✓		✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓	✓	✓
Spanish Brazil								
	GDP per capita		Income Inequality		Income Racial Imbalance		Education Racial Imbalance	
Number of slaves								
over total population	4,735	4,735	0.250***	0.250**	-0.316	-0.316	-1.601	-1.601*
	(10,293)	(7,354)	(0.0473)	(0.0689)	(0.228)	(0.139)	(1.431)	(0.670)
Observations	1,903	1,903	1,905	1,905	1,903	1,903	1,817	1,817
R-squared	0.121	0.121	0.471	0.471	0.078	0.078	0.116	0.116
Region Cluster		✓		✓		✓		✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows state fixed effects estimates for both Portuguese and Spanish Brazil divided by the Tordesillas line. The table shows a higher correlation of slavery - measured by the ratio of number of slaves in 1872 over the total population - with income inequality, the income racial imbalance and education racial imbalance on the Portuguese side, where slavery was in fact higher. Income inequality is positively associated with slavery for both sides of the Tordesillas line. We clustered by region (north, north-east, middle west, south-east, south), whereby the geographic variables used are longitude, latitude, rain, distance to the coast, altitude, distance to the federal capital, sunlight, average monthly temperature and types of soils. We also control for the foundation year of the municipality.

5.1 Tordesillas and Slavery

The empirical analysis of slavery often faces the problem of endogeneity. The use of early colonial territorial boundaries such as the Tordesillas line can isolate slavery from other confounders. The setup delivers a treatment assignment mechanism typical of a RD design. Treatment assignment depends on the running variable, namely municipalities' distance to the Tordesillas line. The idea behind the identification is that Portuguese Brazil received a much higher quantity of African slaves compared with Spanish Brazil.

The historiography describes that there was no consensus concerning where the Tordesillas line was supposed to precisely pass. We adopted the latest study available (Cintra, 2013), which establishes the line at the meridian $48^o42'$ west, while we use other meridians for the robustness check. To circumvent this problem, we also perform a Donut RD design (Barreca et. al., 2011). This approach deals with data heaps and can account for the problem of uncertainty about the actual colonial boundary. As the parameter for the interval around the Tordesillas line, we use the measure of 1^o, approximately 73 km. The Donut RD does not violate the condition that variation close to the treatment threshold is randomized. The estimation of the local linear regressions follows the bias-corrected inference procedure, which is robust with "large" bandwidth choices (Calonico, Cattaneo, and Titiunik, 2014). Local polynomial estimates are also presented.

Figure 2 shows the RD plots for the number of black slaves over the total population in 1872 using binned local averages. The first graph suggests that there were indeed more slaves in Portuguese relatively to Spanish Brazil. Figure 10 shows that there is no discontinuity for the number of free people in 1872, while there is for the number of black slaves. Figure 2 shows that there a discontinuity in income inequality - our main outcome variable - at the cut-off. Other outcome variables also have visual discontinuities (figure 10, such as GDP per capita, the income racial imbalance and education racial imbalance.

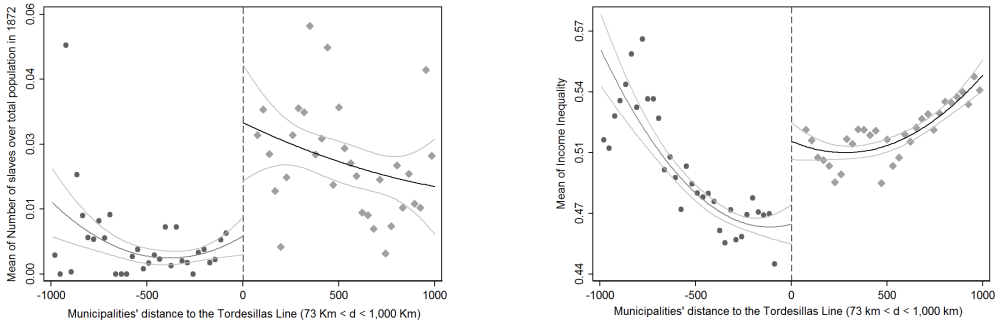
Figure 3 shows that observed pre-determined characteristics such as the geographical variables have similar distributions on both sides of the cut-off. The density of municipalities in the east and west side of the Tordesillas is also well distributed in 1872 and 2010 (figure 6). We test the observables, and we reject the possibility of not having randomization around the cutoff.

The RD estimates are presented in Tables 5 and 6. Table 5 exhibits the linear RD estimates, whereby the first column refers to estimates of the entire sample and the other four columns contain the results with restricted data. In the context of RD, we are interested in the variation around the cutoff. Therefore, we believe that there is not substantial reason to evaluate the influence of the Tordesillas line more than 1,000 km away from the line[13]. Nevertheless, we report the results for the whole sample as well[14]. Table 6 exhibits polynomial and local randomization estimates. For comparison, Table 15 reports the OLS and municipality fixed effects results for the interval 73 to 1,000 Km distance to the Tordesillas line.

[13]The maximum distance to the east of the line is 1,439.96 km

[14]Referred as "All" in the tables.

Figure 2: Donut RD plots: Tordesillas Line



(a) Outcome: Slavery (1872) (b) Outcome: Income Inequality (2010)

Both graphs show RD plots with the municipalities' distance to the Tordesillas line (greater than 73 km and less than 1,000 km) as the assignment variable. The left-hand side graph has as the outcome variable the number of black slaves over the total population in 1872. The procedure for selecting the number of bins is the mimicking variance evenly spaced method. The bins selected are 50 (left)/73 (right) and 76 (left)/66 (right) for the left and right figures.

We use the number of black slaves over the total population in 1872 as an outcome variable to verify whether there was indeed discontinuity at the cut-off, proving our assumption that there were more black slaves in Portuguese Brazil rather than Spanish Brazil. The second and the third columns of Table 5 show the Donut RD estimates of the average treatment effect of 1.75 to 3.3% of the total population. The second outcome variable is income inequality and all the specifications show positive and significant treatment effects. Considering the third column, the Donut RD estimates show that the Gini coefficient increases on average by 0.104. We test the other three outcome variables. Based upon the estimated coefficients, the proportion of the average income of black households in relation to white households (income racial imbalance) decreased by 9% in the presence of treatment.

The average treatment effect on the education racial imbalance differs in different data settings, whereby the size of the "hollow" in the Donut RD influences the result. Using the GDP per capita as the outcome variable, we find positive and statistically significant coefficients. The RD estimates are consistent with our findings using OLS and fixed effects estimates (see Table 14).

The last two columns of Table 6 exhibit the local randomization results. The idea behind this method is to approximate regression functions for control and treatment units locally. Treatment is randomly assigned within the windows selected, working as good as random. On the one hand, this method employs a small window, while on the other hand it uses randomization inference methods (Cattaneo, Frandsen and Titiunik, 2015).

We select the windows using the method based upon pre-determined covariates presented and the bandwidth is -250 on the left-hand side of the Tordesillas line and 187 on the right-hand side. The window that we consider in our estimation

is (-200, 200)[15]. We suppress 73 km from the left and right of the Tordesillas line in the fifth column to apply the same procedure of the Donut RD. The results are consistent with the linear sharp RD estimates in Table 5, albeit with lower magnitudes.

Overall, the results show that slavery causes income inequality, as well as causing a current income imbalance between black and white households. Municipalities where there were more slaves are still richer than more recent municipalities.

5.2 Donatary Captaincies and Slavery

To colonize Brazil, the Portuguese Crown put into place the Donatary Captaincies (DCs) system as the political and administrative organization of the colony.[16] The institution of DCs is tightly connected to the first imports of African slaves to Brazil, providing us a way to see how this institution operated on the ground.[17] The donataries enjoyed full authority under their territories and operated in relative independence from each other. Mattos et al. (2013) argue that DCs are associated with higher land inequality, lower public expenditures by the local governments and lower political persistence. Brazilian historiography has also linked this institution to land inequality in the country (Carvalho, 2015). Here we test whether idiosyncratic differences in the intensity of slavery in different Captaincies had an impact in the long run. Our results for the DCs mimic the ones for Tordesillas, whereby more slavery leads to higher levels of modern inequality.

In Brazil, the Portuguese Crown established seventeen[18] DCs between 1534-1536, which initiated in the coast and reached the Tordesillas line. The division of the DCs was mostly based upon natural borders such as rivers and river mouths in areas from 35 to 100 leagues. The main goal was to go beyond the early exploitation of brazilwood and move towards a more stable colonial productive system. Through a "Carta Foral", the The Portuguese Crown offered generous privileges to affluent Portuguese families, often personally connected King Dom Joao III. These entrepreneurs then had to raise funds to explore the new American colony. Their mandate included settlement and the development of new economic activities, most notably sugar. Indeed, the systematic production of sugar cane in Brazil only started after the establishment of the Donatary Captaincies in 1532. The first boat with African slaves arrived in the Captaincy of Bahia. Many captaincies failed and eventually reverted back to the Crown. The donatary system officially ended in 1821, one year prior to Brazil's independence, whereby

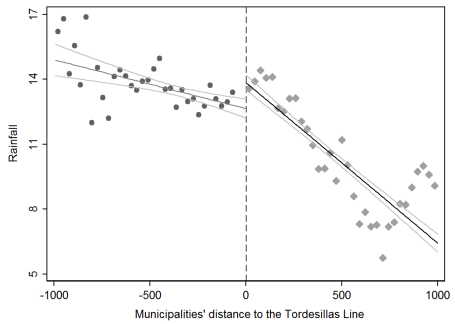
[15]The results are about the same when running the window with the same values of the bandwidths selected.

[16]The translation of "Capitanias Hereditarias" is Donatary Captaincy (DC), according Johnson (1972), and Proprietary Captaincy, according Klein and Luna (2010)

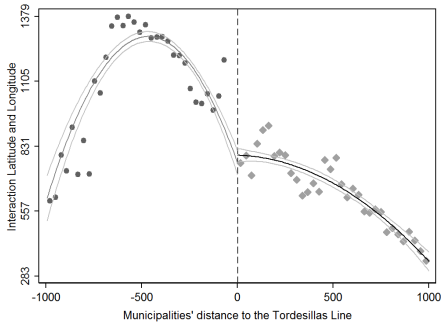
[17]In 1570, the DCs started to import African slaves due to the scarcity of indigenous labor and taking advantage of the high prices of sugar in the international markets (Klein and Luna, 2010).

[18]Two donataries received two DCs, namely Pero Lopes de Sousa and Martim Afonso de Sousa.

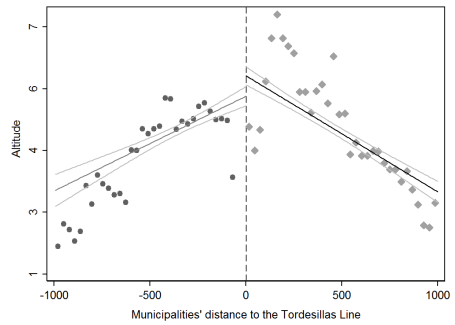
Figure 3: Donut RD plots for Covariate Variables: Tordesillas Line



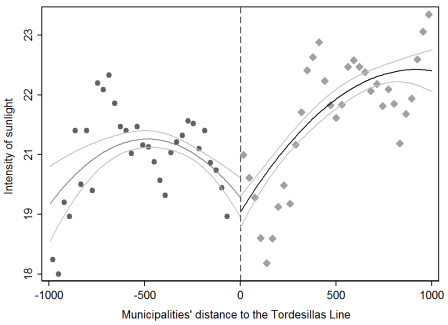
(a) Covariate: Rainfall



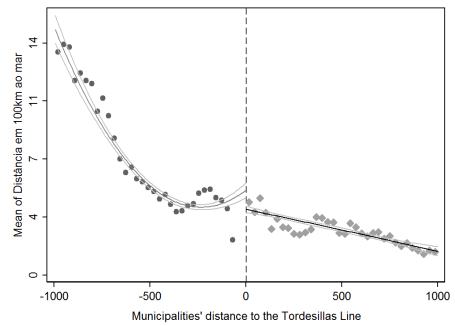
(b) Covariate: Interaction Latitude and Longitude



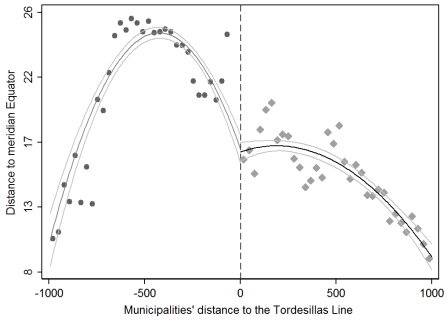
(c) Covariate: Altitude



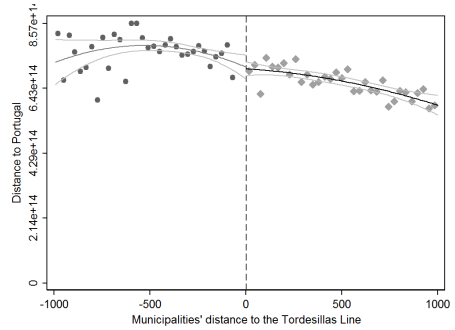
(d) Covariate: Sunlight



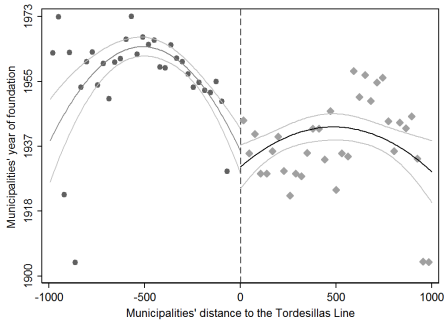
(e) Covariate: Distance to the coast



(f) Covariate: Distance to meridian Equator



(g) Covariate: Distance to Portugal



(h) Covariate: Year of Foundation

Table 5: Slavery, Income inequality and Tordesillas: Linear RD estimates

	Outcome Variable: Number of Slaves over Total Population (1872)				
	All	$73 < d < 500$	$73 < d < 1,000$	$110 < d < 1,000$	$d > 110$
Assignment variable:					
Distance to Tordesillas line	0.00334	0.0330**	0.0175**	0.00598	0.00419
	(0.00553)	(0.0138)	(0.00849)	(0.00824)	(0.01000)
Observations	1,640	1,218	2,173	2,129	1,775
	Outcome Variable: Income Inequality (2010)				
	All	$73 < d < 500$	$73 < d < 1,000$	$110 < d < 1,000$	$d > 110$
Assignment variable:					
Distance to Tordesillas line	0.0370***	0.104***	0.103***	0.0207**	0.0213*
	(0.00605)	(0.0239)	(0.0228)	(0.00979)	(0.0110)
Observations	2,636	762	790	2,138	1,897
	Outcome Variable: GDP per capita (2012)				
	All	$73 < d < 500$	$73 < d < 1,000$	$110 < d < 1,000$	$d > 110$
Assignment variable:					
Distance to Tordesillas line	2,406**	-18,992*	11,422***	13,843***	17,921***
	(1,223)	(10,266)	(3,042)	(3,828)	(4,698)
Observations	2,726	473	1,835	2,121	1,793
	Outcome Variable: Income Racial Imbalance (2010)				
	All	$73 < d < 500$	$73 < d < 1,000$	$110 < d < 1,000$	$d > 110$
Assignment variable:					
Distance to Tordesillas line	-0.0608**	-0.0889**	-0.0880***	-0.0916**	-0.101**
	(0.0250)	(0.0360)	(0.0310)	(0.0382)	(0.0410)
Observations	2,546	1,739	2,327	2,581	2,379
	Outcome Variable: Education Racial Imbalance (2010)				
	All	$73 < d < 500$	$73 < d < 1,000$	$110 < d < 1,000$	$d > 110$
Assignment variable:					
Distance to Tordesillas line	0.112	-0.711*	-0.128	0.325**	0.290**
	(0.148)	(0.373)	(0.196)	(0.161)	(0.132)
Observations	2,196	891	1,572	1,861	2,340

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows RD estimates for four outcome variables: number of slaves over the total population (1872), income inequality measured by the Gini coefficient (2010), average income of black households (2010) and average illiteracy rate of black households (2010). The assignment variable is the municipalities' distance to the Tordesillas line.

Table 6: Slavery, Income inequality and Tordesillas: Polynomial and Local Randomization RD estimates

	Polynomial			Local Randomization	
	Order 2	Order 4	Order 4		
	Outcome Variable: Number of Slaves over Total Population (1872)				
	$73 < d < 1,000$	$73 < d < 1,000$	$110 < d < 1,000$	All	$73 < d < 200$
Assignment variable:					
Distance to Tordesillas line	0.0109	0.0310	-0.00216	0.0161***	0.0210***
	(0.0119)	(0.0220)	(0.0304)		
Observations	3,325	4,072	3,872		
	Outcome Variable: Income Inequality (2010)				
	$73 < d < 1,000$	$73 < d < 1,000$	$110 < d < 1,000$	All	$73 < d < 200$
Assignment variable:					
Distance to Tordesillas line	0.134***	0.117***	0.0253	0.0349***	0.0384***
	(0.0244)	(0.0272)	(0.0350)		
Observations	1,872	4,022	3,872		
	Outcome Variable: GDP per capita (2012)				
	$73 < d < 1,000$	$73 < d < 1,000$	$110 < d < 1,000$	All	$73 < d < 200$
Assignment variable:					
Distance to Tordesillas line	12,073***	7,528	40,268***	1,417.3	3,546.9***
	(3,423)	(7,791)	(13,077)		
Observations	3,464	3,710	3,871		
	Outcome Variable: Income Racial Imbalance (2010)				
	$73 < d < 1,000$	$73 < d < 1,000$	$110 < d < 1,000$	All	$73 < d < 200$
Assignment variable:					
Distance to Tordesillas line	-0.0904**	-0.0834	-0.149	-0.0311**	-0.0375*
	(0.0378)	(0.0715)	(0.143)		
Observations	3,734	4,068	3,869		
	Outcome Variable: Education Racial Imbalance (2010)				
	$73 < d < 1,000$	$73 < d < 1,000$	$110 < d < 1,000$	All	$73 < d < 200$
Assignment variable:					
Distance to Tordesillas line	-0.123	-0.830	0.274	-0.1143*	-0.2002***
	(0.269)	(0.650)	(0.604)		
Observations	2,809	3,748	3,786		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows RD estimates for five outcome variables: number of slaves over the total population (1872), income inequality measured by the Gini coefficient (2010), GDP per capita (2012), average income of black households (2010) and average illiteracy rate of black households (2010). The assignment variable is the municipalities' distance to the Tordesillas line. For the first three columns, we use polynomial RD. The last column is the estimation using the local randomization approach and the estimates are robust bias-corrected (Cattaneo, Frandsen and Titiunik, 2015).

the majority of DCs became states. Despite their imperfect enforcement, the DCs provide some of the first territorial divisions of Brazil.

The Donatary Captancy system can be traced back to the Portuguese *sesmaria* system. This type of feudal agricultural arrangement in the Iberian peninsula itself goes back to Roman times (Johnson, 1972). Some of the first Donatary Captancies based on this seignorial tradition were implemented in the Azores Islands. The *sesmaria* system allowed the captain of the DC to grant someone of his choosing with full authority over a given piece of land. A grantee was supposed to improve the land within five years, otherwise he would lose his title. The grantees also had the right to sell their property. In the case of Brazil, the Portuguese Crown was more lenient regarding succession clauses, rents granted to the donatary and monopoly power to the grantees than in other Portuguese colonies.

We used the Regression Discontinuity approach for both the north and south borders of the Donatary Captaincies with the highest relative population of slaves in 1872 (Pernambuco, Sao Vicente, Bahia, Ilheus and Espirito Santo) to test our main hypothesis. Since few of those are neighboring Captaincies, we will test for discontinuity only the borders to the others Captaincies. They are the northern borders of Pernambuco and Espirito Santo e the southern borders of Sao Vicente and Ilheus Donatary Captaincies.

For each border, we calculated the distances of municipalities to the respective border. We also used a Donut RD specification for similar reasons why we did it in the Tordesillas specification. In this case, we used half degree, which is equivalent of 36.5 Km. Results are presented in Table 7.

5.3 Dutch Brazil and Colonizer Identity

One important confounder of the slavery effect could be colonizer identity. A large literature in economics has explored this issue since the seminal papers of La Porta et al. (1997 and 1998)[19]. In the case of Brazil, Portuguese and Spanish conquerors might have differed not only in the intensity of their slave regimes, but also in other factors such as language and culture. To test the possible role of colonizer identity, we use the Dutch colonization of Brazil as a historical experiment. The Dutch presumably were more different culturally from the Portuguese than the Spanish, yet they were important players in the commerce of slaves, bringing a large quantity of them into Brazil.[20]

For our analysis, we digitized the map from Hettema Jr.'s (1920) book on Dutch Brazil. As can be seen in Figure 1, municipalities that were colonized by the Dutch all lie to the right of the Tordesillas line and are then surrounded by those originally colonized by the Portuguese. The territory is large, covering today 1,135 municipalities from nine states.

[19]For a summary of this literature see La Porta et al. (2008) and Easterly and Levine (2016) for a recent application.

[20]As a matter of fact, the Portuguese and Spanish crowns were temporarily merged during the Iberian Union from 1580 to 1640.

Table 7: Slavery, Income inequality and Donatary Captaincies: Linear RD estimates

RD estimates	Number of Black slaves/ Total Population (1872)	Income Inequality (2010)	GDP per capita (2012)	Income racial gap (2010)	Education racial gap (2010)
Pernambuco (North)	-0.0153	0.000308	-3,160	0.0214	0.0556
	(0.0138)	(0.0138)	(2,788)	(0.0823)	(0.105)
Observations	536	442	821	462	683
Sao Vicente (South)	0.0863***	-0.0202	26,909***	0.00213	0.570
	(0.0325)	(0.0223)	(7,709)	(0.0797)	(0.498)
Observations	247	490	323	306	237
Espirito Santo (North)	0.000534	0.0715*	9,514**	-0.00321	-0.236
	(0.0150)	(0.0399)	(3,924)	(0.0640)	(0.263)
Observations	317	105	277	333	279
Ilheus (South)	-0.0153	-0.0242	-1,721	0.0633	-0.346
	(0.0139)	(0.0264)	(3,018)	(0.128)	(0.362)
Observations	271	138	108	149	96

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

This table shows the RD estimates of the northern borders of Pernambuco and Espirito Santo e the southern borders of Sao Vicente and Ilheus Donatary Captaincies. Those borders were chosen because they have the highest probability of having discontinuity in the concentration of slaves and present day inequalities

For our Regression Discontinuity analysis, we compared the Dutch Brazil area with the area up to 600 Km away from the Dutch Brazil's border. The number of black slaves over the total population in municipalities located in the area occupied by the Dutch until 1649 is 22.6% lower than the municipalities located 600 Km away of the Dutch Brazil border. The number of slaves in 1872 (1,384) is 32% lower and inequality today is 3.2% lower in the Dutch Brazil.

To test our hypothesis empirically we conduct a geographic Regression Discontinuity. As can be seen in Table 8, first we do not find a significant discontinuity between the former Dutch and the former Portuguese territories. Carrying forward with the analysis, we do not find a corresponding jump in income inequality or the income racial gap. We do not find a discontinuity in the GDP per capita or in the education racial gap, our main channel of interest. Overall, the results for Dutch Brazil are suggestive that what mattered for subsequent distributions of income was slavery, more than colonizer identity per se. And since the Dutch had very similar slavery regimes than the Portuguese, it is not surprising to find similar levels of inequality in the long run.

Table 8: Slavery, Income inequality and Dutch Brazil: Linear RD estimates

	Linear		Polynomial		Local Randomization
	Order 1	Order 1	Order 2	Order 4	
	Number of Slaves over Total Population (1872)				
	$d < 600$	$d < 200$	$d < 600$	$d < 600$	
Assignment variable:					
Distance to Dutch Brazil's border	0.0378	-0.139	-0.0521	-0.0932	-0.004
	(0.0444)	(0.110)	(0.0786)	(0.0933)	
Observations	119	29	97	183	
	Outcome Variable: Income Inequality (2010)				
	$d < 600$	$d < 200$	$d < 600$	$d < 600$	
Assignment variable:					
Distance to Dutch Brazil's border	-0.0161*	-0.0253	-0.0119	-0.0103	-0.001
	(-0.0090)	(0.0184)	(0.0133)	(0.0159)	
Observations	558	179	613	1,201	
	Outcome Variable: GDP per capita (2012)				
	$d < 600$	$d < 300$	$d < 600$	$d < 600$	
Assignment variable:					
Distance to Dutch Brazil's border	-530.9	-749.2	-1,049	-2,337*	-87.819
	(-874.9)	(1,384)	(1,013)	(1,244)	
Observations	304	143	525	1,092	
	Outcome Variable: Income Racial Imbalance (2010)				
	$d < 600$	$d < 300$	$d < 600$	$d < 600$	
Assignment variable:					
Distance to Dutch Brazil's border	0.00214	0.0554	0.0173	0.0559	0.040**
	(-0.0318)	(0.0589)	(0.0439)	(0.0665)	
Observations	685	203	776	956	
	Outcome Variable: Education Racial Imbalance (2010)				
	$d < 600$	$d < 300$	$d < 600$	$d < 600$	
Assignment variable:					
Distance to Dutch Brazil's border	-0.125	-0.194	-0.117	-0.0724	0.029
	(-0.0801)	(0.122)	(0.0949)	(0.129)	
Observations	506	185	700	1,006	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows RD estimates for five outcome variables: number of slaves over the total population (1872), income inequality measured by the Gini coefficient (2010), GDP per capita (2012), average income of black households (2010) and average illiteracy rate of black households (2010). The assignment variable is the municipalities' distance to the border of Dutch Brazil.

6 Channels of persistence

Our empirical results prove a causal relationship between the institution of slavery in the colonial period and the current income inequality in Brazil. In this section, we explore the main channels through which we find the persistence of inequality originated in a slavery economy and society.

6.1 The persistence of the income racial imbalance

Our analysis shows that slavery not only causes income inequality between rich and poor but also between white and black households. We present the RD and IV estimates in figures 5 and 10, showing that on average black households have a lower income than white households as a result of slavery. The RD parametric estimates a discontinuity of -9% on average. Furthermore, the local randomization estimates a treatment effect of -3.11 to -3.75%. The IV methodology shows that slavery reduces the ratio black household income over white household income from 51.6% to 95.2%, thus increasing the income racial imbalance.

6.2 The persistence of the education racial imbalance

The illiteracy rate of black households is on average 2.2 times higher than for white households. In Spanish Brazil, this average is 1.97, while in Portuguese Brazil it is 2.67. The lower this relationship is, the more equal the literacy rate of black and white people would be. The estimates regarding this education imbalance are not as conclusive as we find for the income racial imbalance. For the linear RD estimates, when the "hollow" of the Donut RD is 73 km, the results suggest that the education imbalance declines when the slavery in 1872 increases. However, the imbalance increases when the "hollow" is 110 km.

Table 9 and Figure 12 present the estimates for the ratio of black over white children between 7-14 years old who are out of school. The treatment effect estimate is 3.511 for the full sample and 6.819 for the RD Donut estimates. Given that the average ratio of the sample is 3.099, this data suggests that access to education remains an issue for guaranteeing equal opportunities for black people in Brazil.

6.3 The persistence through public institutions

Based upon the available data, we believe that public policies can contribute to the persistence of inequality by either not delivering public services or not managing it well. Table 9 and Figure 12 exhibit that the treatment effect on institutional capacity[21] is negative and statistically significant for the entire sample.

[21]This variable is an index created by the Ministry of Planning from Brazil that balances participation, financial and managerial capacity of the municipality.

At the same time, we observe that municipalities that experienced more slavery are associated with fewer human rights policies in place, including those against racism.

Table 9: RD estimates: channels of persistence

	Outcome variables					
	Human Rights Policies		Children out of school		Institutional Capacity	
	All	73 km < d ¡ 1,000 km	All	73 km < d < 1,000 km	All	73 km < *d* ¡ 1,000 km
Assignment variable:						
Distance to Tordesillas line	-0.986***	-0.607*	3.511***	6.819***	-0.808***	0.160
	(0.354)	(0.367)	(0.415)	(2.264)	(0.154)	(0.115)
Observations	1,744	1,897	885	432	1,127	2,182
	Inequality of land distribution		Child labor Racial Imbalance		Health Centers	
	All	73 km < d ¡ 1,000 km	All	73 km < d < 1,000 km	All	73 km < *d* ¡ 1,000 km
Assignment variable:						
Distance to Tordesillas line	0.0513**	0.138***	-0.294	-0.376	-2.051***	-3.142***
	(0.0219)	(0.0488)	(0.226)	(0.295)	(0.538)	(0.967)
Observations	859	549	2,139	1,513	(0.538)	(0.967)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows RD estimates for variables that can be transmission mechanisms of the causal relationship between slavery in the nineteenth century and income inequality today. The assignment variable is the municipalities' distance to Dutch Brazil's border. All estimates are in the linear RDs.

We did not find significant results with the data publicly available in labor institutions that are correlated with inequality. Overall, these channels are endogenous but suggest evidence of how inequality is intergenerationally transmitted.

7 Robustness checks

7.1 Testing other meridian for the Tordesillas line

We described in section 2 that there were different Tordesillas lines calculated after the Portuguese and Spanish Crowns agreement. We tested a further east meridian $45^o17'$ west calculated by the cartographer Oviedo (see figure 4). Table 10 shows the RD estimates of two outcome variables (slavery and income inequality) using the distance to Oviedo's meridian as the assignment variable. We replicate the methodologies used in Section 5.

Table 10 has two columns of linear RD estimates, followed by two polynomial RDs of orders 2 and 4 and finally the randomization inference estimates. While the coefficients confirm a positive and significant treatment effect of the number of slaves over the total population, they have a smaller magnitude. While the randomization inference estimate in Section 5 was 0.0161 with windows (-200,

200) and 0.0234 with windows (-500, 500)[22], when we apply the new assignment variable using the same randomization rule, statistic and window (-500, 500), the treatment effect reduces to 0.0087. The result for the old specification would be 0.0349. The same phenomenon emerges with income inequality: while the treatment effects in the section 5 were 0.0349 with windows (-200, 200) and 0.0362 with windows (-500, 500), the estimate of the new specification is 0.0240.

Replicating the empirical analysis for a different, more eastwards meridian confirm our main results. The covariates do not present discontinuity in the cut-off.

Table 10: Slavery, Income inequality and Tordesillas ($46^o37'$): Linear, Polynomial and Local Randomization RD estimates

	Linear		Polynomial		Local Randomization
			Order 2	Order 4	
	Outcome Variable: Number of Slaves over Total Population (1872)				
	All	$73 < d < 1,000$	$73 < d < 1,000$	$73 < d < 1,000$	All
Assignment variable:					
Distance to Tordesillas line	0.00955	0.0131	0.0130	0.0427*	0.0087***
	(0.00803)	(0.0100)	(0.0115)	(0.0236)	
Observations	2,100	2,030	4,009	4,608	
	Outcome Variable: Income Inequality (2010)				
	All	$73 < d < 1,000$	$73 < d < 1,000$	$73 < d < 1,000$	All
Assignment variable:					
Distance to Tordesillas line	0.0147*	0.0410	0.0508***	0.0987***	0.0240***
	(0.00875)	(0.0256)	(0.0180)	(0.0245)	
Observations	1,183	633	2,383	4,608	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows RD estimates for two variables outcome variables: the number of slaves over the total population (1872) and income inequality measured by the Gini coefficient (2010). The assignment variable is the municipalities' distance to Dutch Brazil's border. In the first two columns, we use linear RD followed by the other two polynomial RD estimates. The last column is the estimation using the local randomization approach and the estimates are robust bias-corrected (Cattaneo, Frandsen and Titiunik, 2015).

8 Conclusions

This paper exploits discontinuities of the Tordesillas line pre-dating the discovery of Brazil to show the impact of colonial slavery on modern-day inequality. Previous research has shown a correlation between slavery and modern levels of inequality. But to the best of our knowledge, a rigorous empirical test of the Engerman and Sokoloff hypothesis was lacking. And so was a serious scrutiny of the role of slavery for Brazilian underdevelopment.

[22]We did not report this data in the previous data, although we recorded several estimations in parallel.

Here we use an RDD, where the assignment variable is the municipalities' distance to the Tordesillas line. We demonstrate that the number of black slaves over the total population in 1872 was larger on the Portuguese side of the Tordesillas line compared with the Spanish side. Applying a Donut RD design, we find that the treatment effect on income inequality is 0.103, which corresponds to 20.7% of the average income inequality measure of our sample. Using a local randomization inference approach, the treatment effect is 0.0384, which represents 7.6% of the sample average.

The main channels of persistence that we find are the income racial imbalance, education racial imbalance and public institutions. We show that on average black households have a lower income than white households as a result of slavery. Access to school seems to more strongly favor white rather than black children around the cut-off. The treatment effect on institutional capacity is negative.

While the theme of inequality has gained increased attention in the academic literature, these findings can hold interest within the academic community through proving that slavery causes inequality. This is key for academics to understand the key determinants of inequality and development and policy-makers to design appropriate policies that promote equality of opportunities.

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Annex

Description of the variables

1. **Slavery** The main variable used is number of black slaves over total population measured by the Imperial census of 1872. The data sources is IBGE, 2011.

2. **Income inequality** Gini index of household income per capita. Source: Census 1991, 2000 and 2010, IBGE (www.ibge.gov.br).

3. **GDP per capita** Municipal GDP divided by estimated population in 2012. Source: IBGE (www.ibge.gov.br).

4. **Income racial imbalance** The ratio average black household income over average white household income. Source: Census 1991, 2000 and 2010, IBGE (www.ibge.gov.br).

5. **Education racial imbalance** The ratio average illiteracy rate of black households over average illiteracy rate of white household income. Source: Census 1991, 2000 and 2010, IBGE (www.ibge.gov.br).

6. **Distance to the Tordesillas line** Municipalities' (center of the city) distance to the Tordesillas line in Km. We calculated this distance using ArcGis.

7. **Donatary Capitaincies** Dummy generated for municipalities located withing each of the seventeen Donatary Capitaincies. We generated this variable using ArcGis and based on the paper of Cintra (2013).

8. **Donatary Capitaincies Index**[23] The DC Index is equal to zero if the municipality did not belong to any DC. The DC Index will be closer to one the larger the difference between its year of foundation and the newest-founded municipality in the region. The idea is to capture a greater influence of the DC in older regions.

9. **Quilombo** Data produced by INCRA (National Institute of Colonization and Land Reform), available at acervofundiario.incra.gov.br.

10. **Geographical variables**[24]

    - *Rainfall* The average quantity of water precipitation in each municipality for the period of 1931-1990, expressed in 100 millimeters per year, obtained from the National Institute of Geology (INGEO).

[23] We thank Mattos et. al. (2012) for sharing this variable with us.

[24] We thank Naritomi et. all. (2012) for sharing those variables with us. The variables' descriptions are consistent with their original paper.

- *Altitude* The average altitude of each municipality, reported in the "Cadastro de cidades e vilas" published by the Brazilian Census Bureau in 1998.
- *Distance to the coast* Distance (in kilometers) from the municipality center to the Brazilian coast, calculated by the Federal University of Rio de Janeiro (UFRJ).
- *Distance to Portugal* Absolute value of the latitude coordinate of each municipality center, obtained from the National Institute of Geology (INGEO).
- *Interaction Latitude and Longitude* Interaction of latitude and longitude of the municipalities.
- *Sunlight* The average quantity of water precipitation in each municipality for the period of 1931-1990, expressed in 100 millimeters per year, obtained from the National Institute of Geology (INGEO).
- *Distance to meridian Equator* Absolute value of the latitude coordinate of each municipality center, obtained from the National Institute of Geology (INGEO).
- *Temperature* A set of 12 variables indicating the average monthly temperatures (degrees Celsius) in each municipality, obtained from the Brazilian Agricultural Research Institute (EMBRAPA). We use only the months of June and December in our controls.
- *Region* A set of 5 dummy variables indicating the Brazilian macroregions: North, Northeast, Central-West, Southeast and South. We use this variable as a cluster the standard errors.

11. **Year of Foundation** The year of the municipality foundation reported by the Municipal Information System, considering the year 2000 as reference.

12. **Sewage collection** Percentage of households with toilet connected to the public sewage system; calculated in 2000, from the National System of Urban Indicators (Brazilian Ministry of Cities)(Naritomi et. all., 2012).

13. **Public spending on education and culture** Natural logarithm of per capita municipal spending on education and culture; calculated in 2000, from the National System of Urban Indicators (Brazilian Ministry of Cities) (Naritomi et. all., 2012).

14. **Health centers** Number of health centers per 10,000 inhabitants; calculated in 2000, from the National System of Urban Indicators (Brazilian Ministry of Cities) (Naritomi et. all., 2012).

15. **Public institutions** Simple average of four qualitative indicators, normalized from 1 to 6: the year in which the database of the tax on urban property ("IPTU") was updated, the IPTU payment rate in 1999, the number of administrative instruments, and the number of planning instruments;

from the Brazilian Census Bureau; calculated using data between 1997 and 2000. Source: Ministry of Planning.

16. **Unemployment racial imbalance** The ratio average unemployment rate of black households over average unemployment rate of white household income. Source: Census 1991, 2000 and 2010, IBGE (www.ibge.gov.br).

17. **Child labor racial imbalance** The ratio average child labor rate (% of 10-15 years old children working) of black households over average child labor rate of white household income. Source: Census 1991, 2000 and 2010, IBGE (www.ibge.gov.br).

18. **Existence of Human Rights policies** Municipal Profile (Perfil Municipal), 2014, IBGE (www.ibge.gov.br).

19. **Inequality of land distribution** Gini coefficient of the land distribution, constructed with data from the 1996 Brazilian Agricultural Census.

History of Dutch Brazil

The Dutch invaded the second richest region of Brazil – Pernambuco - and installed there from 1531 to 1651. The Dutch occupation negatively affected the colonial economy because they started competing in the international sugar cane market and drove the slave prices up (Klein and Luna, 2010).

The Netherlands were at war against Spain from 1568 to 1648. Both countries disputed maritime supremacy. Portugal and the Netherlands were trade partners. In 1580 the Spanish Habsburg Crown incorporated Portugal after the death of Dom Sebastiao in the north of Africa. Until 1640, the Portuguese empire became a target for the Dutch as well.

In 1604 the Netherlands attacked Salvador, the center of Colonial Brazil, counting with a potential collaboration of the Portuguese. The endeavour failed. Between 1609 and 1621 Habsburg rulers of Spain, the Southern Netherlands and the Dutch Republic ceased their mutual hostilities. The Twelve Years' Truce ended in the same year that the Dutch West India Company (WIC), a chartered company of merchants, was launched. The WIC secured trade monopoly in the Caribbean and the jurisdiction over the Atlantic slave trade in the Americas.

The WIC attacked Salvador again in 1624 for 24 hours. In 1628, the maritime fleet led by Piet Heyn attacked Salvador twice, stealing boats loaded with local products. The captain also stole a Spanish fleet loaded with Silver in Cuba, raising 8 million florins that paid dividends for the shareholders and also financed a new project in Brazil: the invasion of the DC of Pernambuco and neighboring areas of Itamaraca, Paraiba and Rio Grande do Norte (de Mello, 2010; Schwarcz, 2015). The Dutch had many reasons to attack Brazil (de Mello, 2010). First, the Portuguese America was the fragile bond of the Spanish Crown. Second, the opportunity to make considerable profits exploring both brazilwood and sugar cane. The WIC calculated an investment of 2.5 million florins to conquer Pernambuco and a return of 8 million florins per year (or 77 tons of gold). Third, the population in Brazil was based on the coast making it easier and cheaper to conquer than the Spanish colonies located in the altiplanos. Finally, Brazil was an excellent operation base to fight against the Spanish fleets in the Caribbean and the Portuguese in the Orient.

The Pernambuco area in 1630 was the most important area for sugar cane production in the world. The region produced 659 thousands tons of sugar. There were 160 sugar cane mills in operation (de Mello, 2010). Pernambuco was the first DC to have sugar cane plantation in 1535.

The 67 ships transporting seven thousand men of the WIC left the Netherlands in 1629 and arrived in February 1630. Until 1637, the Dutch expanded their area of influence between Ceara and Sao Francisco River. The Dutch colonization in the Brazilian Northeast lasted until 1654, and the Dutch West India Company (WIC) installed their headquarters in Recife.

The most prosperous period of the Dutch Brazil period was between 1637 and 1644, when John Maurice of Nassau acted as governor. When Nassau arrived in Pernambuco, he found several sugar cane mills destroyed, a debilitated economy

and unsatisfied population with the Dutch command (Schwarcz, 2015). Nassau sold the abandoned sugar cane mills and provided loans for the buyers, reestablished the slave trade, guaranteed credit for the purchase of new machinery in the sugar cane mills, incentivized farmers to grow manioc to fight the lack of food in the region. The Calvinist governor also promoted religious freedom and invited artists and scientists to the colony to help promote Brazil and increase immigration.

Nassau also substantially improved the infrastructure of Recife that had an estimated population of seven thousand inhabitants. He built new public buildings, bridges, channels and gardens in the then Dutch style. Nassau invested in sanitation. He established representative councils in the colony for local government, and developed Recife's transportation infrastructure. The governor prohibited the citizens to throw garbage in the streets or throw sugarcane bagasse in lakes and rivers that prevented the procreation of fishes (Schwarcz, 2015).

The local population used to refer to Nassau as "the Brazilian", evidencing his popularity. But the Board of the WIC argued that he was overspending and requested his return to Holland in 1644.

The Dutch Brazil decayed after the departure of Nassau. By 1648 and 1649, the Portuguese, indigenous people and slaves joined forces to fight against the Dutch. They were defeated in Guararapes, 10 Km south of Recife. There are historians who call this war the "ground zero" of Brasil because the war involved a "racial mix". The Dutch controlled Recife until 1654, when the Portuguese took over the city. The conflict between Portugal and the Dutch Republic finally ended in 1661 when both parties signed the Treaty of Hague.

Quilombos

Quilombos are hinterland settlements of escaped slaves created during the slavery period in Brazil. The first quilombos are dated from the sixteenth century and they are typically a "pre-nineteenth century phenomenon" (Anderson, 1996). The slaves runway occurred individually or in groups. The idea of "quilombo" comes from Angola, meaning a fortified and armed settlement populated by warriors.

Quilombos are interpreted as slaves' resistance, along with attempts to seize power and armed insurrections. During the abolitionist campaign in the nineteenth century, the slave runways increased. They tended to look for places with difficult access and further distance from cities and farms. The quilombos used to exchange goods with other communities or even cities, which was very common in Minas Gerais during the gold period.

The quilombolas - the name of the people who lived in the quilombo - lived upon agriculture. The good relationship with their neighbors was crucial for a quilombo, since they lived in an "underground world" (Schwarcz, 2015). Other quilombos also chose to fund themselves by looting farms.

The largest quilombo existed in the current state of Alagoas and was called Palmares, housing about 20,000 inhabitants in 1660. It largest area - "Cerca Real do Macaco" - alone had 6,000 inhabitants, while Rio de Janeiro had 6,000 people. The Portuguese Crown unsuccessfully attacked quilombo Palmares on several occasions. During the Dutch Brazil era, the WIC also twice unsuccessfully attacked Palmares. Indeed, it was only in 1695 that the Portuguese defeated its main leader.

However, 510 quilombos in 24 states remained active. At present, 510 municipalities have quilombola communities and the central government has special programs targeting those communities.

Propensity Score Matching

As a robustness check, we will analyze the long-lasting effects of the quilombos using the propensity score matching to reduce omitted variables bias. The main assumption is that the only source of omitted variables or selection bias is the set of observed covariates, X_i. We construct the treatment effects (D_i) by matching municipalities with the same covariates rather than through a linear model for the effect of covariates, such as year of foundation and geographical variables (rainfall, altitude, longitude and latitude, distance to the state capital).

$$E[Y_{1i} - Y_{0i}] = E\{E[Y_{1i}|X_i, D_i = 1] - E[Y_{0i}|X_i, D_i = 0]\} \tag{2}$$

ATET or ATE are constructed by averaging X_i specific treatment and control contrasts and subsequently re-weighting these contrasts by the distribution of X_i for the treated (for ATET) or by the marginal distribution of X_i (ATE). The ATE is the average over the entire population of the individual treatment effects, while the ATET is the average over the sub-population of treated municipalities

of the treatment effect. In other words, the ATE is the average of the slope over the entire number of municipalities and the ATET is the average of the slope over the subset of the treated municipalities.

We maintain the unconfoundedness assumption. The outcome variables $(Y_t i))$ are the same ones that Weuse in prior tests, namely income inequality, GDP per capita, the income racial imbalance and education racial imbalance.

Quilombos and heterogeneity

The quilombos started to be created in colonial times, whereas today there are many officially recognized quilombos[25] in 510 municipalities spread across Brazil.

For our empirical purposes, we use quilombo to identify municipalities that have a greater persistence of slavery institutions. In the absence of random assignment, we use the propensity score matching methodology to find similar observable characteristics of non-treated municipalities. As a result, the municipalities matched by a propensity score are a credible counterfactual for our analysis[26].

In table 11, we report the values for each estimation of the differences between the treated and untreated groups, average treatment effects (ATEs) and average treatment effects on the treated (ATETs) using a logit model.

We test four outcome variables: income inequality, GDP per capita, the income racial imbalance and education racial imbalance. The effect of long-term slavery increases the outcome variables in different magnitudes. Income inequality increases in the treated municipalities from 0.022 to 0.029. This is a similar coefficient as presented in the prior robustness check (figure 10). The treatment effect on GPD per capita and the education racial imbalance are negative and significant.

[25]In 2003, the government even expanded the legal definition of "quilombo," issuing a presidential decree that categorized quilombo descendants as an ethnicity. The Brazilian law ensures people the right to define their own ethnicity for the purposes of social policy. Since 2003, the number of quilombos has dramatically increased.

[26]See Annex for more information about the methodology.

Table 11: Propensity Score Matching: Quilombos

	Income Inequality	GDP per capita	Income Racial Imbalance	Education Racial Imbalance
OLS (Treated)	0.0252***	-2,287.97**	-0.0138	-0.1591***
	(0.0029)	(811.42)	(0.0113)	(0.0604)
Common				
Support (ATT)	0.0272***	-2,840.90*	0.0185	-0.1937***
	(0.0037)	(1416.35)	(0.0128)	(0.0518)
ATET	0.0272***	-2,840.90**	0.0185	-0.1937***
	(0.0036)	(1443.06)	(0.0127)	(0.0487)
ATE				
(Augmented IPW)	0.0291***	-3,164.71**	0.0080	-0.2910***
	(0.0029)	(1271.56)	(0.0123)	(0.0431)
ATE				
(Nearest-neighbor Matching)	0.0222***	-3195.45**	0.0036	-0.2407***
	(0.0034)	(1278.67)	(0.0206)	(0.0515)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table reports the propensity scores matching estimates of the differences between treatment and control groups, average treatment effects (ATEs) and average treatment effects on the treated (ATETs) using a logit model.

Maps

Figure 4: Early Tordesillas lines

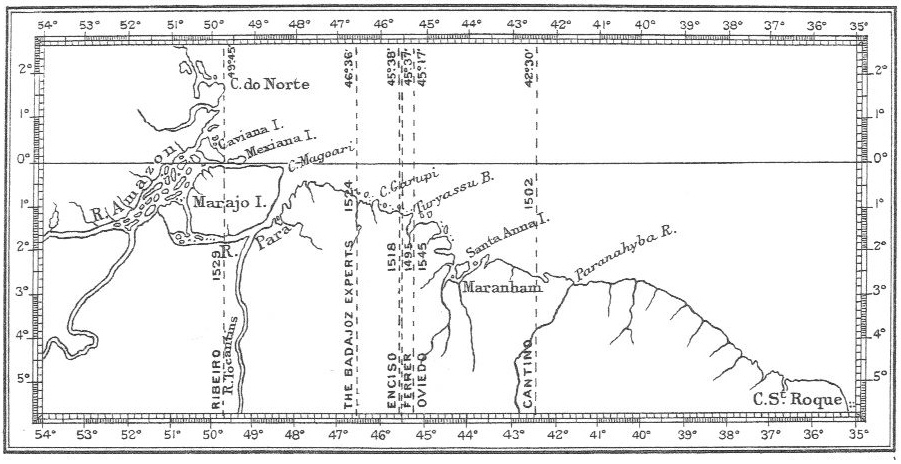
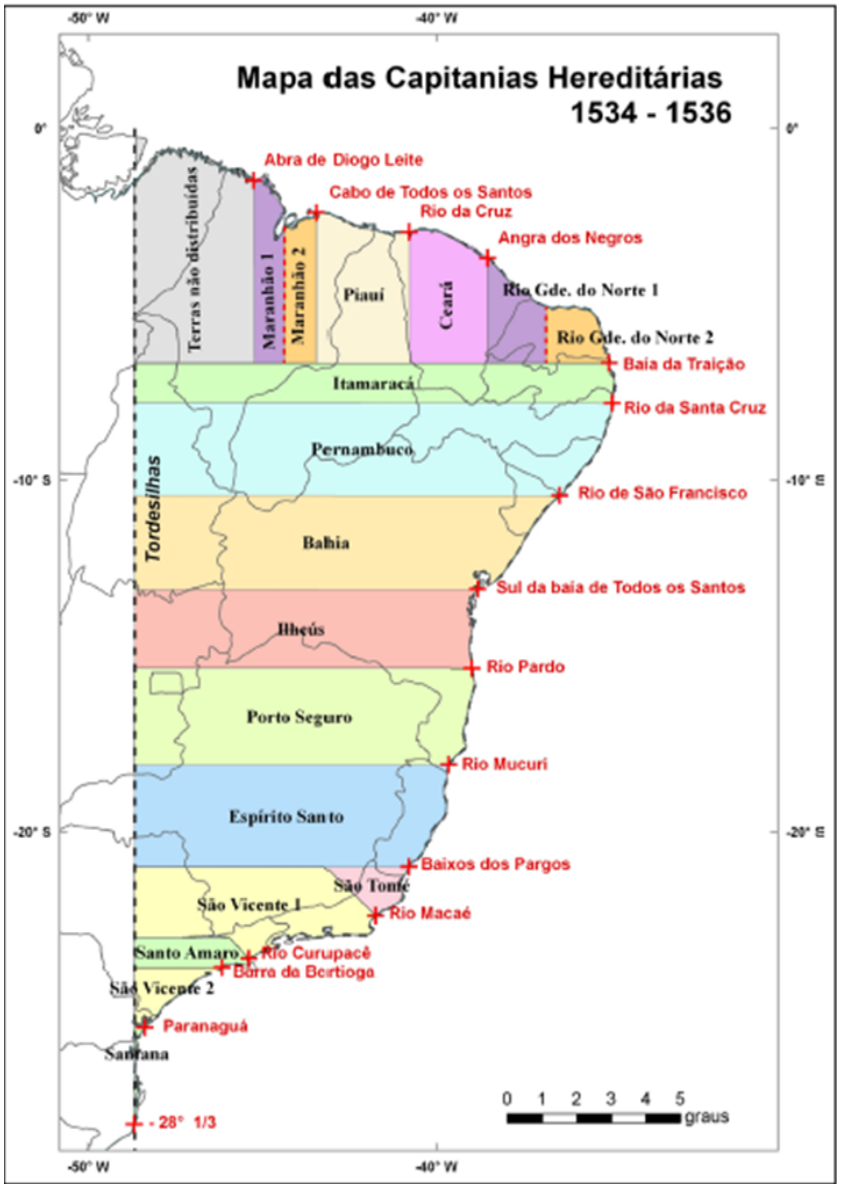


Figure 5: Donatary Captaincies: Portugaliae Monumenta Cartographica (1586)

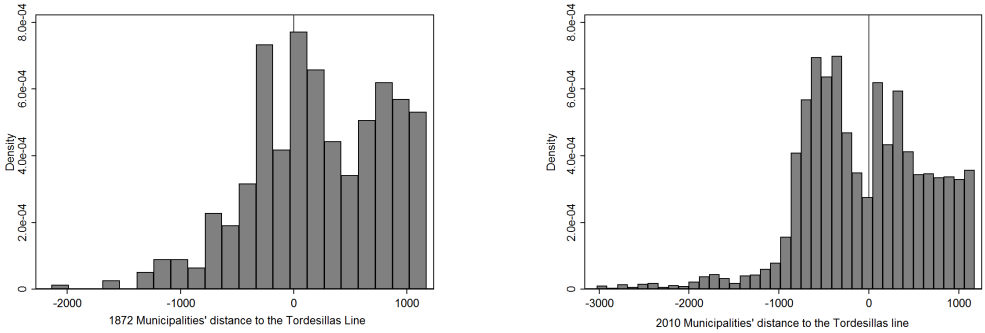


Figure 6: Donatary Captaincies: Cintra(2013)



Graphs

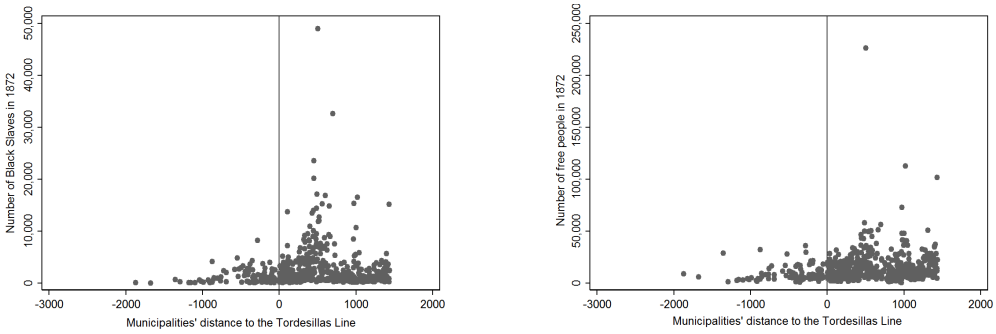
Figure 7: Municipalities' distance to the Tordesillas line: 1872 and 2010



(a) 1a (b) 1b

Figure 8: Number of free and black slave population (Tordesillas Line)

(a) Number of black slaves in 1872 and Mu-(b) Number of Free people and Municipalinicipalities' distance to the Tordesillas Lineties' distance to the Tordesillas Line



(c) Tordesillas line: Municipalities by state

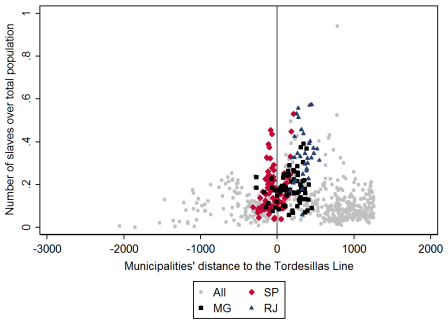
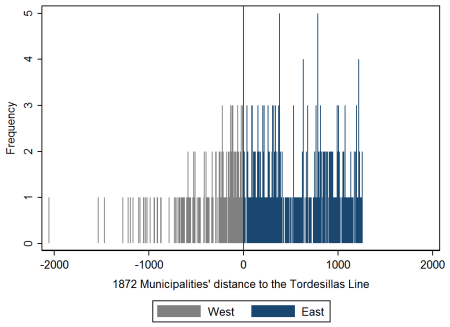
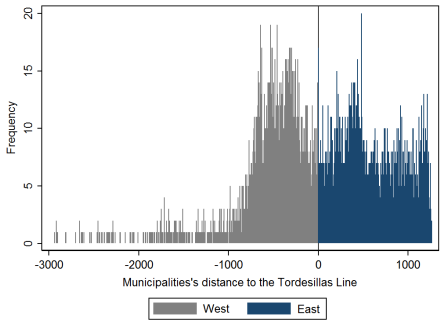


Figure 9: Frequency of the Municipalities' distance to the Tordesillas Line: 1872 and 2010

(a) Frequency of the Municipalities' distance to the Tordesillas Line: 1872



(b) Frequency of the Municipalities' distance to the Tordesillas Line: 2010



(c) Kernel Density of the Municipalities' distance to the Tordesillas Line

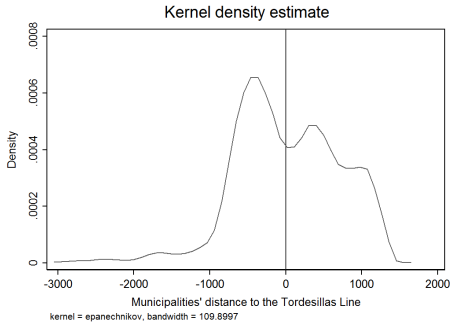
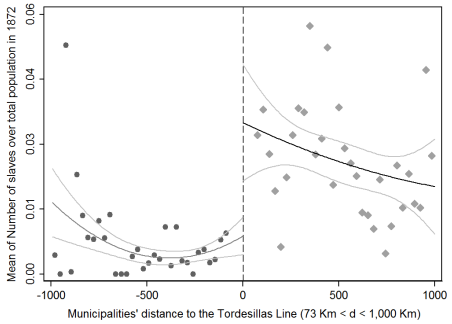
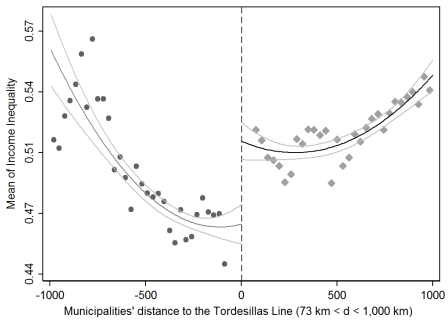


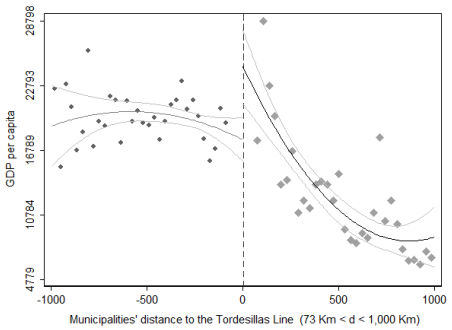
Figure 10: Donut RD plots for Outcome Variables: Tordesillas Line



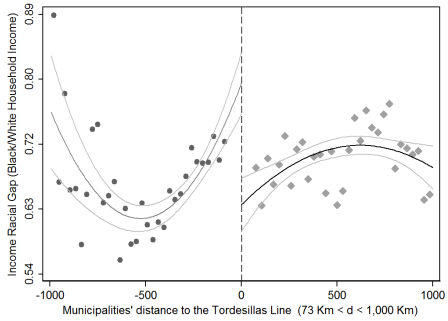
(a) Outcome: Slavery (1872)



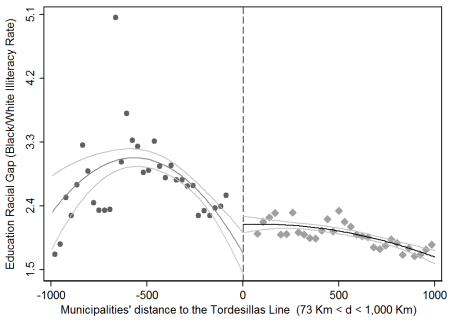
(b) Outcome: Income Inequality (2010)



(c) Outcome: GDP per capita (2012)

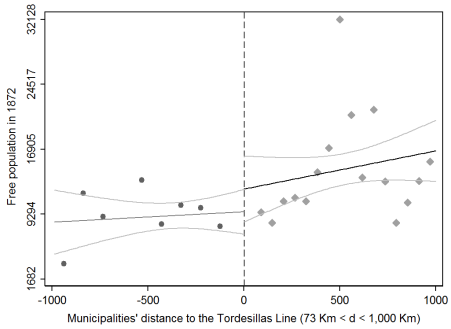


(d) Outcome: Income Racial Imbalance (2010)

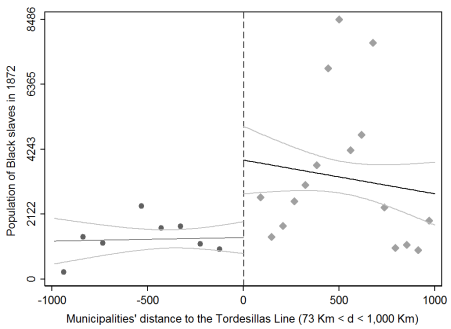


(e) Outcome: Education Racial Imbalance (2010)

Figure 11: Donut RD plots: Free and black slave population (Tordesillas Line)

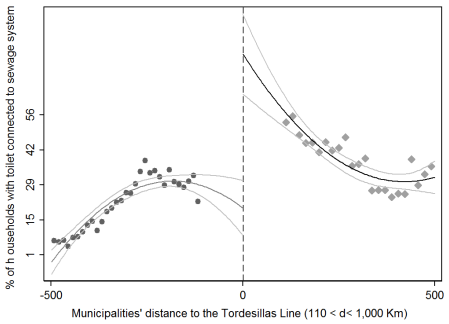


(a) Outcome: Free population

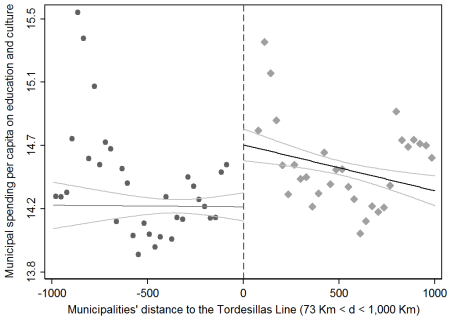


(b) Outcome: Black slave population

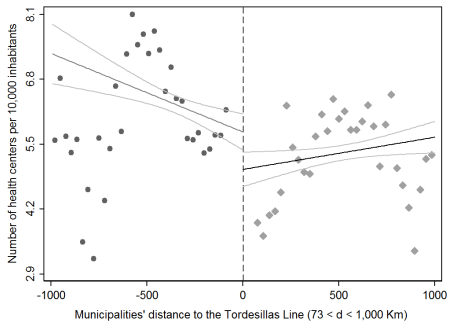
Figure 12: Donut RD plots for other channel variables: Tordesillas Line



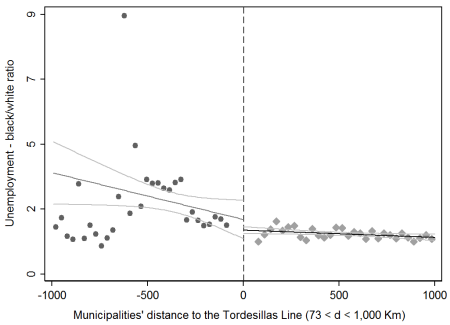
(a) Sewage collection



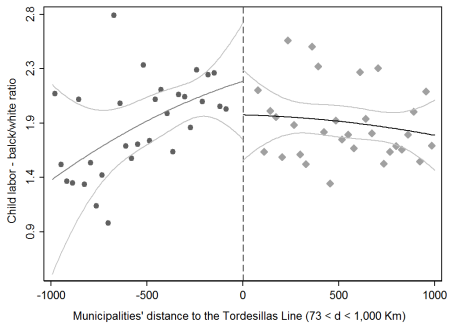
(b) Public spending in education and culture



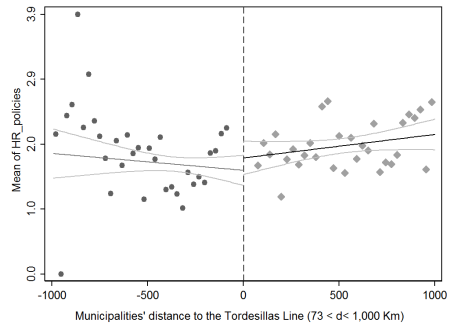
(c) Health Centers



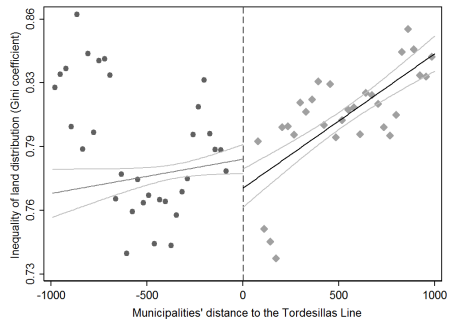
(d) Unemployment Racial Imbalance



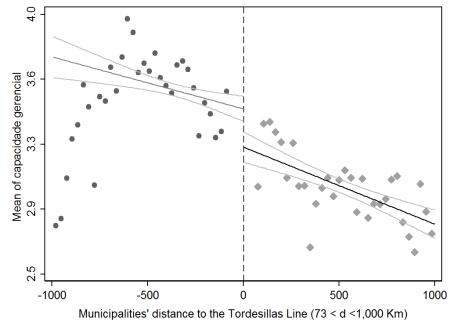
(e) Child Labor Racial Imbalance



(f) Existence of Human Rights policies

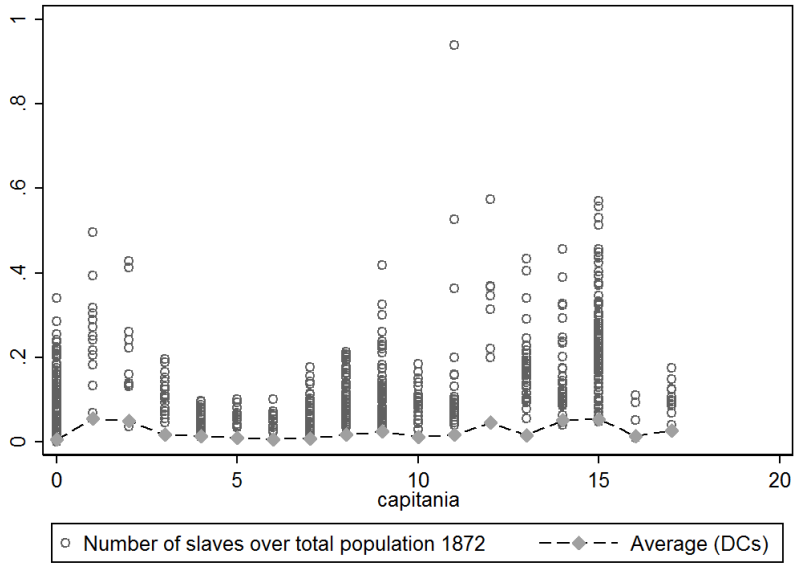


(g) Inequality of land distribution



(h) Institutional effectiveness of local governments

Figure 13: Donatary Captaincies: Heterogeneity



Additional tables

Table 12: Abolition of slavery in the Americas

Country	End of Slave Trade	"Free Birth" Law	Abolition
Chile	1811	1811	1823
Mexico	1824	-	1829
Uruguay	1825	1811	1842
Ecuador	1821	1821	1851
Colombia	1821	1821	1852
Argentina	1813	1813	1853
Peru	1821	1821	1854
Venezuela	1821	1821	1854
Bolivia	1840	1831	1861
Paraguay	1842	1842	1869
Brazil	1850	1871	1888

Source: Andrews (2004)

Table 13: Slavery population and Economic activities: change in relative importance of the slave population by province from 1819 to 1886/87

Province	1819	1872	1886/87
Minas Gerais	15.2	24.5	26.5
Rio de Janeiro	13.2	22.6	23.5
Sao Paulo	7.0	10.4	14.8
Bahia	13.3	11.1	10.6
Pernambuco	8.8	5.9	5.7
Maranhao	12	5	4.6
Other	30.5	20.5	14.3
Total	100	100	100

The table shows the change in relative importance of the slave population by province from 1819 to 1886/87. These changes are directly related to the economic activities in the colony during this period. Source: Klein and Luna (2010), pag. 76.

Tordesillas line

Table 14: Slavery and Development Outcomes: OLS and Fixed Effects estimates

	Dependent variables							
	GDP per capita				Income Inequality			
Number of Slaver								
over total population	21,266***	16,499***	16,499***	16,499***	0.140***	0.139***	0.139***	0.139***
	(5,300)	(5,062)	(3,711)	(1,486)	(0.0136)	(0.0138)	(0.0130)	(0.0240)
Constant	14,439***	14,515***	14,515***	14,515***	0.501***	0.501***	0.501***	0.501***
	(225.5)	(220.8)	(212.0)	(23.67)	(0.000933)	(0.000749)	(0.000744)	(0.000382)
Observations	5,503	5,503	5,503	5,503	5,505	5,505	5,505	5,505
R-squared	0.005	0.172	0.172	0.172	0.015	0.362	0.362	0.362
Region Cluster				✓				✓
State FE		✓	✓	✓		✓	✓	✓
Geographic variables			✓	✓			✓	✓
	Income Racial Imbalance				Education Racial Imbalance			
Number of Slaves								
over total population	-0.384***	-0.395***	-0.395***	-0.395***	-0.367**	0.153	0.153	0.153
	(0.0447)	(0.0443)	(0.0443)	(0.0561)	(0.176)	(0.166)	(0.166)	(0.494)
Constant	0.707***	0.707***	0.707***	0.707***	2.239***	2.230***	2.230***	2.230***
	(0.00333)	(0.00315)	(0.00315)	(0.000894)	(0.0181)	(0.0163)	(0.0163)	(0.00802)
Observations	5,501	5,501	5,501	5,501	5,394	5,394	5,394	5,394
R-squared	0.009	0.096	0.096	0.096	0.000	0.164	0.164	0.164
Region Cluster				✓				✓
State FE		✓	✓	✓		✓	✓	✓
Geographic variables			✓	✓			✓	✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows the correlation of slavery - measured by the ratio of number of slaves in 1872 over total population - with current development outcomes (income inequality (Gini coefficient), GPD per capita, income racial imbalance and education racial imbalance). The income racial imbalance reflects the ratio of the average income of black households over the average income of white households in 2010. The education racial imbalance refers to the ratio of the average illiteracy rate of black households over the average illiteracy rate of white households in 2010. The first estimate of each dependent variable is OLS, while the other three equations are state fixed effects estimates. The geographic variables used are longitude, latitude, rain, distance to the coast, altitude, distance to the federal capital, sunlight, average monthly temperature and types of soils. We also control for the foundation year of the municipality.

Table 15: Slavery and Development Outcomes: OLS and Fixed Effects estimates - $73 < d < 1,000$

	Dependent variables							
	GDP per capita				Income Inequality			
Number of Slaver								
over total population	15,867***	11,776**	11,776***	11,776*	0.159***	0.134***	0.134***	0.134***
	(5,948)	(5,602)	(4,413)	(4,339)	(0.0153)	(0.0153)	(0.0146)	(0.0279)
Constant	15,526***	15,592***	15,592***	15,592***	0.494***	0.495***	0.495***	0.495***
	(279.2)	(278.5)	(266.0)	(69.90)	(0.00107)	(0.000885)	(0.000882)	(0.000450)
Observations	4,071	4,071	4,071	4,071	4,072	4,072	4,072	4,072
R-squared	0.003	0.147	0.147	0.147	0.021	0.333	0.333	0.333
Region Cluster				✓				✓
State FE		✓	✓	✓		✓	✓	✓
Geographic variables			✓	✓			✓	✓
	Income Racial Imbalance				Education Racial Imbalance			
Number of Slaves								
over total population	-0.334***	-0.362***	-0.362***	-0.362***	-0.501***	0.245	0.245	0.245
	(0.0465)	(0.0472)	(0.0472)	(0.0362)	(0.193)	(0.181)	(0.181)	(0.544)
Constant	0.685***	0.685***	0.685***	0.685***	2.351***	2.339***	2.339***	2.339***
	(0.00388)	(0.00372)	(0.00372)	(0.000584)	(0.0229)	(0.0206)	(0.0206)	(0.00898)
Observations	4,068	4,068	4,068	4,068	3,972	3,972	3,972	3,972
R-squared	0.007	0.066	0.066	0.066	0.001	0.154	0.154	0.154
Region Cluster				✓				✓
State FE		✓	✓	✓		✓	✓	✓
Geographic variables			✓	✓			✓	✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table shows the correlation of slavery - measured by the ratio of number of slaves in 1872 over total population - with current development outcomes (income inequality (Gini coefficient), GPD per capita, income racial imbalance and education racial imbalance). We used the numbers from the interval of distance to the Tordesillas line greater than 73 Km and smaller than 1,000 Km to compare with the Donut RD estimates. The income racial imbalance reflects the ratio of the average income of black households over the average income of white households in 2010. The education racial imbalance refers to the ratio of the average illiteracy rate of black households over the average illiteracy rate of white households in 2010. The first estimate of each dependent variable is OLS, while the other three equations are state fixed effects estimates. The geographic variables used are longitude, latitude, rain, distance to the coast, altitude, distance to the federal capital, sunlight, average monthly temperature and types of soils. We also control for the foundation year of the municipality.