The Economic Effects of American Slavery, Redux: Tests at the Border

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Abstract: During their grand tour of the United States in 1831-32, Alexis de Tocqueville and Gustave de Beaumont puzzled on divergent regional economic development, until they traveled down the Ohio River. There, they observed differences on opposite riverbanks, where the environment is similar but the institutions differ. Following their analysis, we use antebellum census data to test for statistical differences at the 1860 free-slave border. We find evidence of lower land values and less intensive land use on the slave side. This does not support the view that abolition was a costly constraint for landowners. Indeed, the lower demand for similar, yet cheaper, land presents a different puzzle: why wouldn't the yeomen farmers cross the border to fill up empty land in slave states, as was happening in the free states of the Old Northwest? On this point, we find evidence of higher wages on the slave side, indicating an aversion of free labor to working in a slave society. This evidence of lower systemic productivity in slave areas suggests that the earlier literature on the profitability of plantations was misplaced, or at least incomplete.

I. Introduction

Economists and historians have long debated the effects of slavery on economic growth. Places that had coercive labor in the 1800s appear to have started modern economic growth later than places that did not. They have worse development experiences today as well. This is now the standard view. A century or so ago, however, historians argued that slavery was unprofitable and was kept in place due to elite resistance to institutional change and a desire to maintain political and social hegemony. A half-century ago, economic historians brought quantitative evidence to bear. They argued that plantations were, in fact, profit-maximizing businesses. Slavery was a dynamic economic form and far from dying out due of unprofitability. In the last two decades, economic historians and others have advanced the position that slavery in the Americas had an economic rationale early on but created institutional impediments to subsequent growth. More recently, the "1619 project" of the *New York Times Magazine* (2019) memorialized the 400th anniversary of the introduction of slavery into what became the United States and popularized the New History of Capitalism, which founds US economic success on slavery (Beckert 2015).

This is a complicated and contested terrain. We seek to return to an investigation of the effects of American slavery on economic performance during its existence. To proceed in a controlled yet tractable way, we examine the effects at the border that divided the country in half, slave and free, circa 1860. We follow in the footsteps of Alexis de Tocqueville and Gustave de Beaumont, who in their famous visit to America in the early 1830s, also sought to understand the effects of slavery. While on the East Coast, they heard much about southern distinctiveness, but they were unable to sort out the impact of slavery from that of climate. But when they traveled to the Ohio River valley, they discovered a setting where the environment was the same on both sides of the river; but the institutions differed.[1] The travelers observed that free state of Ohio was more dynamic, more industrious, and more attractive to immigrants, than the slave state of Kentucky. De Tocqueville noted "It is impossible to attribute those differences to any other

[1] See https://collections.library.yale.edu/catalog/2056803. By the 1830s, local observers have made frequent contrasts between the development patterns on the two sides of the river. See *Edwardville* (IL) *Spectator*, 1 May 1821, p. 3.

cause than slavery. It brutalizes the black population and debilitates the white…. Man is not made for servitude. (Pierson 1938, p. 569).”

We seek direct measures of the effects of slavery on economic performance during its existence. Much of earlier economics literature on slavery conducted tests for whether marginal benefits of something equal its marginal cost at the farm level: roughly speaking, tests of productive efficiency and profit maximization. We argue that these are the wrong questions. Instead, we propose a different perspective: the policy variable on either side of the free-slave border affects how those free to choose could use their land. Abolition may act like a large tax on slavery in local areas. Local public economics teaches us that the inelastic factor bears such taxes. Physical capital is mobile, free labor is mobile, even slave labor is mobile (not by the will of the enslaved, but by the will of those who had their property rights over their labor). Land is immobile. If we wish to measure the systemic productivity of a local or regional policy, we should therefore direct our attention to land use and price.

On the one hand, the institution of slavery created different set of production possibilities. It allowed labor to be coerced, which should have lowered the cost of labor to the slave owner. Whether the cost of labor, on average or at the margin, was indeed lower than its associated output is an open question. The institution of slavery also eased the attainment of greater scale. More generally, the ability to enslave others generated profit opportunities for the enslavers; sites where profitable activities were legal should, all other things equal, be more valuable than sites where such activities are not legal.

On the other hand, the institution of slavery was a social system that oppressed and degraded the enslaved. The system levied taxes on the non-slave-holding free persons. Complicity with the violent system imposed costs that some free people might seek to avoid. Slavery had existed in many parts of the world for millennia. The US North prided itself on being a place where slavery was not permitted and “free labor” was celebrated (Foner 1970). This was a choice, subject to revision but not without cost.

This paper seeks to measure the relative strengths of these opposing forces affecting the valuation of land in areas with and without slavery. We take the testing ground of de Tocqueville and de Beaumont -- the Ohio River valley-- and extend the comparison east to cover the borders dividing Pennsylvania and New Jersey from Virginia, Maryland and Delaware and west to contrast free states of Illinois and Iowa with the slave state of Missouri (de Tocqueville 1838; Wright 2006). We use antebellum census data to test for statistical differences at the 1860 free-slave border. We find evidence of lower land use and land value on the slave side of this border. This does not support the view that abolition was a costly constraint for landowners. Indeed, the lower use of land that was cheaper presents a prima facie puzzle: why wouldn't the yeomen farmers cross the border to fill up empty land in slave states, as was happening in the free states of the Old Northwest? More puzzling still is that we find evidence of higher wages on the slave side of the border. We then turn to interpret the results in a variant of the Rosen-Roback locational choice model (Roback 1982). The combination of lower land values and higher wages indicates that there was a large disamenity for free households to live and work in the slave region. That said, the wage gap appears too small with a production function framework to account for the entire land value gap. This suggests the slave side also suffered from significantly lower productivity as well.

We are treating the two sides of the border as competing for settlement. They are not separate experiment testing grounds, but rather interact and compete. The interactions are a feature, not a bug, in our analysis. Some spillovers such as the prospect for the enslaved to escape complicate the contrast and we need to control for that by looking off the immediate border. It is important to notice that in addition to sharing similar climate and soils, the two sides of the river face similar product prices. There are no internal duties on physical commodities and transportation costs to global markets are the same.

II. The Legal Basis of the Institutional Differences

Allowing for slavery was the default condition of American colonies. Georgia restricted the institution at its founding in 1732 but by 1750 revised its laws to permit slave holding. Following the start of the War of Independence, the Northern states began to eliminate the slave system and emancipate those held in bondage. Pennsylvania was a leader, passing the "Act for the Gradual Abolution of Slavery" on 1 March 1780. The 1787 Northwest Ordinance, passed by the US Congress during the Articles of Confederation period, forbid slavery in the territory north of the Ohio River. The Sixth Article read "There shall be neither slavery nor involuntary servitude in the said territory, otherwise than in punishment of crimes whereof the party shall have been duly convicted." This law would be contested at times and laborers in the region were sometimes bound under indentured servitude contracts. But the founding document of the Northwest Territory prohibited chattel slavery. South of the river, in Kentucky, the legal system adopted Virginia practices; chattel slavery was in place when Kentucky became a state in 1792. In 1820, Missouri was also admitted to the union as a slave state, as part of a compromise excluding slavery in the other parts of the territory of the Louisiana Purchase above the longitude 36 degrees 30 minutes (Wright 2006, pp. 44-46).

Readers who question our assertions might be persuaded by the words of Honest Abe Lincoln. On his speaking tour through Ohio and Indiana in September 1859, Abraham Lincoln repeatedly attributed that the absence of chattel slavery in the states formed from the Northwest territory to 1787 Ordinance and to the refusal of Congress to allow early legislatures to backtrack the provisions of Article VI. "There is no difference in soil nor in climate" along the border, Lincoln noted, but the different institutional choices at founding led to different outcomes. See Basker (1953, pp. 456-57, 467).

We compare the operation of slavery and free labor in a classic testing ground (de Tocqueville, Wright). This region includes the core domain of slavery in the country's early history. Slave labor was commonly used to produce the region's staple crops. And there were repeated attempts, during crop booms, to introduce slavery into the places where it was legally prohibited in the founding period. These attempts were defeated, but many voters in the Free States were not convinced that nature alone would forever keep slavery out. The contest went the other way as well. Slavery disappeared in New Jersey; it was on the decline in Delaware; other parts of the border South might be next. The border test has relevance for how US history played out and how the participants saw it playing out.

III. The Free-Slave Boundary and Census Data

Figure 1, Panel A, maps the Free-Slave Boundary in the United States in 1860 and the surrounding regions. The source for the spatial data is the National Historical Geographic Information System (NHGIS, Minnesota Population Center, 2011), and Appendix A provides detail on the boundary. The thick line is the boundary and the thin lines are 1860 state borders, plus the subsequent border that split the two Virginias. We will investigate the abundance of county-level data from the antebellum censuses: population, by demographic type, land value and land-use, and crop and farm size, and other variable of interest. We offer two examples in the remaining panels of Figure 1: Panel B represents non-white population (mainly blacks) and Panel C represents the rural population. Population data are from census counts compiled in ICPSR study #2896 (Haines, 2010). Each dot is placed at the county centroid and is proportional to the percentile of the respective outcome.[2] The propensity of nonwhites to be south of the boundary is noteworthy, while the rural population appears denser in free states. A few other features are evident in the maps: the relative emptiness of Appalachia and the settlement along the Missouri River, for example.

Table 1 (in Appendix A) provides summary statistics for some of the data in our sample. In Panels A and B, respectively, we consider two samples: counties 300 miles from the border and counties on the border. The columns present numbers of observations, means, and standard deviations, for the entirety of each sample as well as for free-region and slave-region subsamples. There are three variables for population: nonwhite, white, and rural, all normalized by county area. There are 5.3 (4.2) nonwhites per thousand acres in the first (second) sample. However, there is a much greater density of nonwhites south of the boundary, with an additional 8.7 (5.0) per thousand acres on the slave side. White population density is higher in each of the subsamples, but the difference across the border is reversed: there are 43.9 (21.3) more whites per thousand acres on the free side. A similar pattern holds for rural population. There are also four agricultural outcomes, also drawn from Haines (2011), but compiled originally by the Census of Agriculture. About 60 percent of acres were in farms, on average, and these numbers are fairly similar across samples. A large gap is seen in land improvement, however, across the free and slave counties. Finally, we present farm values per county and also per farm acre. At the border, farms are valued at about $24 per farm acre, but there is an over $8 difference on either side. Measured in logs, the farm acres on the slave side are approximately 37 percent less valuable.

Below, we use the following estimation procedures. We focus on four samples: those counties that touch the border (the border sample), those that are near the border but do not touch it (the donut sample), those that are within 150 miles of the border, and those that are within 300 miles.[3] All of these specifications will control for a cubic in longitude. For the 150- and 300-mile buffers, we also control for a cubic in distance to the boundary, which is defined as a positive to the North in a negative to the South. For the border and donut samples, distance to the boundary is nearly collinear with free or slave. This analysis is weighted by county area so as to not inflate the importance of states that subdivide more than others. To account for spatial correlation, we cluster by 15 bins of longitude. The coefficient of interest is on an indicator for whether slavery is legal. Generally speaking, the slave region is south of the boundary.

[2] We use percentiles to make the graph legible. The statistical analysis below is based on levels and natural logarithms.
[3] The distances are measured from the county centroid. See Appendix Figure A-1 for a map of the buffers and the border sample in 1860. The donut sample is not on the boundary directly, but within 55 miles of it. The 55-mile cutoff is approximately double the maximum average distance to the boundary in the "border sample" and it ensures that there is at least one county on either side. We created the donut sample to address the concern that right at the border slave owners fear the workers might escape.

Figure E (in Appendix A) provides evidence on ‘environmental’ variables, e.g. weather and soil, which are for the most part pre-determined. This helps us assess the strength of our research design that compares area on either side of the border. Panel A contains results in the areas of weather, topography, river/water access, and seismology. Panel B represents tests for soil-related variables, including the glacial coverage (which is described in Appendix C). Some rows have numerous coefficients because the categories (listed on the y axis) are measured at various soil depths.

We plot the p-value on the slavery coefficient for each variable and sample. A uniform distribution across [0,1] would imply no meaningful differences across the border. A departure from uniform indicates otherwise, with caveat that the coefficients are not independent draws (e.g. sandy soil 10 inches down is correlated with sand fraction at 15 inches). Panel A has 10 of 52 (19 percent) coefficients significant at the 10 percent level. Outside of the climate variables, 4 of 36 p-values are below 10 percent, and none are below five percent. There are not significant differences in elevation on either side of the river. The climate should also be quite similar on either side of these borders. Much of the boundary line is defined by a river that runs through flat terrain, so there are not issues of rain shadows from mountains.[4] Our review of the river course indicates that the bends on the river are evenly distributed. There is local heterogeneity for sure— there may be better farmland on the inside of the riverbend—but this averages out over the river course. The rest of the boundary is defined by geometric constructs (east/west lines and the Twelve-Mile Circle) that were set well before much was known about land quality. Nevertheless, the story is bit more complicated in Panel B, where 29 percent of coefficients have p-values before 10 percent. A few outcomes look reasonably uniform, e.g. porosity or bulk density. Several look uniform for some samples, but not others: for example, soil pH, which looks uniform for the buffer sample, but bad for the donut. Glacial extent (meaning fraction of the county covered by ice at the previous glacial maximum) and depth to bedrock are most significantly related to the free-slave boundary. All of the above controls will be used in sensitivity analysis below.

IV: Demographics

Figure 2, Panel A graphs the point estimates and 95-percent confidence intervals for key demographics attributes in 1860, for the four samples described above. The variables are transformed using natural logs.[5] The very top set of results represents the principal attribute, non-whites as a share of the population. These results demonstrate the non-white share was indeed higher in the slave region. Given that non-white people were more likely to be subject to labor coercion, finding this difference is something like a first-stage regression for our analysis. The second set of results indicates the ratio of non-white population to total land area is also higher in the slave region. The third set of results shows the white population per land

[4] For temperature and rainfall, the p-values for the standard errors of the kriging (interpolation) exercise are somewhat more related to region than are the interpolated climate variables themselves. This indicates that these effects come in part from the endogenous placement of weather stations rather than real differences in climate. Note that the climate data come from the mid-19th Century and are described in Bleakley and Hong (2017). We eschewed modern climate raster data because (endogenous) urban heat islands are clearly visible.

[5] Using logs prevents analyzing variables with extensive zeros, as is the case on the free side. (Some non-white persons were held in bound labor status in these areas, while not in the formal status of chattel slaves.) In levels, we estimate a drop at the border of, per thousand acres, 6 fewer nonwhites and 5.5 fewer slaves. Thus, almost all of this effect at the border is coming from enslaved population.

area is lower. The fourth set of results combines the previous two variables into a single measure and reveals that total population density is lower. The fifth set, at the bottom, shows this gap is not due solely to differences in urbanization. The total rural population per land area is also lower in the slave region. For all the variables, the point estimates for "on the border" and "within 150 miles" samples are very close. The point estimates for "within 300 miles" sample shows larger gaps; and that for "donut" sample indicates still larger gaps or differences. These patterns are as one expects. A parallel analysis of population attributes in 1850 would yield very similar results.[6] The lower density speaks to land use; a given land area in the slave region was devoted to supporting fewer people. We now consider land use and value more fully.

V. Land Use and Value

Figure 2, Panel B graphs the point estimates and 95-percent confidence intervals for key variables related to farmland use and values in 1860. As noted in the introduction, the local public finance literature considers such variables to be sufficient statistics for evaluating the economic effects of local property rights regimes. (Such a calculation does *not* account for equity issues, which are great in this case.) We start with farmland use. The very top set of results shows that the share of farmland in total land is smaller in the slave region, but just barely so. The differences are not statistically significant. The second set indicates that the share of improved farm acreage in total land is lower, and, for both the "donut" and "on the border" samples, the differences are statistically significant. The third set parses the previous two and reveals that the share of improved acres in farm acreage is lower in slave region, and the differences are now all statistically significant at the 95-percent level. In summary, usage of farmland in less intensive on the slave side.

We now turn to farmland values. The fourth set of results from the top examines the value of farms divided by the population. Farm values per capita are lower in the slave region, but the gaps are not so large as to be significantly different from zero. The next set looks at farmland values divided by county land area. Here the gaps are large and statistically significantly different from zero. The last and very bottom set delivers a headline result. Farmland values per farm acre are lower in the slave region. The gaps are economically large and statistically significant for the "on the border" and "within 150 miles" samples. And the gaps are larger still for the "donut" and "within 300 miles" samples. One notable outcome comes from contrasting the third set of results and the sixth (and bottom) set. The third set shows the fraction of farmland that was improved was lower in the slave region whereas the sixth set shows farmland values were lower. The point estimates in the third set of results are smaller than those in the sixth, so the farmland value gaps are not explained mechanically by the gap in improved acreage.

[6] Appendix Figures F-3 and F-4 extend the analysis to cover differences in the age composition of the 1860 population and in sex, race, and nativity, respectively. Appendix Figure F-3 shows the slave region had relatively more young people (aged 10-14 years) and fewer older people (40-79 years). This pattern is in line with the characterization of the border South as an area where young slaves were raised to be sold "down river." The magnitudes of the differences, however, were not great. Appendix Figure F-4 shows more non-whites in the slave region, more males and more females. But the gender differences were not great. There were fewer free people of color and fewer foreign-born whites. The evidence of lower fraction of foreign-born is weaker that one might expect given the common narrative that immigrants strictly avoided slavery. There appears to be little difference from the behavior of native-born whites.

An analysis of land use and value in 1850 would yield roughly similar results. In that year, farmland as a share of total land and farm value per capita were higher in the slave region, but the differences were not statistically significant. Improved land per farm acreage and farm values per farm acre were lower in the slave region, and the differences were statistically significant. The gap in farm values per farm acre was marginally larger than that in improved land per farm acre.

In summary, land values were substantially lower in the slave region. The ratio of improved land per acre of farmland was also lower. That land values and land use were depressed on the slave side is puzzling for models in which coercion made labor cheaper or the legal capacity to engage in activities-of-value raise land rents. At the strictly micro-level, producers had access to more modes of production south of the border. But before proceeding, let's check the robustness of what we have found so far.

VI: Sensitivity Analysis

New results, reported in Tables 2 and 3, are offered to assuage concerns about omitted variables and endogeneity. The estimates are qualitatively similar under a variety of alternate assumptions.

VI.A: Additional Variables

In Table 2, we present estimates of the effect being in the slave region on the main outcomes, in the full sample. In the first row of Panel A, we see the baseline results, which use land area as a weight in the regression. In the next two rows, we find broadly similar results if we weight by rural population or use no weights at all. (Neither of these was the preferred specification because the former is endogenous to county land quality and institutions and the latter gives more weight to states, e.g. Kentucky, with greater proclivities to subdivide itself.) The final row of Panel A assigns the few observations with a zero or missing value for the outcome to the sample minimum value instead. This has its greatest effect on the sample size of the nonwhite population, as there were a comparatively large number of counties that were 100 percent white in the 1860 census. In any case, this adjustment does not affect the estimates to a great degree.

Panel B of Table 2 presents estimates using a variety of spatial controls. In the first three rows, we include dummy variables based on splitting the sample into five, ten, and then fifteen bins of longitude. The fourth row includes instead a cubic polynomial in latitude and longitude, which is distinct from the default specification based on latitude and distance from the free-slave border. Results including these purely spatial controls do not deviate substantially from the baseline. The next five rows show results controlling for the environmental factors. These variables were described already in reference to Figure 2, and most were not significant predictors of being on the free side of the boundary. The first row in this batch contains variables for topography, river access, groundwater, and climate. The next row controls for depth to bedrock, which is correlated in a statistically significant way with the institution of slavery, but whose inclusion in the model does not affect estimates associated with the free-slave boundary. The row that follows includes instead the remaining soil measurements described above. Results are generally similar, although there is now a statistically significant effect of slavery on farm acreage per county area and the estimated effect of slavery on farm value per county area is somewhat lower than the baseline. The next two rows control for the fraction of the county covered by the most recent glacier. The second row of this pair ignores the Driftless region, mostly within southwest Wisconsin, and is therefore simply a measure of being north of the terminal moraine. These estimates are comparable to the baseline, albeit with a weaker version of the phenomenon just discussed for the row on soil variables.

We now discuss the possible confounding influence of land surveys. Notably, most of the Old Northwest was brought into the Public Land Survey System (PLSS), while much of the rest of the sample used non-rectangular, mostly metes and bounds, surveys for the demarcation of property (see Appendix D). Attention to this issue is motivated by two factors. On the one hand, the PLSS may affect transaction costs: perhaps reducing them, as argued by Libecap and Leuck (2011), or perhaps increasing them if the grid is set too far away from the optimal farm size, as argued by Bleakley and Ferrie (2014). On the other hand, the Northwest Ordinance's demarcation scheme was in part motivated by a 'Jeffersonian dream' of yeoman farming (Gates 1996). The final row of Panel B reports results that directly control for the fraction of each county covered by the PLSS. Estimates are qualitatively similar to those with other specifications. We also split the sample based on whether the closest free-slave boundary is associated with the change in land demarcation system (specifically, PLSS versus something else). Most of the Ohio River, for example, is associated with a change, with the main exceptions near Cincinnati and Louisville. The Mason-Dixon line is not associated with a change, nor is most of the Missouri border, with the exception of riverside land near St. Louis that is associated with colonial French land claims. The first two rows of Table 3, Panel A, display these subsample estimates. Coefficients are remarkably similar, with the exception that the effect size is almost halved for fraction improved of farm acreage.

Panel C, Table 2 presents results for the same outcomes, but defined in levels rather than in natural logarithms. These estimates differ because of the change of units, but the patterns of statistical significance are largely unchanged. The first row of the panel is for a standard regression. The slave side of the boundary is associated with, per thousand acres, six more nonwhites and with 40 fewer whites. This defies the simple story that enslaved laborers and artisans displaced free ones at specific tasks, for which one might have expected estimates closer to parity. On the slave side, the mean densities are about 16 and 61 for nonwhites and whites respectively, per thousand acres, so these are large effects. (The use of levels instead of logs also facilitates the analysis of slave population, which is zero in many of the counties. If we put enslaved population density on the left-hand side, we obtain a coefficient of 5.5 more slaves per thousand acres. This is very close to the estimate for nonwhite population.) The reduction in farm value is about $8 per county acre or $11 per farm acreage. Furthermore, approximately 13 percentage points less of total farm acreage is improved on the slave side. These effects are attenuated if estimated with a quantile regression at the median, as shown in the next row. Nevertheless, the relative sizes of effects are similar.

VI.B: Subsamples

Table 3 presents results for select subsamples, an exercise which is informative for its own sake and sheds light on the possibility of certain alternative hypotheses and mechanisms. Panel A splits the sample based on characteristics at the closest segment of the free-slave boundary. The role of different land surveys, analyzed in the first two rows of Panel A, was discussed above. The next three rows split the sample into three, less heterogeneous chunks of boundary: the Mason-Dixon line (plus northern and eastern borders of Delaware), the Ohio River, and the state of Missouri. Estimates are qualitatively similar across segments.

Next, we stratify based on whether the boundary is defined by a natural feature (in our case, rivers) or an artificial, geometric construct (the Missouri/Iowa border, the Mason-Dixon line, and the arc of the northern border of Delaware).[7] Both choices are arbitrary in some sense, and often selected historically based on imperfect knowledge of what is on either side. Nevertheless, the course of a river is itself defined by geological features that might render one side better for farming. This is frequently true at any given point along the river, perhaps at a bend where one side is characterized by a bluff and the other by an alluvial plain. That said, rivers that bend in one direction at one location frequently bend in the other direction downstream, so these local advantages would tend to average out over the course of the river. In any case, estimates across these two subsamples are broadly similar.

We next turn to heterogeneity of this effect by the timing of settlement along the boundary. We already saw similar effects across three different, contiguous border segments, which were settled at different points in time. The last two rows of Panel A do something similar by splitting the sample by whether the closest boundary is east or west of the confluence between the Miami and Ohio Rivers (at the Indiana/Ohio boundary). Then, in Panel B, we use the Newberry (2010) data on historical county boundaries to approximate the timing of settlement. The first two rows discriminate by whether the county's FIPS code first appears before the median year in the sample; the second pair of rows split the sample based on the emergence of the current county boundaries instead.

We now turn our attention to soil exhaustion. Planters, it was commonly asserted, were irresponsible stewards of the soil. A number of reasons were given: plantation crops themselves were hard on the soil, the planters' ability to coerce the migration of their slaves gave little incentive to conserve the soil on their current farm, principal/agent problems on large farms, etc. If true, this could explain the lower farm values on the slave side. It might also explain lower land improvement, if previously tilled acreage was abandoned and reclaimed by nature. We should first note that this claim is not consistent with the evidence just presented. Generally, coefficient estimates are similar across the previous three sets of sample splits, even though the timing of settlement would have been quite different. Furthermore, in two of the three splits, the effects on farm value are weaker for counties settled earlier, even though those would have had more time to ruin their soil. We can also use a direct measure of the soil's susceptibility to erosion: the kf-factor, which measures the "susceptibility of soil particles to detachment and movement by water," and the k-factor, which is the same measure but adjusted for the presence of rocks. (Miller and White 1998). In Panel C, we display results for subsamples with larger or smaller values of these factors. The effect of being in the slave region on nonwhite population density is quite similar across the subsamples. However, we see discrepant results for most of the other outcomes. Nevertheless, these discrepancies do not favor the soil-exhaustion claim; for example, the effect on farm value is greater in places *less* susceptible to erosion. The skeptical reader might

[7] The main natural rivers, the Ohio and Mississippi, provided ready transportation to both regions. Many of the smaller rivers saw active batteaux and flatboat traffic. Investments in other types of transportation improvements—river clearing, wing dams & sluices, roads, canals, railroads—are best viewed as endogenous outcomes in the development process. See Zimran (2020).

now observe that the soil variables are based on 20th-century surveys, and that the susceptibility measure might have been affected by earlier bad farming. But recall from Figure 2 that the free-slave boundary is not a significant predictor of erosion susceptibility.[8]

As the data permit, we can see broadly similar patterns in earlier years. We focus on 1860 because it is the year of greatest data availability before the Civil War. However, all of the earlier censuses had population and a few subcomponents, if the county was organized. The 1850 census also had farm values. Readers are referred to Appendix Figure F-3, which plots the year-specific slave-region coefficients for nonwhite and rural population density 1790-1860 and farm value per farm acre for 1850-60. The coefficients vary by year, especially in the whole sample, which is influenced by the emergent county boundaries in the western part. However, the general finding throughout the antebellum years is similar to what we report above. (See Appendix G for a discussion regarding spatial correlation.)

VII: Measurement and Interpretation of County-Level Wage Rates

VII.A: Wage Gaps at the Free-Slave Border

We now compare the returns to labor on the two sides of the border. The 1860 Census of Social Statistics collected county-level data on wage rates for various occupations (Lebergott 1964, Margo 2000). The manuscript records include monthly wages of farm hands, daily wages of day laborers and carpenters, weekly wages of female domestics, and the weekly price of board for laboring men. Unfortunately, the schedules for Ohio, apart from one county, are lost. We supplement the sample with 1857 state data for daily labor and farm hands (Ohio Board of Agriculture 1857, Ohio Commissioner of Statistics 1858). We also convert the wages into daily equivalents by assuming a six-day week and estimate the principal component of the natural logs of the five series to summarize the relatively noisy data in a single, convex measure.[9]

We start the discussion of Figure 3 with the results for weekly board. The point estimates and confidence intervals for the county-level data on weekly board reveal the differences are not statistically significant. The key take-away is that regional differences in board are not driving the wage gaps. The next results refer to the weekly wages of female domestics. The point estimates are generally higher in the slave region and the confidence intervals, though wide, often lead to rejection of the hypothesis of no difference. The results for carpenters show wages (without board) are higher by statistically and economically significant magnitudes in the slave region. The results for day laborers (with and without board) show higher point estimates in the slave region. The confidence interval strays over and back across null hypothesis line.

[8] The boundary is a significant predictor of depth to bedrock, as seen in Figure 2, and the coefficients indicate five to 10cm deeper soil on the free side. For comparison, a typical depth to bedrock in the Old Northwest is greater than the 152cm (60in) measured in the soil surveys. However, our inspection of the detailed raster data on bedrock depth indicate that this is a footprint of the terminal moraine (extent of glaciation) and not of the free-slave boundary.

[9] To facilitate interpretation, we renormalize the principal component to be a convex combination. By convention, variable weights for principal components are vectors of unit length, meaning that their *squared* elements sum to one. This fails to produce a convex combination of what are, in this case, essentially similar objects, log wages. It instead implies a function that is homogeneous of some degree greater than one in the level of wages, analogous to a Cobb-Douglas with increasing returns to scale. To address these issues, we renormalize the variable weights to sum to one. We also wish all of the variables to have positive weights, so as to form a convex combination. This happens to be the case with these data, so there is no need to constrain the estimate further. As this weighting vector nevertheless points in the same direction as the conventional one for a first principal component, it yields the geometric mean of wages that best summarizes the variance in log wages.

But we never see what we might have first expected, that daily wages were lower by statistically significant magnitudes in the slave region. The results for weekly farm wages (with board) show a gap that is positive and significant. The results without and with the Ohio supplementary data are not fundamentally different. Finally, we turn to the results for the estimated first principal component. Again, labor returns are higher by statistically and economically significant magnitudes in the slave region.

The overall findings are striking: wages were about 10 percent higher on the slave side. Coercion might extract work from slaves at lower cost, but wages for free workers were higher.

VII.B: Interpreting the Results within the Rosen/Roback model.

There is a puzzle. A yeoman farmer from the East or from Europe coming down the Ohio River could unload on the left or the right bank. The land is essentially the same on either side. But on the southern bank, the land is cheaper and wages higher. What does this tell us about the preferences of the settlers?[10]

We can interpret the results using the Rosen/Roback spatial equilibrium model (Roback 1982). Firms and (free) households pick their preferred locations. In the most general version of the model, both firms and households use land.[11] In the variant that best fits our case, only firms (here farms) use land and households do not (as housing costs were negligible in rural areas). A free household's utility is affected by wages (positively) and amenities (positively). Farms' land rents (and land values) are determined by productivity (positively) and wages (negatively). The rents adjust to generate zero profits. The summary interpretation is that the observed combination of lower land values and higher wages is consistent with a strong household-side disamenity for free people associated with living and working in the slave region.

The vast literature on "Free Labor" offers numerous reasons for such a disamenity (see Foner 1970, Helper 1857). One thing we know about slave societies is that the institution of slavery permeated all aspects of the society. Things were structured to accommodate, support, and perpetuate slavery and the interests of slaveowners. Those external effects can distort many other choices. A landless white might have to serve in the militia, or just worry about slave rebellions. Free workers might not want to work alongside slaves or just be a place where the slavery existed. It is hard to distinguish between the two motives, but narrative evidence suggests that many yeoman farmers felt that the slave system did not work for them (Merritt 2017).

VIII: Productivity Effects of Slavery

The dominance of disamenity effects do not rule out negative effects of slavery on productivity as well. We examine here the role of several proximate determinants for farm values and then compare the magnitudes of slave wealth and of the gap in farm values. We find that farm improvements and higher

[10] See Appendix H for an analysis of crop production choices, farm size distributions, and wealth distributions.

[11] In more common variant, only households use land. A firm's profits are determined by productivity (positively) and wages (negatively). Firms enter until a zero-profit condition holds. A household's utility is affected by amenities (positively), wages (positively), land values (negatively) through the effect on housing costs which depend on density (positively). Households pick their highest utility location, driving land values to equalized utilities. Land values do not directly enter in the firm's profits, only in the household's utility through the density-dependent cost-of-housing effect. The predictions of the standard model are simple and intuitive: (1) the combination of higher land value and higher wages is associated with the higher productivity of local firms; whereas (2) the combination of higher land value and lower wages is associated with higher amenity values for local households.

wages explain most, but not all of the effect on farm values at the free-slave border. (Taxes, however, do not explain the gap.) This indicates an independent role for a productivity gap, which might well be expected. There is a vast literature on how the labor of coerced workers may be grudgingly given and how the ideas that generate long-run economic growth do not flow so readily in a slave economy. We then argue that, in the borderlands, the loss of land value was likely larger than the slave wealth emancipation might have liberated. Looking at the border example brings the drawbacks of the slave system into sharper light.

VIII.A: Investments in Improvements

A decent proportion of the difference in farm values stems from more investment on the free side. We quantify two channels here. First, we find the free side has 0.13 more improved acres per total farm acre. According to Gallman (1970), the 1860 ratio of improved to unimproved was two. Doubling the value of 13 percent of farmland would yield 13 percent higher farm values. Second, the higher rural population on the free side (about 50 percent more) would have required more farmhouses. The 1860 Census of Agriculture lumped land and buildings together in its value measure, and various sources report structures as being almost 20 percent of farm value.[12] These numbers combine to imply perhaps 10 percent higher farm values on the free side. Together, these factors explain about one-fifth of the estimated difference in farm value.

VIII.B: The Price of Free Labor

Free labor's preference for free soil could explain a substantial part of the differences in farm value. Recall that, on the slave side, land values were roughly 55 percent lower and wage rates about 10 percent higher. The higher wage rates would, other things being equal, result in lower land rents and land values. To a first approximation, the elasticity of one to the other would be the ratio of the labor share to the land share in net output. Intuitively, a given percentage increase in the price of a mobile factor affects total cost in proportion to its cost share; the increase in total cost is incident on land (the immobile factor) in inverse proportion to its own cost share.[13]

For the purposes of this analysis, we can focus on the free side of the border and ask what land rents/values would be if wages were at the levels prevailing on the slave side. Estimates of the ratio of the labor share to the land share in nineteenth-century US agriculture vary greatly—from 1.5 to 3.2.[14] Our read of the evidence suggests a ratio of 2. Using this number, the higher wages would reduce land rents by 20 percent, less than two-fifths of the total gap at the border.

[12] Primack (1965, Table 1) reports a structure share in farm value of around 0.18. Gallman (1975) reports a share of 0.23 whereas Gallman and Rhode (2019, pp. 19, 29) have this proportion at 0.19. There would also be compositional differences in the housing stock, as the slave side would have proportionately more planters' mansions and slave quarters. We have not attempted to adjust this number for composition, as the large effect on total population itself is likely to dominate compositional effects. Additionally, some of these structures would not be housing but farm assets. The latter need not scale down with population to the same extent as housing. This suggests our calculation is an overestimate.

[13] See Appendix B for a formal derivation. There we show that, at an interior solution, the second-order effect amplifies the impact on the land price. Therefore, this calculation is likely a lower bound.

[14] Edward Young's numbers in US Treasury (1871) yield a ratio of 1.5 (=0.5/0.33) based on land rental arrangements. Fogel and Engerman (1974, vol. 2, p. 132) used a ratio of 2.32 (=0.58/0.25); this revised their earlier (1971, p. 358) ratio of 3 (=0.6/0.2). Gallman (1971, Table 5) put the ratio of labor to farm real estate of 3.18 (=0.7/0.22). Atack and Bateman (1987, p. 193) offer a ratio of 2 (=0.6/0.3) as a plausible conjecture.

VIII.C: Taxes

It does not appear the land values and wages can be easily explained by higher overall rates of taxation in the slave areas. One can compare tax revenues collected relative to wealth reported by state in the 1860 federal census (US Census Office 1866, pp. 511-12). The revenue numbers include the taxes levied by different levels of state and local governments within each state. The tax collections can be compared to either reported real estate wealth or all reported wealth, which includes the value of slaves. For both measures, the ratio was lower in the states of the Border South (DE, DC, VA, KY, TN, MO) than those in the Border North (PA, OH, IN, IL, IA). The ratio of taxes collected to all wealth was 0.0045 in the Border South and 0.0065 in the Border North, substantially lower in the slave areas. The ratio of taxes collected to real estate wealth was 0.0084 in the Border South and 0.0089 in the Border North, modestly lower in the slave areas, but lower nonetheless. Both the relative and absolute magnitudes of these numbers are inconsistent with a story of higher state and local tax rates in the South created the land value differences. Non-pecuniary taxes, such as militia service, or different expenditure patterns, such as lower support for public schools, remain possible explanations.[15]

VIII.D: Cassius Clay's Math

With any productivity-enhancing reform, there are usually incumbent interests that stand to lose. Our estimates above suggest that land on the slave side of the free-slave boundary would have been more valuable as free soil. But would this gain from switching have been enough to compensate the slaveowners? Cassius Clay, the noted Kentucky abolitionist and sometime slaveowner himself, believed that land values would rise more than the loss in wealth if the enslaved were liberated. In 1834, Clay opined that, for the emancipation of his slaves: "I shall ask nothing in return but the enhanced value of my land which must ensure gradually from the day that we become indeed a free and independent state. (quoted in Martin 1918, p. 112)." In 1845, Clay added: "Kentuckians will be richer in dollars and cents by emancipation, and slaveholders will be wealthier by the change. (Martin 1918, p 114.)"

Does this claim hold up to further inspection? As a simple first exercise, we note that land values were lower on the slave side by around $8 per county acre while there were 5.5 fewer slaves per thousand acres.[16] If the gains from converting to free soil could be realized immediately, there would be enough land appreciation to generate around $1450 for every slave. This is almost double the typical price of a slave, which suggests that there could have been enough economic surplus from abolishing slavery in the borderland to compensate the losers from such a policy.[17] This would work even if we discount the part of the gap attributable to costly improvements.

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[15] It does not appear that differences in financial regulations and markets explain the differences either. Bodenhorn (2000, ch. 4) shows antebellum regional capital markets were well integrated, with roughly equalized interest rates.
[16] Well in advance of our paper, Clay had his own estimate: "I assert from my own knowledge, that lands of the same quality in the free, are from one hundred to one hundred and fifty per cent higher in value than in the slave states" (quoted in Martin, 1918, p. 114). There are indeed stretches of the Ohio border where this is true in the census data.
[17] Ransom and Sutch (1988) estimate the average price of a slave in 1860 to around $800. Clay's math would have been even more favorable when he made this claim.

Indeed, in Clay's view, there would be no need to compensate slaveowners, because they were also landowners. This second claim is stronger, and we can inspect it in 1860 full-count data. If we use personal property as an upper bound on slave wealth, we can compare losing 100 percent of slave wealth to a conjectured 55 percent appreciation of real estate. We estimate that at least 50 percent of the households in the border counties (on the slave side) and 41 percent in Clay's Kentucky would not have lost wealth in such a circumstance. Likely more than half of the diminution of slave wealth, at the household level, would have been covered by the appreciation of farmland in this counterfactual.

How would the timing of possible institutional change affect this calculation? As Cassius Clay assumes, the rise in farm value would be gradual, which would reduce the present value of the appreciation. But emancipation proposals floating around Upper South at the time would also have been gradual and reduced the cost to slaveowners. Thomas Jefferson Randolph (namesake of his famous grandfather) proposed in 1832 a gradual emancipation in which those born after 1840 would receive freedom as an adult (Freehling 1967). Henry Clay (distant cousin of Cassius) proposed a similar scheme in Kentucky in 1849 (Martin 1918).[18] Slaveowners would have ample opportunity to sell their slaves out of state before then, so gradualism would also limit the economic loss to slaveowners (and the restoration to the enslaved of what both Randolph and Clay acknowledged was a natural right to freedom).

IX. Conclusion

In the latter half of the twentieth century, economists dropped into the literature on antebellum US slavery with a systematic analysis of productivity (Conrad and Meyer 1958, Fogel and Engerman 1971, *inter alia*). Earlier historians had argued that slavery was unprofitable and therefore moribund as a mode of production. In that sense, it bore more resemblance to feudalism, with its attention to rigid social hierarchies, than to the capitalism emergent elsewhere in the world. Economists reported a variety of evidence to the contrary: farms using slave labor were indeed competitive (meaning profitable in the accounting if not the economic sense), slave prices reflected underlying considerations of revenue and cost, markets were thick for all manner of inputs and outputs, etc. Therefore, while slavery was, as Jefferson's first draft of the Declaration of Independence stated, an 'execrable commerce', it was not associated with unproductive misallocation of resources (so went their argument).

Also in the latter half of the twentieth century, Douglass North brought to the fore the idea that 'institutions' are fundamental determinants of economic performance. This idea has proved useful in understanding the large disparity of incomes per capita across countries, for example. In this framework, there could be disparities across countries or regions even if locally markets and firms are behaving as in the textbook model of competition, maximization, etc. Instead, a place with weaker institutions suffers from a systemic reduction in productivity.

These two strands came together in the work of Engerman and Sokoloff (2011), who argued that historical labor coercion constrained institutional development, even after slavery ended. They argue that the

[18] Clay's proposal was not adopted by the Kentucky Constitution Convention, but delegates voted nearly unanimously to affirm a statement that "slavery as it exists by law in this state is injurious to the prosperity of the Commonwealth" along with moral objections familiar to the modern reader (Martin 1918, p. 126).

slave societies of the Americas were indeed quite productive early on, but that they grow more slowly than free-soil societies in the past century and a half. Societies with labor coercion (slavery, serfdom etc.) are often the last to acquire the modern institutions–depersonalized rule of law, competitive markets, universal suffrage, mass public education, public health and sanitation, etc.–associated with economic growth, enlightenment, and human flourishing. The story is one of path dependence. Engerman and Sokoloff argue that labor coercion might have been the highest productivity mode in colonial times, but it left behind institutions unable to adapt to modern economic growth.

Our results indicate instead that the path dependence started before slavery ended, at least in the US free-slave borderlands. Slavery endured not just by the coercion of the slaveowner, but by the force of the state, which had to become quite intrusive. Ira Berlin (1998) wrote that 'slave societies' were not just 'societies with slaves,' but rather societies in which every aspect was affected by protecting slaveholder's interests. The stark differences at the border highlight that the slave system depressed land productivity and repulsed potential settlers and migrants. Free labor demanded a wage premium to be on the slave side and whites preferred (and improved) otherwise-comparable land on the free side. Amazingly, in the area of this study, the reduction in land value associated with slavery was larger than the value of slave wealth itself.

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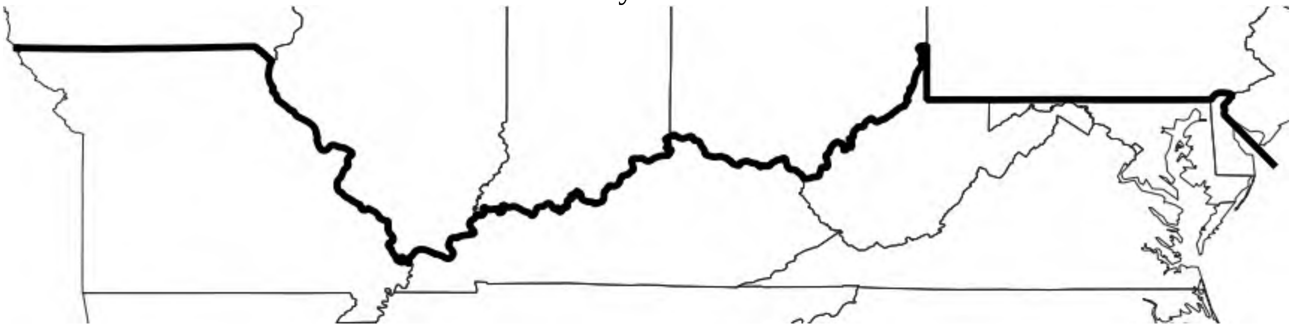
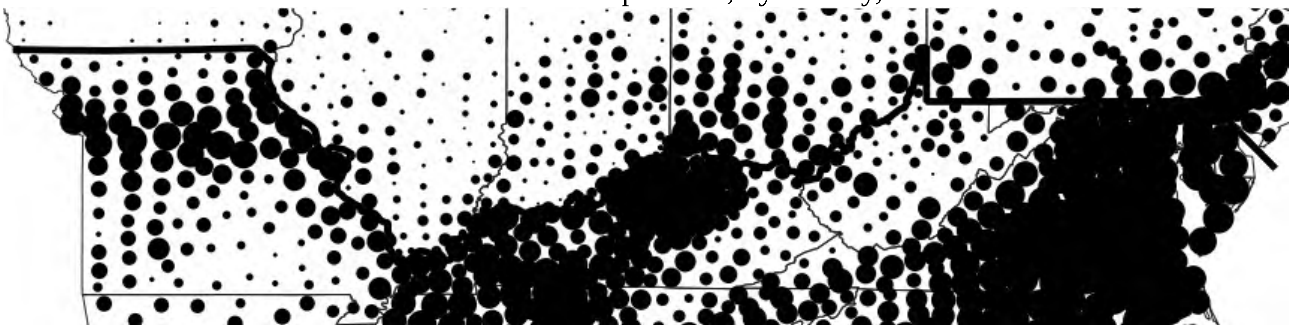
The appendices of the paper are available here.

Figure 1: The Borderlands between Free and Slave Sections of the United States

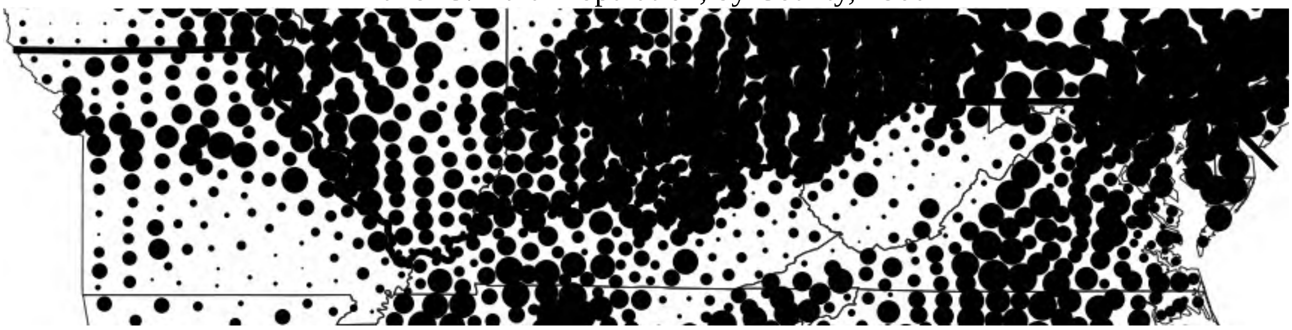
Panel A: The Free/Slave Boundary in 1860 in Relation to State Borders



Panel B: Nonwhite Population, by County, 1860



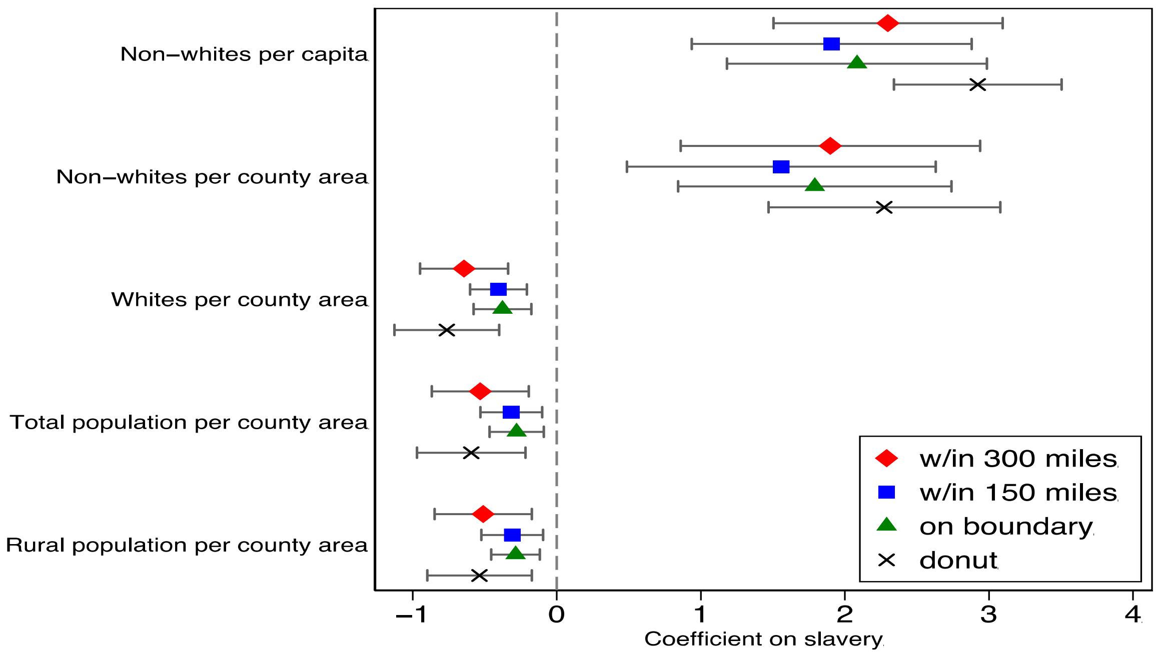
Panel C: Rural Population, by County, 1860



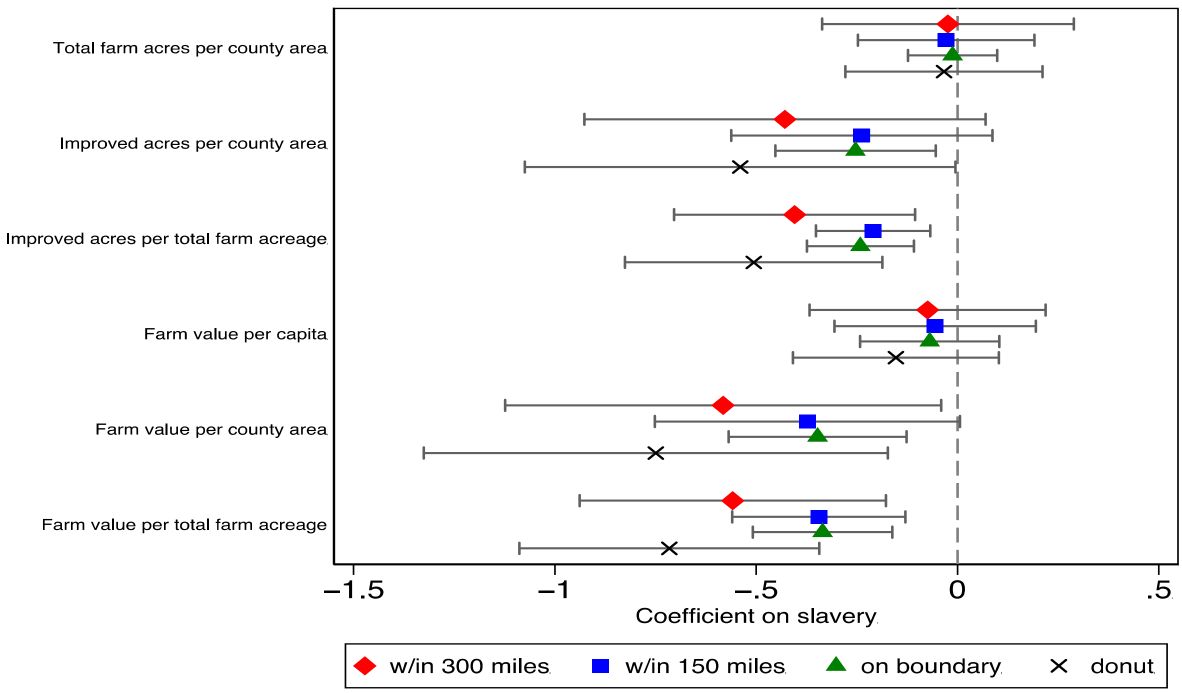
Notes: This figure uses as a base map the 1860 free/slave boundary, the 1860 state borders, and the later border of West Virginia for reference. These features are displayed by themselves in Panel A. (See Appendix A for details on the measurement of the free/slave boundary.) The remaining panels display 1860 county-level data using dots on top of the base map. The dots are proportional to the percentile of the indicated outcome. Each dot is placed at the respective county's centroid. The source for the spatial data is the National Historical Geographic Information System (NHGIS, Minnesota Population Center, 2011). The population data are based on census counts compiled in ICPSR study #2896 (Haines, 2010). Panel B presents the total non-white population, which principally consists of blacks in the displayed region. Panel C presents the total rural population, defined as total county population minus population in urban places with at least 2500 inhabitants.

Figure 2: Main outcomes

Panel A: Population

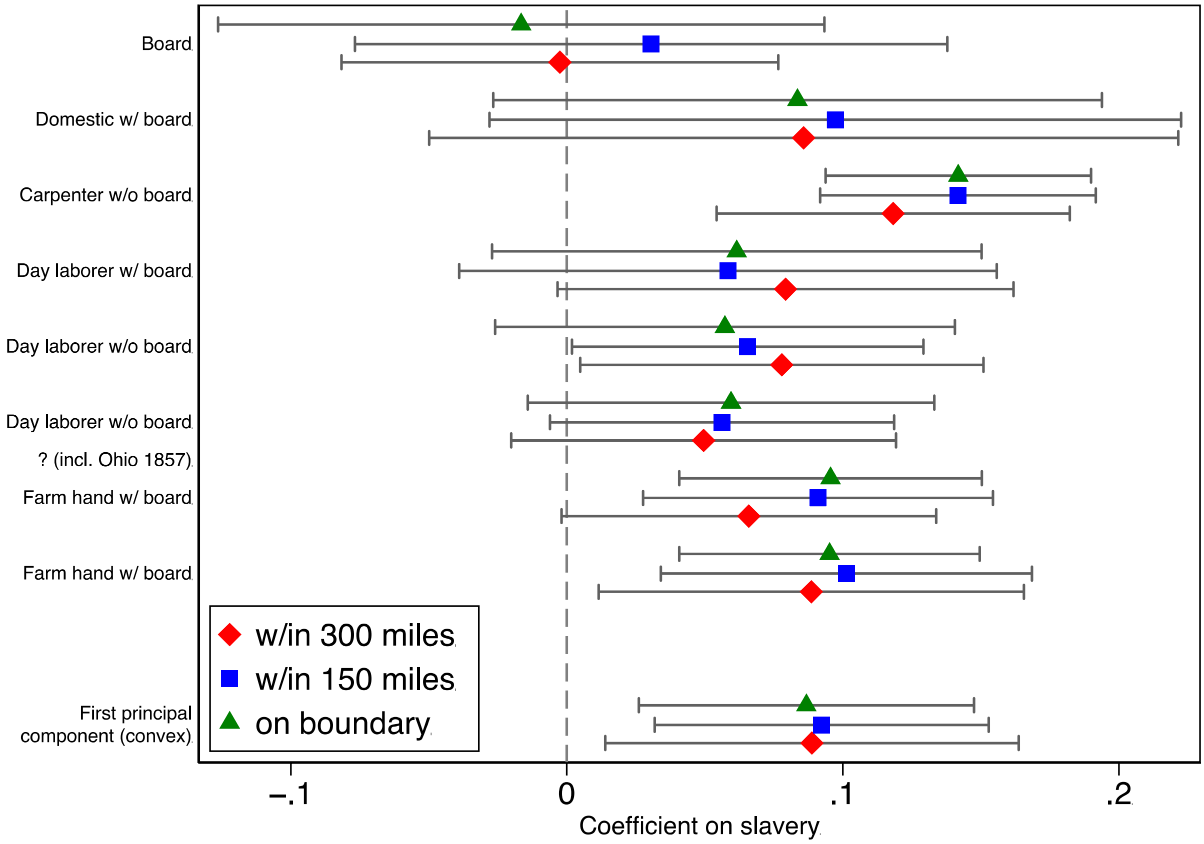


Panel B: Land Use and Land Value



Notes: This figure presents point estimates and confidence intervals for the coefficient on slavery for the outcomes indicated in the row label and for various samples of counties. Point estimates are denoted with symbols within horizontal bands denoting 95-percent-confidence intervals. Standard errors are estimated using 15 quantiles of longitude as clusters. The vertical, dashed line denotes a null hypothesis of zero.

Figure 3: Wages (natural logs)



Notes: This figure presents point estimates and confidence intervals for the coefficient on slavery for the outcomes indicated in the row label and for various samples of counties. Point estimates are denoted with symbols within horizontal bands denoting 95-percent-confidence intervals. Standard errors are estimated using 15 quantiles of longitude as clusters. Each symbol type denotes a distinct sample: red diamond for counties within 300 miles of the boundary, blue square for counties within 150 miles of the boundary, and green diamond for counties adjacent to the boundary. The vertical, dashed line denotes a null hypothesis of zero.

Table 1: Sensitivity analysis, select variables

Outcomes (in natural logarithms):	(1) Nonwhites per county acre	(2) Whites per county acre	(3) Rural population per county acre	(4) Total farm acres per county area	(5) Improved acres per total farm acre	(6) Farm value per county acre	(7) Farm value per total farm acre
Panel A: Reweighting and recoding of zeros							
Baseline	1.899 (0.485) [1280]	-0.644 (0.142) [1362]	-0.511 (0.157) [1357]	-0.024 (0.146) [1356]	-0.405 (0.140) [1356]	-0.582 (0.252) [1356]	-0.558 (0.177) [1356]
Weight by Rural Population	2.036 (0.362) [1275]	-0.580 (0.100) [1357]	-0.365 (0.0817) [1357]	0.045 (0.0593) [1352]	-0.212 (0.0867) [1352]	-0.380 (0.147) [1352]	-0.425 (0.132) [1352]
Unweighted	1.993 (0.459) [1280]	-0.533 (0.145) [1362]	-0.431 (0.132) [1357]	-0.035 (0.122) [1356]	-0.278 (0.133) [1356]	-0.429 (0.220) [1356]	-0.394 (0.168) [1356]
Assign zeros to minimum	1.927 (0.521) [1364]	-0.661 (0.150) [1364]	-0.513 (0.168) [1364]	-0.068 (0.179) [1364]	-0.428 (0.135) [1364]	-0.629 (0.265) [1364]	-0.586 (0.171) [1364]
Panel B: Additional spatial controls							
Dummies for 5 quantiles of longitude	1.860 (0.505) [1280]	-0.641 (0.138) [1362]	-0.516 (0.157) [1357]	-0.023 (0.146) [1356]	-0.419 (0.144) [1356]	-0.600 (0.258) [1356]	-0.577 (0.184) [1356]
Dummies for 10 quantiles of longitude	1.866 (0.508) [1280]	-0.640 (0.136) [1362]	-0.510 (0.155) [1357]	-0.023 (0.146) [1356]	-0.416 (0.145) [1356]	-0.598 (0.259) [1356]	-0.575 (0.185) [1356]
Dummies for 15 quantiles of longitude	1.876 (0.514) [1280]	-0.653 (0.129) [1362]	-0.522 (0.147) [1357]	-0.034 (0.140) [1356]	-0.418 (0.146) [1356]	-0.607 (0.255) [1356]	-0.572 (0.186) [1356]
Add cubic polynomial in latitude and longitude	1.873 (0.508) [1280]	-0.571 (0.120) [1362]	-0.455 (0.137) [1357]	0.003 (0.132) [1356]	-0.374 (0.130) [1356]	-0.506 (0.193) [1356]	-0.509 (0.148) [1356]
Variables from Panel A of Figure 2	1.982 (0.508) [1280]	-0.533 (0.130) [1362]	-0.407 (0.137) [1357]	0.005 (0.136) [1356]	-0.327 (0.121) [1356]	-0.429 (0.243) [1356]	-0.434 (0.171) [1356]
Depth to bedrock	2.109 (0.427) [1280]	-0.670 (0.143) [1362]	-0.471 (0.151) [1357]	0.011 (0.154) [1356]	-0.367 (0.125) [1356]	-0.498 (0.236) [1356]	-0.509 (0.160) [1356]
Soil variables from Panel B of Figure 2	1.665 (0.389) [1280]	-0.520 (0.137) [1362]	-0.311 (0.126) [1357]	0.186 (0.0938) [1356]	-0.315 (0.102) [1356]	-0.346 (0.198) [1356]	-0.532 (0.154) [1356]
Fraction glaciated	1.962 (0.488) [1280]	-0.514 (0.179) [1362]	-0.383 (0.179) [1357]	0.119 (0.142) [1356]	-0.346 (0.140) [1356]	-0.396 (0.258) [1356]	-0.515 (0.181) [1356]
Fraction glaciated (excl. Driftless)	1.975 (0.488) [1280]	-0.525 (0.160) [1362]	-0.397 (0.163) [1357]	0.107 (0.131) [1356]	-0.343 (0.138) [1356]	-0.402 (0.248) [1356]	-0.509 (0.179) [1356]
Fraction in Public Land Survey System (PLSS)	1.712 (0.458) [1280]	-0.682 (0.131) [1362]	-0.517 (0.147) [1357]	-0.059 (0.121) [1356]	-0.364 (0.150) [1356]	-0.561 (0.246) [1356]	-0.502 (0.171) [1356]
Panel C: Outcome variables in levels (per acre), various estimators							
Mean (OLS)	0.006 (0.00207) [1362]	-0.040 (0.0182) [1362]	-0.021 (0.00533) [1362]	0.017 (0.0502) [1356]	-0.133 (0.0476) [1356]	-7.988 (2.785) [1356]	-11.050 (3.923) [1356]
Median (Quantile Reg.)	0.002 (0.000643) [1362]	-0.028 (0.00320) [1362]	-0.019 (0.00329) [1362]	-0.030 (0.0369) [1356]	-0.174 (0.0309) [1356]	-5.132 (1.229) [1356]	-9.062 (1.613) [1356]

Notes:

Table 2: Results for various subsamples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcomes (in natural logarithms):	Nonwhites per county acre	Whites per county acre	Rural population per county acre	Total farm acres per county area	Improved acres per total farm acre	Farm value per county acre	Farm value per total farm acre
Panel A: Subsamples based on closest boundary segment							
Change to PLSS at Free/Slave Boundary	1.834 (0.725) [694]	-0.697 (0.224) [706]	-0.533 (0.235) [706]	0.015 (0.126) [706]	-0.535 (0.238) [706]	-0.529 (0.378) [706]	-0.544 (0.275) [706]
No change to PLSS at Free/Slave Boundary	1.987 (0.517) [586]	-0.573 (0.123) [656]	-0.501 (0.148) [651]	-0.054 (0.223) [650]	-0.290 (0.150) [650]	-0.635 (0.284) [650]	-0.581 (0.232) [650]
Mason-Dixon	1.241 (0.693) [321]	-0.518 (0.0208) [323]	-0.427 (0.188) [318]	0.226 (0.185) [322]	-0.215 (0.232) [322]	-0.402 (0.198) [322]	-0.628 (0.217) [322]
Ohio (the river)	1.384 (0.855) [582]	-0.836 (0.260) [590]	-0.611 (0.284) [590]	-0.069 (0.148) [590]	-0.552 (0.287) [590]	-0.725 (0.459) [590]	-0.656 (0.321) [590]
Missouri (the state)	3.000 (0.638) [377]	-0.519 (0.186) [449]	-0.480 (0.213) [449]	-0.167 (0.333) [444]	-0.425 (0.205) [444]	-0.581 (0.437) [444]	-0.415 (0.301) [444]
Riverine boundaries	1.879 (0.586) [895]	-0.665 (0.167) [906]	-0.519 (0.186) [905]	-0.023 (0.143) [904]	-0.494 (0.196) [904]	-0.646 (0.339) [904]	-0.622 (0.236) [904]
Geometric boundaries	1.910 (0.658) [385]	-0.522 (0.188) [456]	-0.435 (0.245) [452]	-0.003 (0.288) [452]	-0.224 (0.134) [452]	-0.409 (0.234) [452]	-0.407 (0.188) [452]
Closest boundary east of Miami River	1.570 (0.717) [724]	-0.772 (0.187) [733]	-0.607 (0.230) [728]	-0.027 (0.151) [732]	-0.422 (0.241) [732]	-0.640 (0.362) [732]	-0.613 (0.254) [732]
Closest boundary west of Miami River	2.338 (0.653) [556]	-0.494 (0.160) [629]	-0.404 (0.173) [629]	-0.046 (0.242) [624]	-0.410 (0.146) [624]	-0.544 (0.332) [624]	-0.498 (0.238) [624]
Panel B: Subsamples based Newberry data on historical county borders							
FIPS code first appears in or after 1823	2.235 (0.596) [606]	-0.637 (0.216) [685]	-0.534 (0.207) [684]	-0.079 (0.267) [679]	-0.510 (0.201) [679]	-0.595 (0.383) [679]	-0.516 (0.263) [679]
FIPS code first appears before 1823	1.944 (0.468) [674]	-0.588 (0.115) [677]	-0.435 (0.140) [673]	-0.020 (0.0861) [677]	-0.314 (0.126) [677]	-0.503 (0.186) [677]	-0.483 (0.159) [677]
Current boundary first appears in or after 1845	1.352 (0.666) [628]	-1.162 (0.244) [704]	-1.027 (0.263) [702]	-0.420 (0.317) [698]	-0.777 (0.176) [698]	-1.302 (0.380) [698]	-0.882 (0.247) [698]
Current boundary first appears before 1845	2.434 (0.450) [652]	-0.420 (0.139) [658]	-0.274 (0.119) [655]	0.100 (0.0752) [658]	-0.112 (0.0856) [658]	-0.224 (0.173) [658]	-0.324 (0.147) [658]
Panel C: Subsamples based on susceptibility to soil erosion							
More susceptible to erosion (K-factor)	1.876 (0.485) [659]	-0.455 (0.114) [682]	-0.345 (0.101) [680]	-0.004 (0.0694) [679]	-0.341 (0.108) [679]	-0.497 (0.204) [679]	-0.492 (0.173) [679]
Less susceptible to erosion (K-factor)	1.589 (0.610) [621]	-1.127 (0.364) [680]	-0.974 (0.375) [677]	-0.043 (0.352) [677]	-0.570 (0.283) [677]	-0.925 (0.517) [677]	-0.882 (0.281) [677]
More susceptible to erosion (KF-factor)	1.951 (0.507) [674]	-0.475 (0.111) [682]	-0.332 (0.116) [682]	0.061 (0.111) [680]	-0.371 (0.113) [680]	-0.435 (0.252) [680]	-0.496 (0.172) [680]
Less susceptible to erosion (KF-factor)	1.945 (0.803) [606]	-1.131 (0.345) [680]	-1.003 (0.353) [675]	-0.176 (0.416) [676]	-0.606 (0.267) [676]	-1.044 (0.486) [676]	-0.868 (0.265) [676]

Notes: