Was Free Soil Magic Dirt?

Endowments versus Institutions in the Antebellum United States

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Abstract: In the antebellum United States, "free soil" areas had greater economic development than the areas where slavery was legal, even in places that were ecologically similar, such as along the free-slave border. Was free soil "magic dirt," or could free farms compete in the slavery-legal region? We consider three classes of tests. First, we construct, separately for the two regions, suitability indices using soil and climate endowments. The indices suggest free-soil techniques could have prospered in the Upper South. Second, we show that endowments earning a high (hedonic) return on free soil received little return where slavery was legal. Third, we randomly sample farmers from the 1860 agricultural census in Kentucky and compare them to free farmers in states across the Ohio River. Kentucky farmers without slaves occupied land of lower value per acre but produced more output per farm value than either their slave-owning neighbors or farmers in the neighboring free states. Together, this evidence indicates that a free-soil society could have thrived in the border South but prevailing institutions held back free farms.

Institutions, modes of production, and environmental endowments affect economic outcomes. We consider the case of antebellum US agriculture and distinguish between the farm and the societal levels. Where slavery was legal, farm operators could employ free or enslaved labor. But on 'free soil,' slavery was prohibited. In each region, this was not simply a legal choice about labor contracts, but rather something tied up with all aspects of society. In a "slave society," as Frank Tannenbaum (1947, pp. 117-18) famously put it: "Slavery influenced the architecture, the clothing, the cooking, the politics, the literature, the morals of the entire group — white and black, men and women, old and young. Nothing escaped, nothing, and no one." The two systems competed in national government, on the frontier, and finally on the battlefield. Yet the border between free and slave states was set relatively early in the Republic and showed little sign of moving during the antebellum period.

In Bleakley and Rhode (2022), we found that the free-soil region had greater economic development than the region where slavery was legal, even in places that were ecologically similar, such as along the free-slave border.[1] This presents a puzzle: why did free farming, apparently more productive, not displace slave-based agriculture immediately to the south? Was the free-soil region in possession of some kind of 'magic dirt'? Or could free farms compete in the slavery-legal region as well? If so, where? How far south?[2]

We consider three classes of tests. First, we construct, separately for the two regions, suitability indices using soil and climate endowments. The suitability indices for settlement under the two regimes differed substantially because the institutions assigned different marginal values for endowments.[3] We find ecological conditions supporting free farming were present in

[1] Specifically, in Bleakley and Rhode (2022), we compare neighboring places with similar environments rather than distant, different places--the Deep South and the North—as the previous literature had done. We also sought to distinguish between the effects on mobile and immobile factors. We found that land on slavery-legal side was underused (lower population density and farm value). In summary, in the borderlands, half of the land was half underutilized on the slavery-legal side. Additionally, we showed that wages were higher there. Combined, these results demonstrate a dis-amenity: free labor did not want to work alongside slavery.

[2] An earlier literature suggested slavery thrived in more productive environments. Bushman (2018) cites climatic conditions, specifically the length of the growing season, as defining the border where slave labor prevailed. The prior literature (see Wright 2006 and Majewski 2016) also focused on conditions within the slavery-legal region and found positive relationships between measures of performance (population density and farm values per farm acre) and the prevalence of slavery (slave density and percent enslaved). This "within regime" finding directed attention away from the "between regime" result that the legality of slavery was associated with lower performance.

[3] Gavin Wright (2006) noted that the free soil and slavery-legal regimes were developing differently. Each was, in some sense, a success by its own metrics and a failure by the other's. But the conditions in the slavery-legal regime in the late antebellum period did not lay the foundations for long-run economic growth.

the South in ample measure. Indeed, the free-soil index is higher than the index for slavery across a wide swath of the South. Second, with these indices, we show that endowments predicting high land demand in the free-soil region have little predictive power for land demand in the slavery-legal region, even in places where the fraction of the population enslaved was low.

Third, to investigate how free and slave farms fared in the border South, we randomly sample farmers from the 1860 agricultural census in Kentucky. We compare these agricultural operations with the existing micro sample of free farms from neighboring states across the Ohio River. Kentucky farmers without slaves apparently occupied land of lower value per acre, but produced more crop output per farm value than either their slave-owning neighbors or farmers in the nearby free states.[4] We relate this finding to the claim by Hinton Helper (1857, p. 164) that slave owners had monopolized the best land and explore other hypotheses about the preferences of yeoman farm families.

I. Half Free, Half Slave?

The phrase, "Half Free, Half Slave," is often applied to the antebellum United States (Levine 1992). But it belies an important fact: growth in the North was leaving the South behind. Apologists for the economic system of the slave states observed regional incomes were similar on a per-capita basis. But the success of a frontier society – with land abundant relative to the Old World – lay in using land more intensively.[5]

The fifty-fifty split had been approximately correct at the nation's founding. But, as Figure 1 displays, the division had dramatically changed by the 1850s. Population growth was much more rapid in the free states, even before the advent of mass migration from Europe in the late 1840s. The share of the slave South in total US population fell below 45 percent by 1840 and its share of the free population fell to about one-third at this time. Mass migration only

[4] Thomas and Ayers (2003) compared economic development in Augusta County, VA, and Franklin County, PA, two communities on different sides of the Mason-Dixon line.

[5] Hinton Helper (1857) observed that southern economic performance was unimpressive when judged on basis of the extent of economic activity per land area whereas Beebe (1860) asserted the region was doing well when economic performance was measured on a per capita basis. As financial capital and free labor could move to obtain their best returns, we would expect per capita income to be similar across areas within a country. This undermines the utility of per capita income as a metric for comparing performance. In contrast, the existence of otherwise comparable land with different output (per unit areas) represents a productive inefficiency (a failure to arbitrage). This, standard economic reasoning favors Helper's metric: output per area. In general, analysis of the effects of a local or regional policy should consider the price of immobile factors and the quantity of mobile factors.

intensified the sectional imbalance. By 1860, the slave South's share of the total population was below four-tenths and its share of the free population was near three-tenths.

Measures of economic activity mirror these patterns. Evidence from Lindert and Williamson (2016) indicate that the "colonies" and "states" below the Mason-Dixon line generated about 56 percent of income in 1774 and 45 percent in 1800. By 1860, their implied fraction was less than one-third. The numbers of Easterlin (1960, 1961) and Fogel and Engerman (1974, p. 264) paint a similar picture for the late antebellum period.[6]

The relative growth rates of economic activity and population had important consequences for political balance. The slave South's share of membership in the US House of Representatives was always less than one-half, lying between its share in the total population and that of the free population (due to the three-fifths compromise). In absolute numbers, the South's count of representatives peaked at 100 members in 1830. By 1860, the count was down to 85. The South's share of the Senate fell below 50 percent with the admission of California as a free state in 1850. (No Slave state had been added after the annexation of Texas in late 1845.) The South had long held more territory than the North, but with the conquests from Mexico even this balance shifted after the late 1840s.

Our previous work (Bleakley and Rhode 2022) showed the competitive advantages of the free-soil regimes were apparent locally, in the border region. Population density and real estate values per acre were higher in the free-soil side than in the slavery-legal side. Yet the free-soil regime was not pushing slavery out of its domain—which is a puzzling outcome.[7] Is this because there were no environment endowments suited to free soil in the slavery-legal region? We begin by seeking to measure which environmental conditions generated "success" under each institutional regime.

[6] Easterlin (1961, p. 256) placed Delaware and Maryland in the Mid-Atlantic region and Missouri in the West North Central region. Fogel-Engerman (1974) and Lindert-Williamson (2016) followed suit. To calculate the income share of the slave South, we attribute to the populations of these states the per capita incomes of their assigned regions and include the resulting total income with the South.

[7] A long-standing policy of some Whigs (e.g. Henry Clay) and later many Republicans (e.g. Abraham Lincoln) was to contain the slave system from expanding on the frontier, not to rollback.

II. Estimation Strategy for Suitability Indices

The key suitability variables that we seek to predict at the county level are the rural population density, the fraction of the population enslaved, and slave population density.[8]

For rural population density, we develop separate calibrations in the slavery-legal and free-soil regions. These two measures, which may be taken as suitability indices for settlement under the two regimes, will differ if the institutions have different marginal values for endowments. We estimate for each system, r, over a sample of counties, i, operating under the system, the following specification:

(1) $\text{Density}_i = \varphi_r(\text{Ecological Endowments}_i)$.

The second set of measures -- the fraction of the population enslaved and slave population density -- may be treated as suitability indices for slavery. These indices, estimated in a specification analogous to (1), will necessarily be calibrated only in the slavery-legal region. We apply estimates of the relationships from that region to a more comprehensive sample of counties. There is sufficient internal variation in the prevalence of slavery within the slavery-legal region and sufficient commonality in environmental conditions between the slavery-legal and free-soil regions for this to be a meaningful exercise. But care must be taken to avoid extrapolating far from the common support of the data.

We use the voluminous ecological data described in the border paper to estimate settlement suitability indices in what we conceive to be a comprehensive and methodologically transparent manner.[9] The variable list is as follows:

[8] Due to data limitations, the slave population density is for the entire county, including both rural and urban areas.

[9] The indices include longitude but not latitude. The ecological variables do not alone capture the unfolding of the settlement process, which largely proceeded from east to west. Including longitude captures these effects without incorporating endogenous variables such as the date of county formation.

1. General variables

Elevation: mean and std. dev.
Longitude (not but latitude)
Slope: mean and std. dev.
Aquifer
On river, excl. Ohio & Miss.
Karst
Earthquakes (count)
Seismic Hazard (g)

2. Weather variables

Temperature (8 mo.): mean and std. dev.
Rainfall (8 mo.): mean and std. dev.

3. Soil variables, at various depths

Available water capacity
Bulk density
Fractions of clay, sand, and silt.
k−factor
pH
Porosity
Depth to bedrock

We combine these ecological data with a cross-validated shrinkage estimator to generate indices of suitability for slavery and settlement under the two systems. Using a cross-validated shrinkage estimator instead of OLS helps address the concern that when we fitted a prediction equation to one dataset and apply them to a second dataset, we will over-fit and make the estimates too sensitive to select variables in the first dataset due to the sampling. This will lead to higher variance in the predicted values in the second dataset. This concern is especially salient as we are using a large number of ecological variables as predictors. We specifically use Ridge, which penalizes large coefficients, introducing some downward bias to reduce variance.[10]

We calibrate the indices on the counties in each region within 300 miles of the border. In addition to the default specification of a. the shrinkage estimator run on geographical variables and a quadratic in the weather variables, we also run the following alternative specifications: b. the shrinkage estimator run on weather interacted with all of the geographical variables; and c. an OLS estimator on geographical variables and a quadratic in the weather variables. (Later in the analysis we will use leave-one-out estimators.) We then applied the predicted equations φ to the entire sample, hence extrapolating the suitability indices calibrated from one region onto the other.

[10] We use Stata's "elasticnet" command, which allows for a mix of ridge regression and LASSO. We tried various mixes until choosing to set alpha equal to zero, which gives ridge regression. LASSO typically did not seek to exclude any of the variables, which undercuts the purpose for employing that procedure.

III. Extrapolations of Suitability Indices

The endowments that supported successful free-soil settlement were present in the slavery-legal region, and vice versa to a certain extent. But institutions do value endowments differently. Figure 2 maps the predicted values of rural population density. Panel A denotes the prediction calibrated to the free-soil region whereas Panel B uses those calibrated to the slavery-legal region. Both the similarities and the differences are interesting. The similarities capture the locations that would be densely settled under either system; the differences show the locations favored in one system and not the other. In neither panel is there a sharp break at the border, indicating that policy choices about institutions rather than environmental conditions account for the differences in actual outcomes.

According to the indices, free-soil institutions could have succeeded far south of the free-slave border. The shading of the maps is set to the same scale, so Panel A displays a denser rural population than Panel B. Panel C graphs the fitted values against one another. Most of the points are below the 45-degree line (of highly correlated suitability indices under the two systems). This reveals that a. the institutions valued the endowments differently and that b. in most counties, the predicted population density would have been higher under the free-soil regime than under the slavery-legal regime. Panel D conducts the same analysis for states (excluding those far from the border). Again, most states are below the 45-degree line. Iowa is one exception, which perhaps points to the source of the conflicts over the Kansas-Nebraska territory. (Abraham Lincoln was, based on this evidence, right to dismiss the claims of Stephen Douglas that nature excluded slavery from much of the West.)

Figure 3 maps the predicted distribution of the enslaved population. Panel A maps the predicted density per unit area whereas Panel B maps the predicted fraction of the population enslaved. These exercises allow for counterfactual assessments of where, for example, slavery would have been prevalent within the free-soil states were it legal. Note the distributions do not consider limitations on the existing size of the enslaved population in 1860 nor of the effects of the hypothetical expansion of the domain of the peculiar institution on slave prices. The region around Toledo, Ohio appears a potential hotspot for slavery; it shared environmental characteristics with the parts of the South where slavery was prevalent. As above, there is no clear break in the predicted values at the actual free-slave border.

Another way to visualize the suitability of free-soil agriculture is Figure 4, which plots each county's free-soil index for rural population density versus the distance to the free-slave border. To separate the regions, free soil areas have a negative distance in this graph. Each county is a dot (proportioned to county area) and the gray line is a quadratic fit in distance, for the region where slavery was legal. Panel A shows the default calibration (from a cross-validated ridge regression with ecological variables and a weather quadratic). The index is a predicted value throughout, but everything to the right of zero is predicted out of sample. South of the border, the distribution of the index is at least as good as on free soil over a rather large range. The peak itself is at almost 300 miles, which is well into the Deep South.

Allowing for interactions of climate and geology does not alter the conclusion of high free-soil suitability in the Upper South. Presumably a geological variable (e.g. sandy soil at a certain depth) has a different hedonic value if the climate differs. To check this, we recomputed the index with interactions between the weather quadratic and each geological variable. (This estimation has around 500 variables now, so shrinkage is even more important.) Panel B contains a plot of the new index. If anything, the distribution of outcomes in the Upper South looks better and the quadratic fit peaks farther south.

We obtain a similar result using OLS to construct the index on the default set of variables. (A few variables are dropped, per Stata's algorithm, for collinearity.) This index shows the possibility of successful free-soil agriculture in the Upper South. The quadratic fit, however, peaks closer to zero, and the index is lower for the Deep South than before.

We can also focus our inference to Southern counties within the support of the ecological variables in the North. This is a restrictive criterion that ignores a county if any of the more than four-score variables lies outside the range measured for free soil. Essentially all of the counties in the Deep South are excluded. In Panel D, we flag the retained observations with gray dots and estimate the quadratic fit for those alone. (These are the same values displayed in Panel A.) The gray dots tell the same story: there is ample room for free-soil agriculture in the Upper South.

Do the rural density indices created for 1860 apply to earlier periods as well? We can readily carry out the same estimation procedure for 1850 and the results are close. The correlation for the indices calibrated to the free-soil regime in the free-soil sample between 1850 and 1860 is 0.907. For the whole sample, the correlation is 0.904. The correlation for the indices calibrated to the slavery-legal regime for the slavery sample

between 1850 and 1860 is 0.671. For the whole sample, the correlation is 0.270. For both indices, the correlations were higher in the sample in which the indices were fitted than in the sample in which they were applied. And the correlation between the indices under the same regime over time is much higher than the correlation between the indices calibrated to the free-soil and slavery-legal regimes at the same point in time. (The correlation of the free-soil and slavery-legal indices in the whole sample is 0.437 for 1860 and 0.187 for 1850.) It is reasonable then to focus on the 1860 indices and learn what we can in detail.[11]

IV. Returns to Endowments

The endowments associated with successful settlement in one region were not highly valued in the other. In the North, this should be no surprise, as slavery was banned. In the South, however free farms were permitted and indeed represented the vast majority of agricultural operations.

We estimate the (hedonic) returns to each endowment. We will examine the effects of the settlement indices on a set of outcomes including rural population per county area, farm value per county acre, farm value per total farm acres, total farm acres per county area, and improved farm acres per total farm acres.[12]

How do the settlement indices predict the outcomes when used together in the same regression? Consider the following model:

$$(2)\ Y=\beta_{free}\,\varphi_{free}+\beta_{slave}\varphi_{slave}+\text{Spatial Controls}$$

Model (2), including the "own" and "other" settlement suitability indices, is analyzed in Table 1. The results for the free-soil states appear on the left, columns (1)-(5) and those for the slavery-legal states appear on the right, columns (6)-(10). The baseline is for the counties in a 300-mile buffer of the free-slave border. The spatial controls are a cubic in distance from the border and a cubic in longitude. As a way of focusing attention, Figure 5 displays the regression coefficients

[11] Appendix Tables 3 and 4 relate the suitability indices to the outcomes in the border paper, Bleakley and Rhode 2022.

[12] The first outcome, rural population density, is used to construct the settlement index. To avoid inference problems, we re-estimate the index for each county leaving out its own observation.

for a key outcome, farm values per county area, columns (2) and (7), over the different specifications.

Table 1, Panel A presents results when only the own regime's index is included. The results consistently show strong effects of the expected sign. Panel B presents results when only the other regime's index is included. For the Free-Soil states, the results for the slavery-legal index are always small and statistically insignificant. For the Slave states, the results for the free-soil index are small—smaller than for the own index—and statistically insignificant for most variables.

Panel C includes both indices in combination. For the Free-Soil states, the results for the free-soil index are always strong and statistically significant whereas those for the slavery-legal index are always small and statistically insignificant. There is a similar pattern with respect to the own and other indices in the Slave states. To take column (7) on farm value per county acre as an example, the coefficient on the own index is close to unity whereas that on the other index is of very small magnitude (indeed, negative but insignificant). The only meaningful exception to this pattern occurs in column 6 on rural population density where the coefficient on the free-soil index is positive and statistically significant, if very small in magnitude. It is not entirely surprising that the environmental conditions that predicted higher population density in the free-soil region had positive effects in the slavery-legal region even controlling for the slavery-legal settlement index. Free farming was legal in the South and slavery was uncommon in many counties in the southern states. What is surprising is that the effects are not stronger. Column (10), on the improved land share, again echoes the results of column (6).

Panels D-H present a series of robustness checks, altering the spatial controls, including interactions with temperature and rainfall, leaving out the county's own state in calibrating the index, narrowing the sample to a 150-mile buffer, and broadening the sample to cover all counties. Again, the own index matters much more than the other index.

We now examine the returns to endowments controlling for the local prevalence of slavery. Consider an alternative model (3) with interaction terms:

$$(3)\ Y=\beta_{free}\,\varphi_{free}\,(1-s)+\beta_{slave}\,\varphi_{slave}\,s+\text{Spatial Controls}$$

where s is the fraction of the population enslaved. Model 3 is in the spirit of a Roy model of selection. This is run only in the slave states, in the counties in the 300-mile buffer of the border. The results are reported in Table 2. The free-soil index should matter more in the counties where the fraction slave, s, is smaller and the slavery-legal index matter more where s is higher. As s is endogenous in the model under consideration, we supplement the OLS analysis of Panel A with a 2SLS analysis in Panels B-F, where we instrument for the fraction enslaved in various ways.

In the OLS regressions of Panel A, the slavery-legal settlement index interacted with the fraction slave has strong, statistically significant coefficients of the expected signs. The free-soil settlement index interacted with the fraction free has statistically significant, positive but small coefficients for rural population density and the improved land fraction. But the term has insignificant impacts on the other outcomes.

In the 2SLS regions of Panels B-F, the slavery-legal interaction terms are always strong, statistically significant and of the expected positive sign. The free-soil interaction terms are now always small and statistically insignificant. What is notable here is that conditions that predict success in the free-soil region do not generate success in the slavery-legal region, *even where slavery is not commonly used*.

A few comments about the various 2SLS specifications are in order. As mentioned, the fraction of the population enslaved is endogenous, but we take the ecological indices as exogenous and excludable. In Panel B, we use a quadratic in the rural-density indices as instruments. For Panel C, we add the indices for slave fraction and population density as instruments. A remaining concern is that this estimator embeds a selection problem within it. The issue is that the mode-specific error term is correlated with the outcome, when that mode is chosen. This attenuates the coefficient under standard assumptions. Our estimates for β_{free} are generally negative, so we do not worry about missing large, positive effects for the own bias. (The standard approach to correcting this would be to model the choice with logit or probit and use conditional expectation of the error term as a control. Here this would be inappropriate as there are counties with zero slaves.)

Finally, we find similar results after tweaks to the calibration or to the estimation sample. In Panel E, we re-run the models in Panel B, but with indices that used interactions of geological and climate variables, as in Panel B of Figure 3. For Panel F, we use the entire region where slavery was legal in the estimation of Model (3).

In summary, the counties in the North with a comparative advantage under the free-soil regime enjoyed a boost in rural population density and farm values. The counties in the South with a comparative advantage under the slavery-legal regime also enjoyed a boost. But those southern counties with a comparative advantage under free-soil regime did not enjoy anything near the benefits that comparable counties in the North did.

V. Micro-Data on Farms

Based on the settlement suitability indices, the free-soil regime could have succeeded much further South. The border South, in terms of its endowment, looked as attractive or more attractive than the border North. The shares model (Model 3) reveals that southern counties, even with the environmental conditions conducive to free-soil success, did not prosper in terms of rural population density or farm values. But how did free farms actually fare in the slavery-legal region?

Here we go beyond the existing economic history literature (see, for example, Craig and Field-Hendre 2004). This literature compared the rural North—as reflected in the Bateman-Foust (1976) sample—with the Cotton South—as reflected in the Parker-Gallman (1991) sample. We compare Kentucky farms with only free household members with those in the state with enslaved members, and with farms in states across the Ohio river. The exercise requires that we collect a new micro-sample of Kentucky farms from the agricultural census of 1860, link these observations with the families reported in the population census, and with the schedules of the slave census.[13]

We picked 30 pairs of pages at random from the Kentucky agricultural schedules. Figure 6 maps the counties covered and compares our sample to the Bateman-Foust sample for Ohio, Indiana, and Illinois. Each pair of pages that we drew included up to 80 observations. We record the farm data. The main variables of interest are (a) Acreage (improved and unimproved); (b) Cash value of farm (not just land); (c) Value of implements and of livestock; and (d) Crop output and animal products.

[13] Several scholars – Schaeffer (1978a, 1978b), Irwin (1988), McKenzie (1994), and Dunaway (1996) —collected linked micro samples partially covering the border South before the age of the micro-computer. Most are lost now; only Irwin's sample for the Virginia Piedmont is available as digital micro data.

We then link the listed owners/operators manually to the population and slave schedules. From these records, we determined whether or not the agricultural operator held enslaved persons. Searching for farm operators in the census population schedule was facilitated by several factors, namely that the agriculture and population schedules were taken (a) in most cases, by the same enumerator; (b) often in the same order; and (c) sometimes on the same day. The linkage rate was an impressive 98 percent.

The resulting sample includes 1,979 Kentucky farms. We break the Kentucky farms into those with and without slaves. We compare these two subsamples with free farms operating North of the Ohio River—in Ohio, Indiana, and Illinois—as recorded in the Bateman-Foust sample.

The panels of Figure 7 compare the frequency distributions of these three samples for several key variables. For Improved Acres per Farm (Panel A), the Kentucky farms with slaves were much larger, on average, than the free Northern farms, which were slightly larger than the Kentucky farms without slaves. For Farm Value per Improved Acre (Panel B), the rank order was the same, but the distributions were more spread out. The distribution for Kentucky farms without slaves lay far to the left of the distribution for free Northern farms.

We take the crop output data from the census of agriculture, remove seed requirements, apply local prices and sum to generate the value of farm's total crop output. A notable finding emerges if the output value is divided by farm values (see Panel C.) The Kentucky farms without slaves have much higher ratios of crop output to farm values than either of the comparison groups. Table 3 reports coefficients for farm-type dummies in regressions explaining the log of the value of farm output to farm values. The omitted category is Kentucky slave farms.

We can break up the ratio and seek to determine whether the gaps between free and slave farms in Kentucky were due to differences in location. Figure 8 reports the coefficients as we move to ever tighter comparisons-- from the whole state, to census pages (column two), to one-half census page, to pairs (column eight). The last comparison, involving slave farms next to free farms on the same census page, is quite sparse, and the standard errors grow large. The one-half page comparisons represent near neighborhoods in the census and may be used as a baseline sample to control for local geography. In Table 3, the regressions with one-half-page fixed

effects, show Kentucky free farms had ratios of crop output to farm values over 40 percent higher than Kentucky slave farms.

In summary, slave farms in Kentucky were larger than the farms in the comparison groups. Free farms in Kentucky were of lower value per acre than the comparison farms. More notably, the free farms had higher output per farm value. These differences mostly survive controlling for local circumstances.[14] The value ratios are consistent with the slave farms buying up the better lands, as Hinton Helper (1857) argued. But the results also show that the free farmers required higher output values per dollar invested. This could be a compensating differential for operating in a disadvantageous environment. The premium also indicates that those who remained were not simply unproductive losers who could not make anything of their efforts, as Alexis DeTocqueville (1838) suggested in his discussion of Virginians.

We can conduct a similar analysis within the Parker-Gallman (1991) sample of farms and plantations in cotton-producing counties in 1860.[15] In these counties, about one-half of the farming operations were free and one-half slave; slave operations had significantly more land than free farms. And it was the more valuable land, even controlling for locality. That is, we can regress the log of farm value per acre of land (improved plus unimproved) and the log of output per farm value on an indicator variable for the absence of slaves on the farming operation with fixed effects for the specific locality, for the cluster of observations. (Recall Parker and Gallman's (1991) sampling design involved collecting five names in a cluster from the middle of the page in the manuscript Census of Agriculture. The inclusion of fixed effects here controls for the page from which the cluster was drawn.) Table 4 shows the regression results. As above, free farms in the Parker-Gallman sample were of lower value per acre and generated higher value of output per farm value than neighboring slave operations. This confirms the findings in the Kentucky sample, although the magnitudes are smaller.

VI. Commentary

The inhibiting effects of slavery on the economic performance in the border South had been the subject of long commentary. In a speech to the Virginia House of Burgesses in 1759,

[14] Other notable results in the sample are (a) no difference in mules vs horse holdings for free vs. slave operations; (b) about half of tobacco in Kentucky sample was produced on farms without slaves. See also Schaefer (1978b).
[15] Here we gauge farm output as the value of all crops (at national prices) and the reported value of animal slaughtered. The national crop prices for 1860 are from Towne and Rasmussen (1960, pp. 255-316). We did not include the value of orchard or market garden products or of home manufacturing.

Richard Henry Lee inquired: given "some of our neighbouring colonies, though much later than ourselves in point of settlement, are now far before us in improvement, to what, Sir, can we attribute this strange, this unhappy truth?" The cause was not the environment, Lee asserted: "Nature has not particularly favored them with superior fertility of soil, nor do they enjoy more of the sun's cheering influence, yet greatly have they out stripped us." Instead, he opined: "The reason seems to be this: that with their whites they import arts and agriculture, whilst we with our blacks exclude both." His suggested remedy was legislation " to lay so heavy a duty on the importation of slaves, as effectually to stop the disgraceful traffic." (See Moore 1857, p. 41).

Reverent Jonathan Boucher (1797, pp. 38-43), the Anglican minister from Virginia, also asserted that the Upper South was lagging behind the Middle colonies, although the latter began to settle much later. He blamed the institution of slavery, which introduced a labor force without incentives to improve and turned their owners into worse people.

In 1821-23, George Ogden (1907, pp. 111-12) wrote: "No part of the country possesses a more a salubrious climate or better soil, than the extensive state of Virginia; yet her white population is comparatively small. Kentucky is likewise a slave-state; her population is considerable, but it is owing to many adventitious circumstances, and accidental causes, which are not difficult of explanation. — The state of Ohio is in its infancy; slavery is excluded from it; and even colored people cannot reside here except under certain regulations. This will induce a rapid population, augment her number and resources, and she will be soon able to rise superior to her sister states in every point of view."

In 1832, during Virginia's debates over slavery in the aftermath of Nat Turner's Rebellion, Charles J. Faulkner (1832, p. 20) observed:

> If this should not be sufficient, and the curious and incredulous enquirer should suggest that the contrast which has been averted to, and which is so manifest, might be traced to a difference in climate or other causes distinct from slavery itself, permit me to refer him to the two states of Kentucky and Ohio. No difference of soil no diversity of climate no diversity in the original settlement of those two states can account for the remarkable disproportion in their national advancement. Separated by a river alone, they seem to have been purposely and providentially designed to exhibit in their future histories the difference which necessarily results from a country free from and a country affected with the curse of slavery. The same may be said of the two states of Missouri and Illinois.

In his Address to the people of west Virginia, Henry Ruffner (1847, p. 15), a slave-owner and opponent of the institution of slavery, opined:

> There are certain drugs, of which large doses are poisonous, but small ones are innocent or even salutary. Slavery is not of this kind. Large doses of it kill, it is true; but smaller doses, mix them as you will, are sure to sicken and debilitate the body politic. This can be abundantly proved by examples. For one, let us take the rich and beautiful State of Kentucky, compared with her free neighbor Ohio. The slaves of Kentucky have composed less than a fourth part of her population. …. This wonderful difference could not be owing to any natural superiority of the Ohio country. Kentucky is nearly as large, nearly as fertile, and quite equal in other gifts of nature….
> Ohio is by this time considerably more than twice as thickly peopled as Kentucky; yet she still gains both by natural increase and by the influx of emigrants; while Kentucky has for twenty years been receiving much fewer emigrants than Ohio, and multitudes of her citizens have been yearly moving off to newer and yet newer countries.

Ruffner (1847, p. 17) continued:

> Many of these multitudes, who have left the slave States, …settled in the free countries of the West. These were generally industrious and enterprising white men, who found by sad experience, that a country of slaves was not the country for them. It is a truth, a certain truth, that slavery drives free laborers—farmers, mechanics, and all, and some of the best of them too—out of the country.… Some go because they dislike slavery and desire to get away from it: others, because they have gloomy forebodings of what is to befall the slave States…: others, because they cannot get profitable employment among slaveholders: others, industrious and high-spirited working men, will not stay in a country where slavery degrades the working man: others go because they see that their country… does not prosper, and that other countries, not far off, are prospering, and will afford better hopes of prosperity to themselves.

Many similar statements were made for other parts of the border South (Tallant 2005; Stampp 1944).

Northerners also expressed opinions. In the debates over the expansion of slavery onto the territories conquered from Mexico, the Pennsylvania congressman David Wilmot (1847) proclaimed: “Where the negro slave labors, the free white man cannot labor by his side without sharing in his degradation and disgrace.” And in his Peoria speech, in which he resumed his political career, Abraham Lincoln (1854) stated: “Whether slavery shall go into Nebraska, or other new territories, is not a matter of exclusive concern to the people who may go there. The whole nation is interested that the best use shall be made of these territories. We want them for the homes of free white people. This they cannot be, to any considerable extent, if slavery shall be planted within them. Slave States are places for poor white people to remove FROM; not to

remove TO. New free States are the places for poor people to go to and better their condition. For this use, the nation needs these territories."

William Seward (1858), in his famous "Irrepressible Conflict" speech at Rochester, New York, added: "In states where the slave system prevails, the masters, directly or indirectly, secure all political power, and constitute a ruling aristocracy. In states where the free-labor system prevails, universal suffrage necessarily obtains, and the state inevitably becomes, sooner or later, a republic or democracy."

VII. Conclusion

Free Soil was not just "magic dirt," with an emphasis on "Dirt," on endowments. Rather "Free Soil" was the set of institutions that arose in the Northern states where slavery was prohibited (Foner 1970). As noted by many antebellum politicians and later observers, these institutions seemed materialized from the Jeffersonian dream of yeoman farmers with the opportunity to rise economically and participate politically and to take responsibility for their own fortunes (Gates 1976; Edwards, Fiszbein, and Libecap 2022). Such small holders would be suitable for both economic and political agency, in contrast with the widespread patterns of social exclusion in most of the world. To be sure, not everyone was included in this invitation. But that the legal systems favored the widespread participation within that group. In this way, it was unusual. This vision found reality in the Northwest Ordinances, which opened those frontier territories for settlement as free soil.

In the antebellum United States, both population and economic activity grew more rapidly in the free-soil region than in the slavery-legal region. In 1860, population density and real estate values per acre were higher in the free-soil region than in the slavery-legal region, both locally (close by) and globally (over the entire regions). Yet the free-soil regime was not pushing slavery out of its own domain. Is this because the environmental endowments suited to free soil were absent in the slavery-legal region? No, we show the endowments were similar. The different outcomes arose from the operation of the different institutions. Free-soil endowments had low returns where slavery was legal. And turning from ecological analysis to newly collected farm-level data, we show free farmers in the border South operated on less valuable land and generated more output per dollar invested, in line with requiring a compensating differential to operate there. Free farming was legal in the South and indeed most

southern agricultural operations were free-labor farms. And yet the areas in the South suited to the free-soil regime appear to have fallen under the developmental shadow of slavery. "Plain folks" existed in the South, as Frank Owsley (1949) asserted, but they did not exert the same demand for land as they did in the free-soil North.

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Appendix

Appendix Tables 1 and 2 replicate the results for Table 1 and 2, respectively, using suitability indices estimated by OLS rather than Ridge regression. The results are robust to this change.

We now relate the findings of this paper to the framework of our border paper (Bleakley and Rhode 2022). There, we compared the economic effects of the institution of slavery across locations which, according to antebellum observers, had fundamentally similar environments. The design had the beauty of a controlled experiment. Current-day observers have asked us whether there were subtle environment differences within the border region across locations regarding their suitability to slave or free settlement that would affect our results; they have also asked whether the results from the border sample extend beyond the region, for example, further South.[16]

We can use the suitability indices developed above within our border-design regression framework from our earlier paper. We first compare the estimated coefficient for the slavery-legal variable in samples split at median suitability in the 300-mile buffer sample. That is, we assign those counties with low predicted values for, say, fraction slave to the "Below median" or "less suitable" group and those with high predicted values to the "Above median" or "more suitable" group. We then run our standard regressions within each sample and compare the slavery-legal coefficients.

Table Appendix 3 reports results akin to our previous baseline (Panel A) and then new findings for sample splits based on the fraction of the population enslaved (Panel B), the density of the enslaved population (Panel C), rural population density calibrated to the slave region (Panel D), and rural population density calibrated to the free-soil region (Panel E). We examine the slavery-legal effects on the non-white population density, the white population density, the rural population density, total farm acres per county area, improved farm acres per total farm acres, farm value per county acre, and farm value per total farm acres. We focus the discussion on rural population per county acre and farm value per county acre.

[16] The effects of the peculiar institution depended on how suitable the land is for slave-labor versus free-labor uses. While it would be tempting to use the measures of crop suitability (from the FAO/GAEZ) commonly used in the literature, we believe – for reasons documented in the elsewhere—that approach deeply problematic. FAO/GAEZ places the zone highly suitable for cotton is the wrong place.

We do find some heterogeneity in slavery's effects depending on environmental characteristics. But the signs in the various subsamples and specifications always match those in the baseline specification. The slavery-legal effects differ in magnitude, but never disappear.

The results show the slavery-legal effect on the non-white population, column (1), is positive in every subsample while that on the white population, column (2), is always negative. These findings are in line with the baseline results. The effects for non-white density are stronger in the places in the above median predicted fraction enslaved and density enslaved (Panel B and C). This is perhaps as expected. What may be surprising is the effects of whites are weaker in such places.

The slavery-legal effect on rural population density, column (3), is always negative. But the gap is smaller in places with above median predicted fraction enslaved and density enslaved. White density in the slave region was depressed everywhere, but especially depressed in areas not suited to slavery. Panel E, based on the predicted rural population density as calibrated in the free-soil sample, provides additional illumination. It shows negative effects of the slavery-legal variable on rural and white population densities, in line with the baseline results. But here the gap is larger for the "above median" category, as measured by suitability for free-soil settlement. The institutions clearly have differential effects of the rural population densities predicted given pre-determined environmental conditions.

In column (6), on farm values per county acre, the slavery-legal effect is negative in every subsample, as it was in the baseline. Again, for Panels B-D, the gap is smaller (and typically statistically insignificant) in places in the "above median" categories. Again, for Panel E, with predictions are based on the free-soil region, the gap is larger in places in the "above median" settlement category.

In summary, the results for indices measuring suitability for slavery imply that the costs of the peculiar institution were greatest where slavery was less suitable. The results for predicted rural population density are more nuanced. By the calibration fitted to the slavery-legal region, the damage of having slavery is similar in above and below median groups. But, by the calibration fitted to the free regions, the damage is worse in areas more suited for free settlement.

Where does the larger gap come from? Is it due to conditions on the free side, or on the slave side? Examining these issues using an interaction framework proves clarifying. We add to

the baseline model, the index, φ_r, and its interaction with being in a slave state. Appendix Table 2 reports, in an analogous format, the results of the regression:

(A1) $Y=\alpha$ Slavery_Legal$+\beta$ Index$+\chi$Slavery_Legal$*\varphi_r$ + Spatial Controls

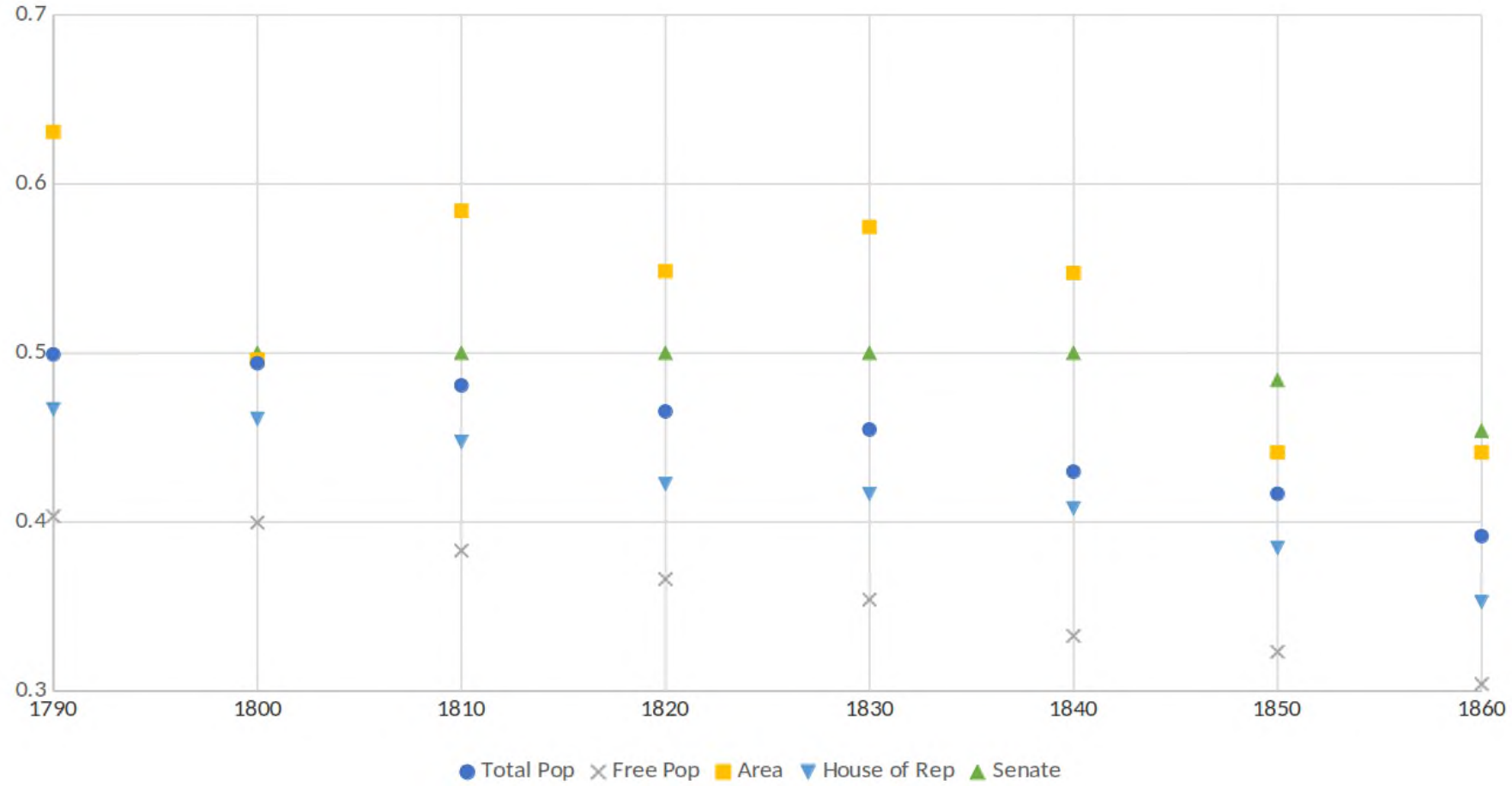
where S is the is the dummy for slavery legal and φ is the index of choice derived from those above. The index, φ_r, is continuous and has been rescaled so that the full range of the variable is unity. The interaction, Slavery_Legal$*\varphi_r$, is constructed to evaluate each main effect at the mean of the other variable.

The suitability indices themselves perform as expected; they are predictive of greater density, improvement, and farm values per county area. For the indices calibrated in the slavery region, greater suitability attenuates the effect of slavery. The main effect of slavery remains negative, but this effect is weaker in places where the ecological variables would predict greater settlement. For the index calibrated on free soil, however, greater suitability predicts a stronger adverse effect of slavery. Here the interaction effect switches sign. This indicates that the effect of the peculiar institution is even more negative in areas predicted to have greater rural population density. (Per construction of the variables, the estimated main effect of slavery is similar to the baseline results because it is evaluated at the mean of the index.) This makes sense if the spatial pattern of within-region settlement is a function of institutions.

In each region, the given index picks up both the effect of the ecological variables and how they are filtered through institutions. A location that scores highly on one index, but not the other, is better suited to one institution versus the other. In general, the slavery effect is diminished with an increased in an index calibrated on the slavery-legal region; the effect is intensified with an increased in an index calibrated in the free-soil region. In each case, the weights are optimized to pick up how the institutions map endowments to settlement activity.

As a summary, the institutions value environmental endowments differently. In addition, the free-soil institutions would support higher population densities and farm values thorough much of the border South region. The effects of the slave-legal variable on improvement and farm values are a. more adverse in places with below median suitability for slavery; b. below median rural population density as calibrated to the slavery-legal region; and c. above median rural population density as calibrated to the free-soil region.

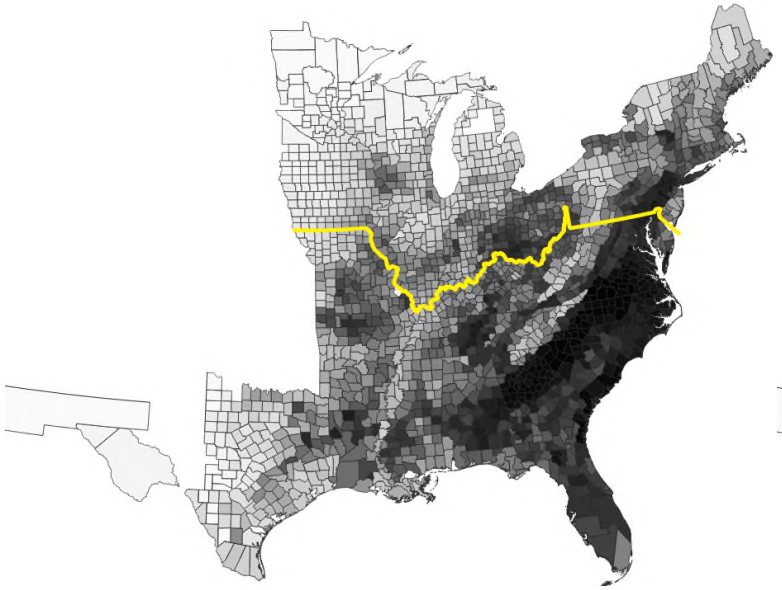
Figure 1: Southern Shares on National Population, Land, and Political Representation, 1790-1860



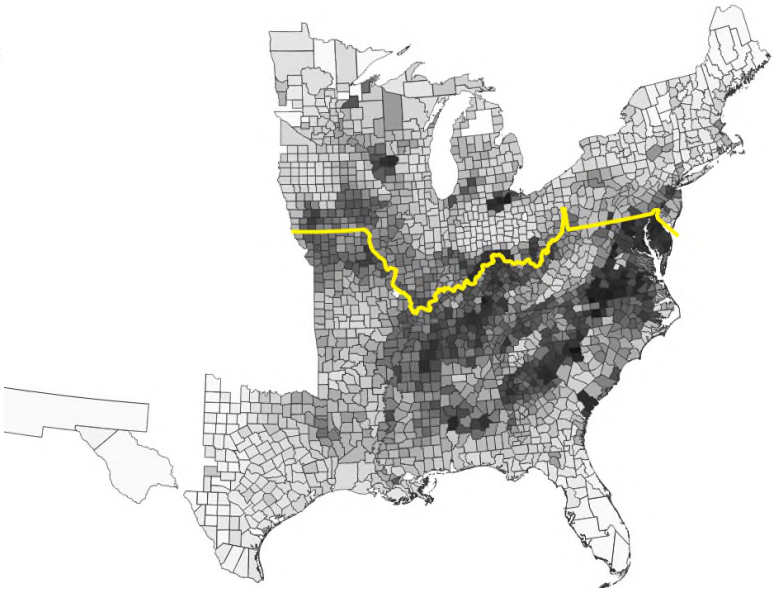
Sources: Historical Statistics of the United States, Mill. Ed. Series Eb3 (politics); Bicent. Ed. A195 (pop), A210-262 (territory), and authors' calculations.

Figure 2: Ecological Indices for Rural Population Density, 1860

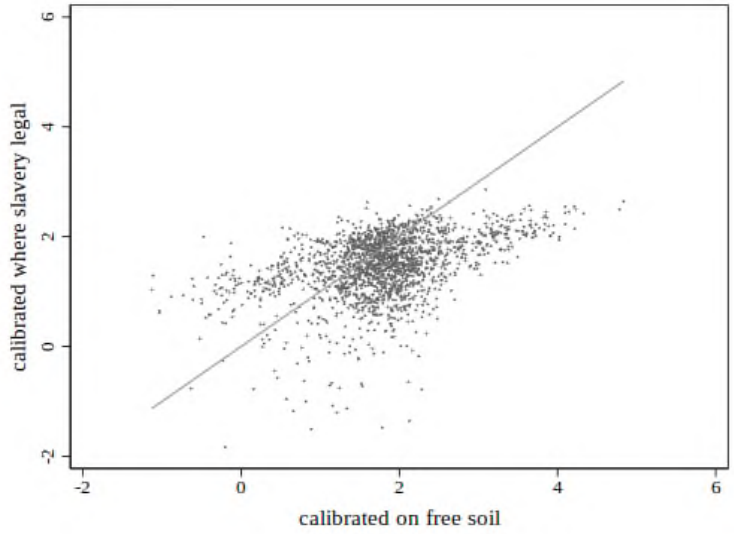
Panel A: Map of Index Calibrated in Free-Soil Region



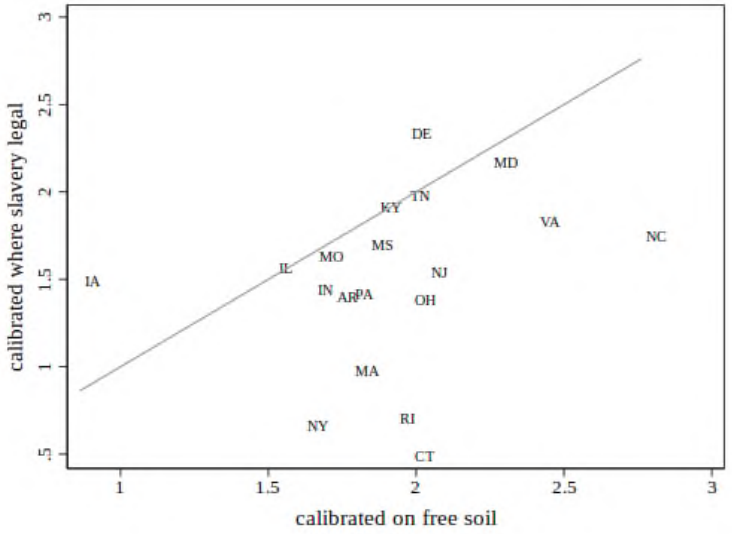
Panel B: Map of Index Calibrated in Slavery-Legal Region



Panel C: Comparison of Indices, by County



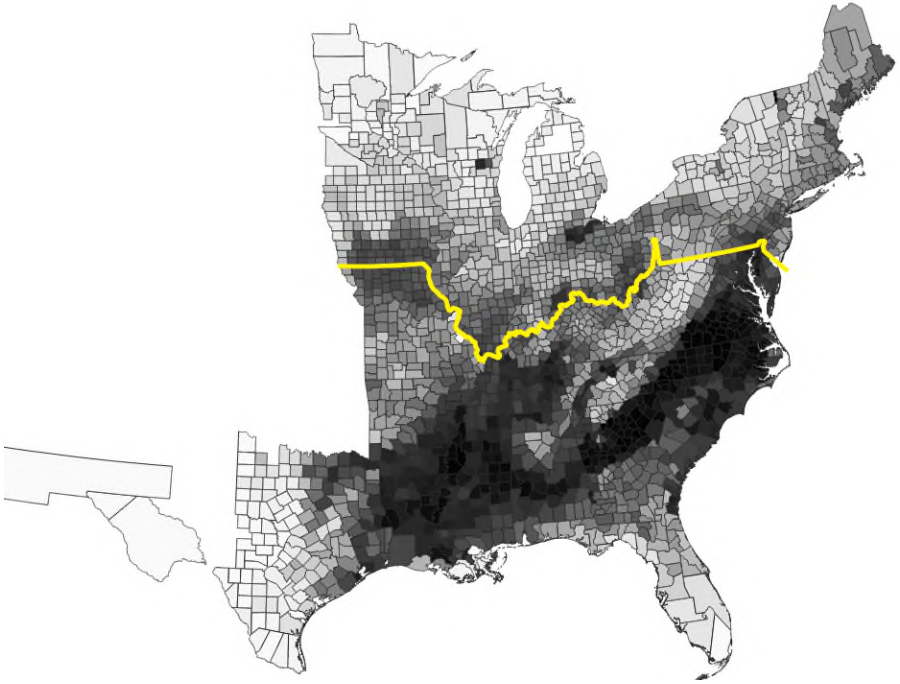
Panel D: Comparison of Indices, by State



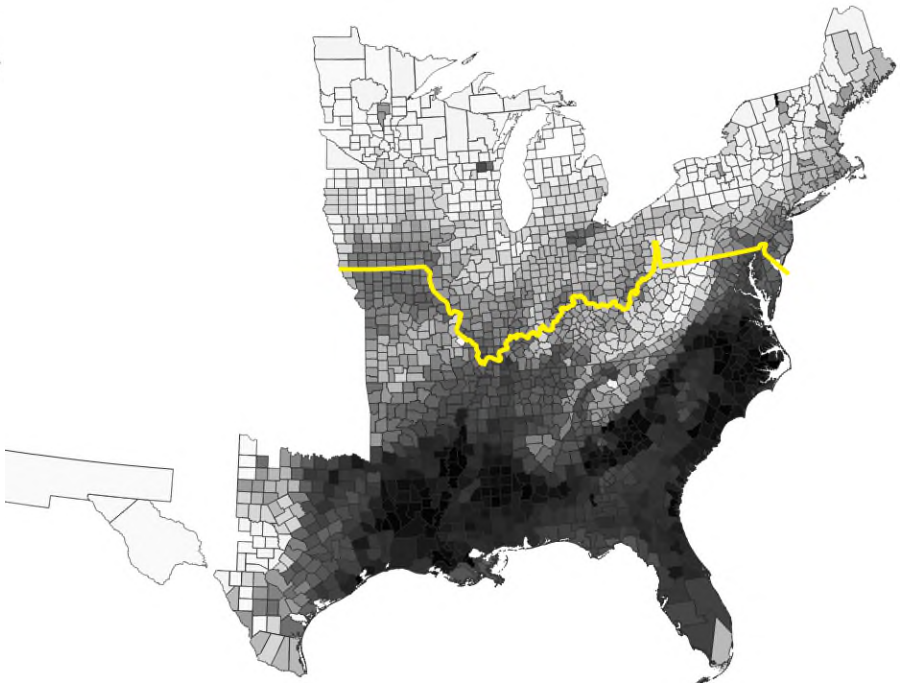
Notes:

Figure 3: Ecological Indices for Slave Population Share and Density, 1860

Panel A: Map of Index Calibrated to Density



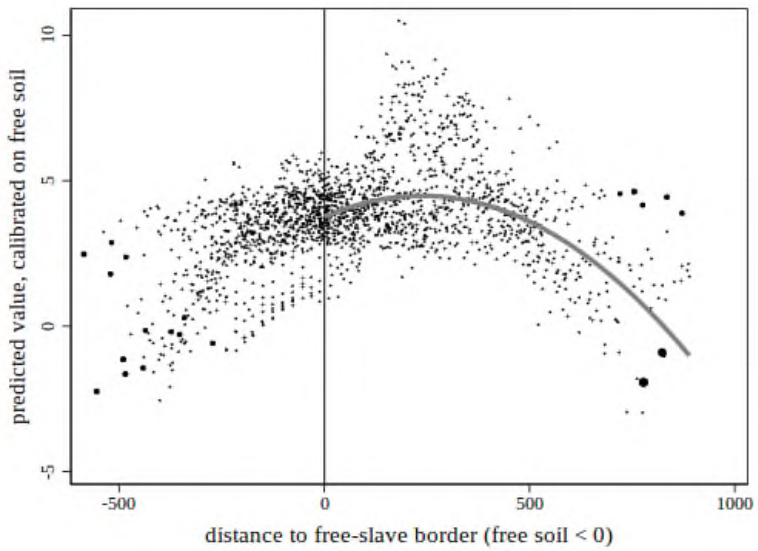
Panel B: Map of Index Calibrated to Population Fraction



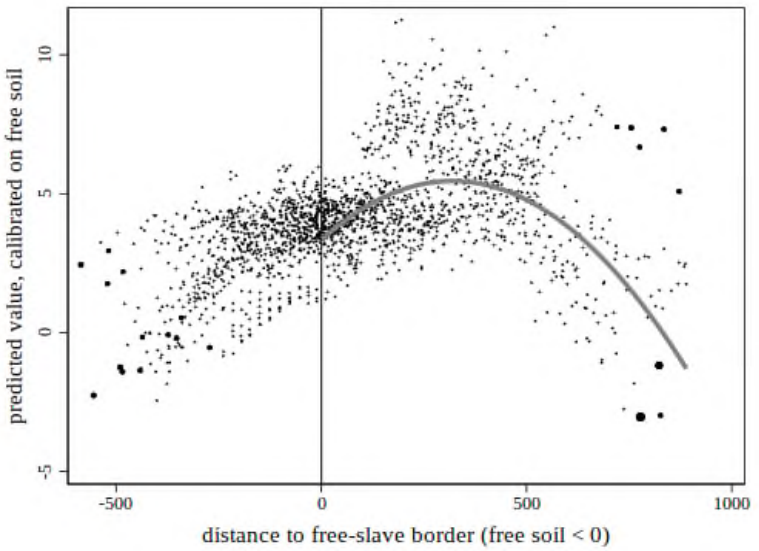
Notes:

Figure 4: Ecological Index of Rural Population Density vs the Free-Slave Border

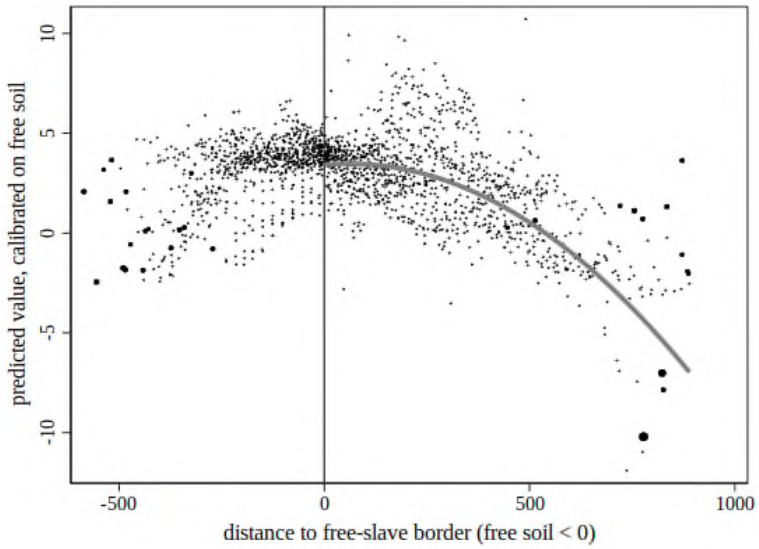
Panel A: Default Index (Geological Variables and Weather Quadratic)



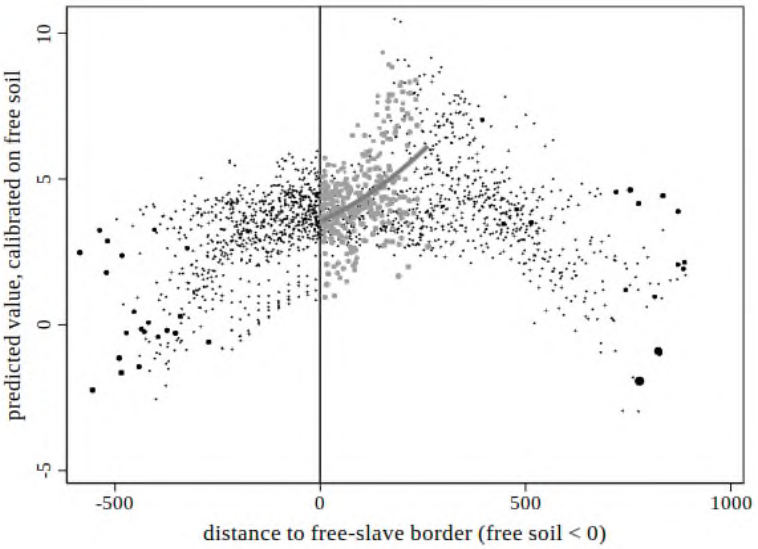
Panel B: Index with Weather Interactions



Panel C: Default Index, Calibrated with OLS instead of Ridge

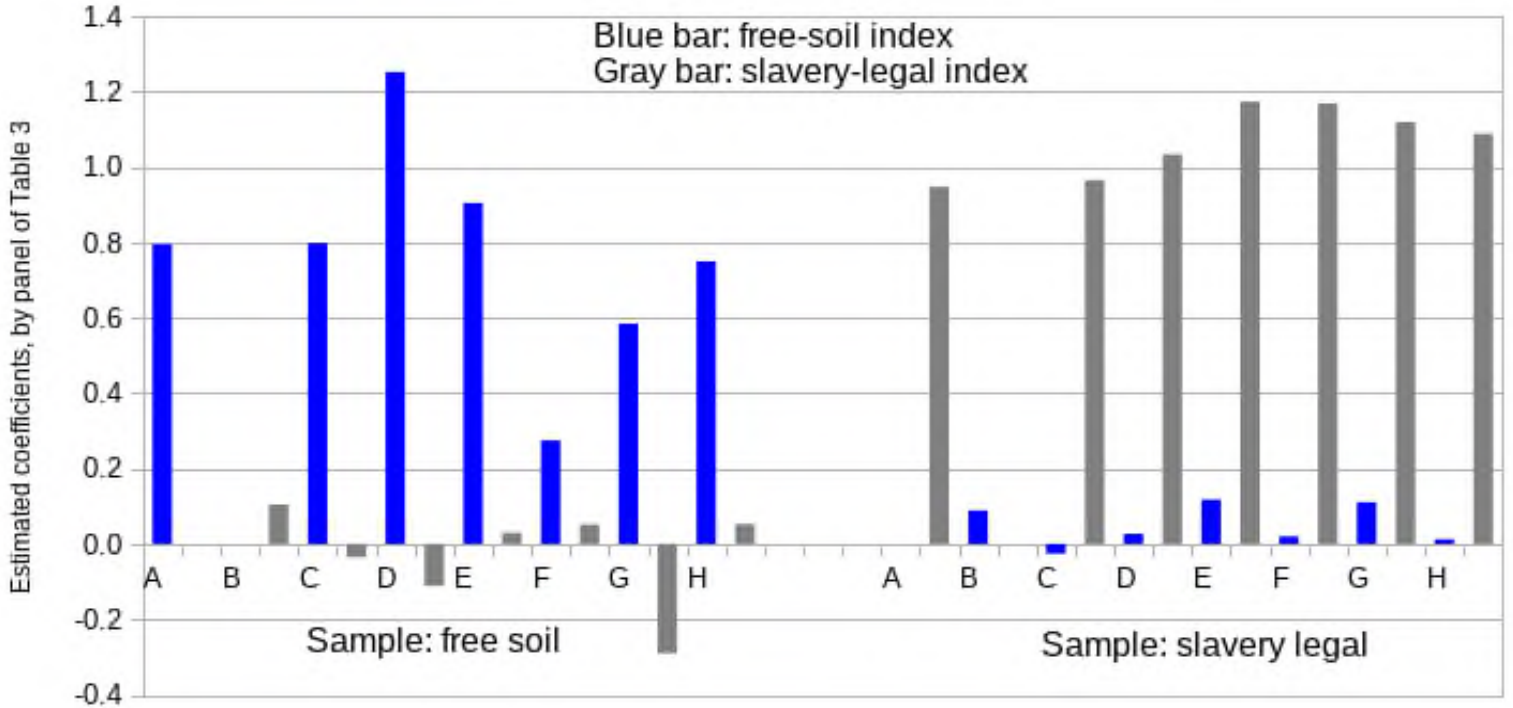


Panel D: Default Index, Focus on Common Support



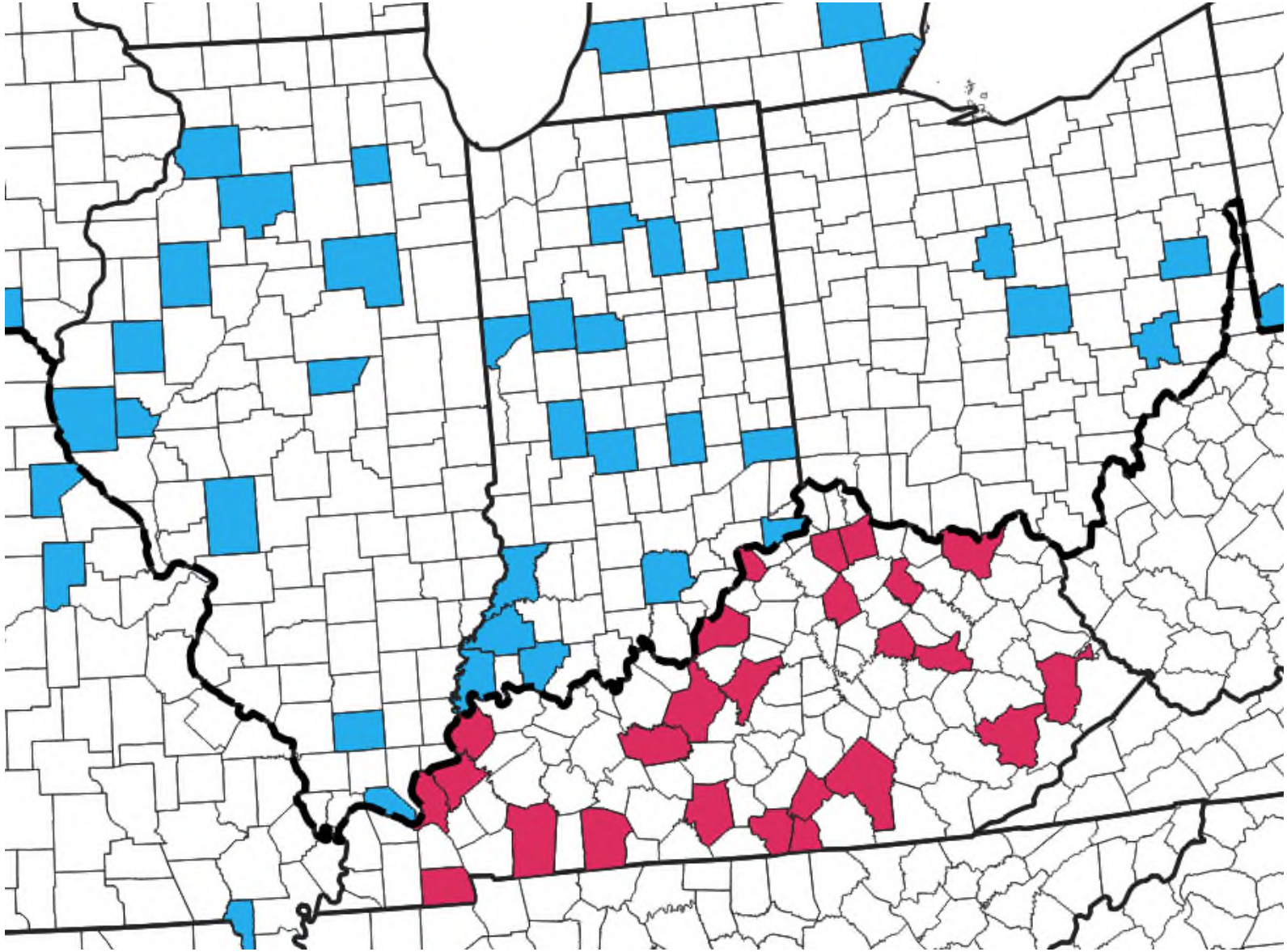
Notes:

Figure 5: Regressions Coefficients for Shares Model, Farm Value per County Area



Notes: this reproduces coefficient estimates from Table 1, columns (2) and (7).

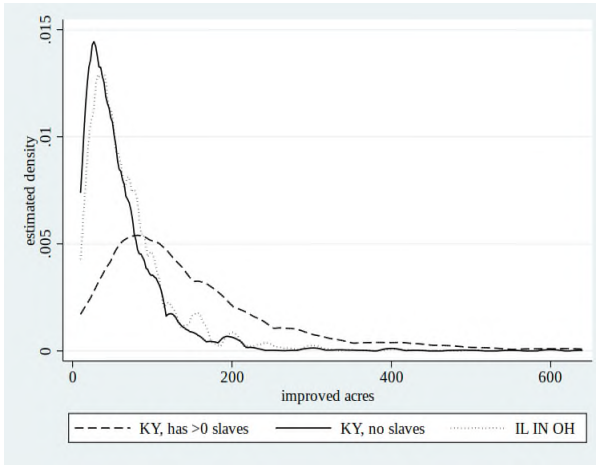
Figure 6: Coverage of Kentucky Farm Sample and Bateman-Foust Sample in IL/IN/OH



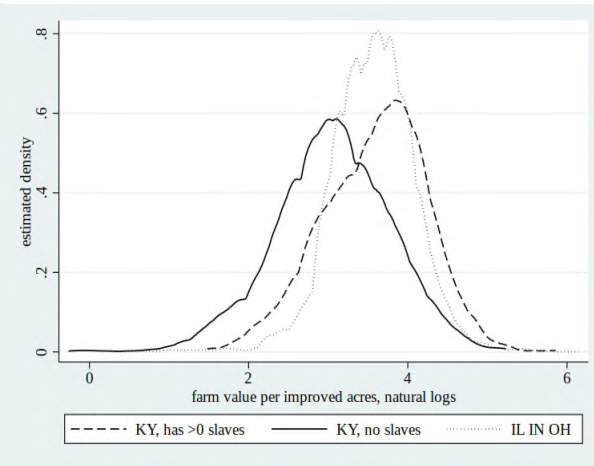
Notes:

Figure 7: Distributions of Various Outcomes, Farms using Slave Labor versus Free Labor Only

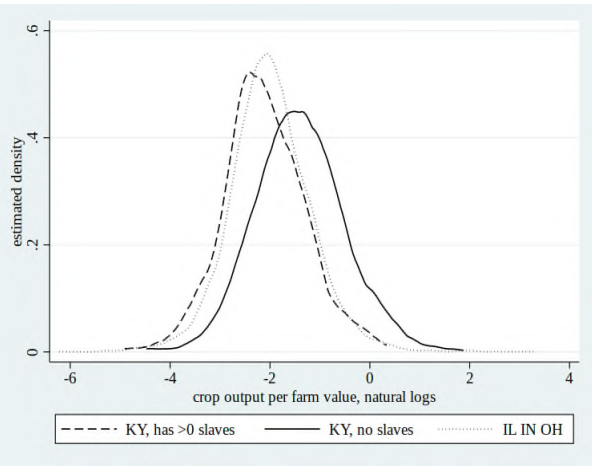
Panel A: Improved Acres



Panel B: Farm Value per Improved Acre



Panel C: Output Value per Farm Value



Notes:

Figure 8: 95% Confidence Intervals from Regressions of Select Outcomes on Farm using Slave Labor, KY Sample

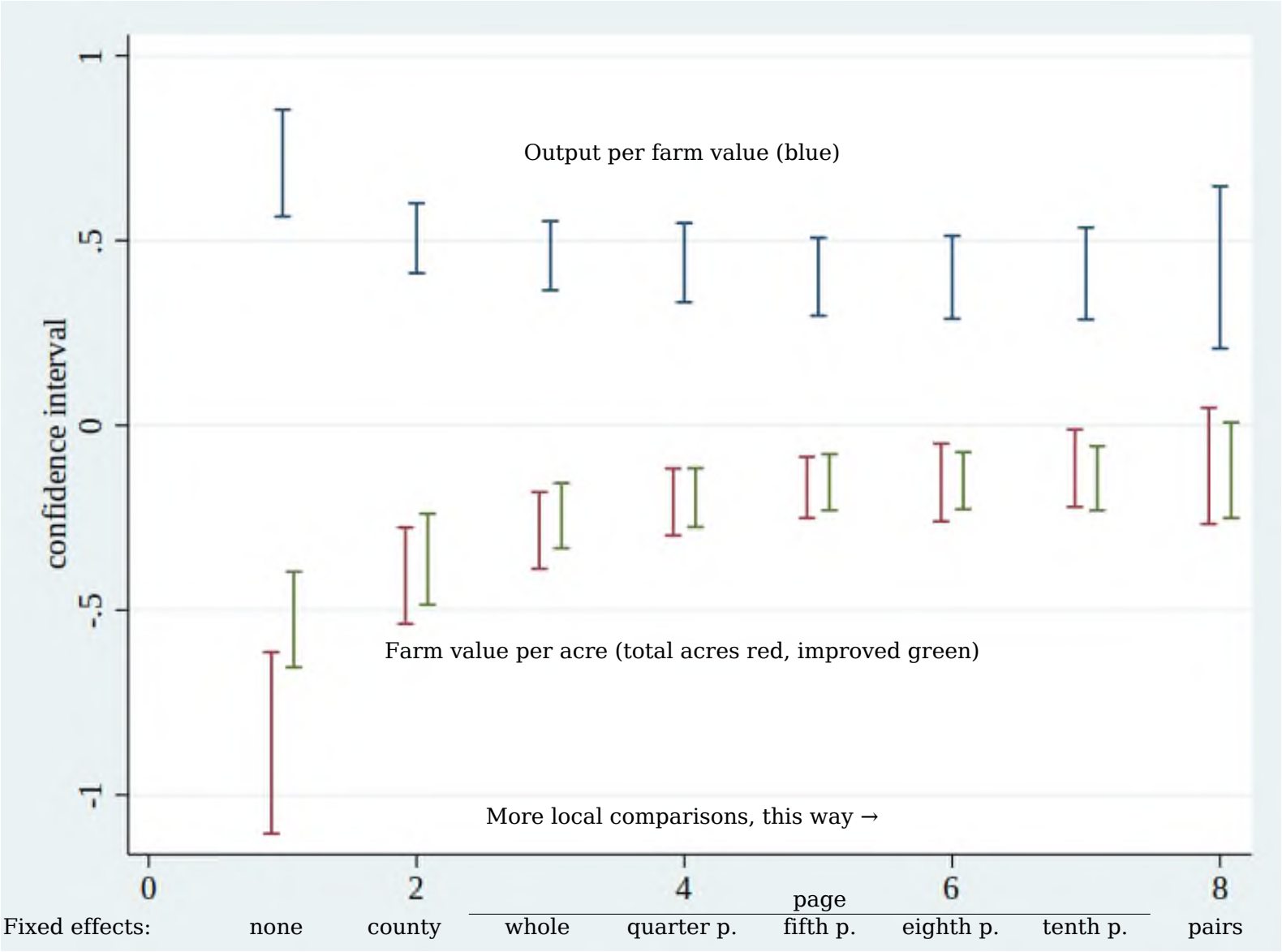


Table 1: Regional differences in the effects of leave-out-own-county ecological indices

	Free-soil states					Slavery-legal states				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Outcomes (in natural logarithms):	Rural population per county acre	Farm value per county acre	Farm value per total farm acre	Total farm acres per county area	Improved acres per total farm acre	Rural population per county acre	Farm value per county acre	Farm value per total farm acre	Total farm acres per county area	Improved acres per total farm acre
Control variables:										
Panel A: Index from Own Region										
Index calibrated to free states	0.557	0.810	0.292	0.518	0.660					
	(0.0652)	(0.101)	(0.0687)	(0.0822)	(0.0904)					
Index calibrated to slave states						0.613	0.886	0.447	0.439	0.849
						(0.0734)	(0.171)	(0.0883)	(0.125)	(0.134)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel B: Index from Other Region										
Index calibrated to free states						0.181	0.162	0.093	0.069	0.215
						(0.0402)	(0.0837)	(0.0621)	(0.0255)	(0.0490)
Index calibrated to slave states	0.108	0.038	0.018	0.020	-0.094					
	(0.137)	(0.232)	(0.128)	(0.126)	(0.155)					
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel C: Index from Both Regions										
Index calibrated to free states	0.554	0.816	0.294	0.523	0.676	0.063	-0.030	-0.002	-0.029	0.042
	(0.0610)	(0.0935)	(0.0658)	(0.0774)	(0.0884)	(0.0334)	(0.0691)	(0.0523)	(0.0280)	(0.0392)
Index calibrated to slave states	0.034	-0.072	-0.021	-0.050	-0.185	0.565	0.910	0.448	0.461	0.817
	(0.0928)	(0.164)	(0.104)	(0.0855)	(0.107)	(0.0952)	(0.183)	(0.0925)	(0.132)	(0.148)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel D: Omit Spatial Controls										
Index calibrated to free states	0.958	1.219	0.440	0.780	1.076	0.088	0.003	-0.058	0.061	0.111
	(0.163)	(0.161)	(0.0299)	(0.156)	(0.188)	(0.0268)	(0.0252)	(0.0183)	(0.0296)	(0.0372)
Index calibrated to slave states	-0.067	-0.164	-0.184	0.020	-0.122	0.659	1.026	0.486	0.540	0.910
	(0.0986)	(0.159)	(0.0991)	(0.0969)	(0.119)	(0.122)	(0.192)	(0.0696)	(0.208)	(0.186)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel E: Index has Interactions with Temperature and Rainfall										
Index calibrated to free states	0.519	0.761	0.276	0.485	0.626	-0.021	-0.150	-0.077	-0.073	-0.073
	(0.0617)	(0.0934)	(0.0574)	(0.0728)	(0.0859)	(0.0204)	(0.0515)	(0.0373)	(0.0251)	(0.0288)
Index calibrated to slave states	0.132	-0.012	-0.068	0.056	-0.019	0.882	1.348	0.686	0.662	1.227
	(0.0846)	(0.108)	(0.0647)	(0.0859)	(0.110)	(0.0645)	(0.152)	(0.113)	(0.129)	(0.110)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel F: Leave Out Own State from Estimation of Indices										
Index calibrated to free states	0.320	0.491	0.216	0.274	0.339	0.104	0.023	0.041	-0.018	0.090
	(0.0549)	(0.0996)	(0.0663)	(0.0530)	(0.0915)	(0.0453)	(0.0967)	(0.0716)	(0.0367)	(0.0555)
Index calibrated to slave states	0.101	-0.106	-0.044	-0.062	-0.318	0.640	1.074	0.412	0.662	0.989
	(0.210)	(0.362)	(0.209)	(0.206)	(0.252)	(0.178)	(0.322)	(0.144)	(0.238)	(0.272)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel G: Sample Restricted to Counties Within 150 miles of Free-Slave Border										
Index calibrated to free states	0.361	0.562	0.306	0.256	0.397	0.205	0.226	0.178	0.047	0.253
	(0.0289)	(0.0696)	(0.0562)	(0.0311)	(0.0681)	(0.0890)	(0.123)	(0.117)	(0.0672)	(0.106)
Index calibrated to slave states	-0.159	-0.325	-0.172	-0.154	-0.220	0.686	1.019	0.552	0.467	0.939
	(0.0798)	(0.120)	(0.0686)	(0.0773)	(0.117)	(0.106)	(0.233)	(0.128)	(0.125)	(0.187)
	[409]	[411]	[411]	[411]	[411]	[404]	[405]	[405]	[405]	[405]
Panel H: Sample Expanded to All Counties										
Index calibrated to free states	0.563	1.004	0.248	0.755	0.961	0.133	0.008	0.056	-0.048	0.105
	(0.0601)	(0.0837)	(0.0616)	(0.0929)	(0.0988)	(0.0720)	(0.102)	(0.0631)	(0.0909)	(0.0966)
Index calibrated to slave states	-0.027	-0.252	0.104	-0.356	-0.493	0.702	1.054	0.039	1.016	0.991
	(0.132)	(0.0671)	(0.109)	(0.0845)	(0.103)	(0.116)	(0.0823)	(0.129)	(0.110)	(0.0659)
	[765]	[749]	[749]	[749]	[749]	[1100]	[1089]	[1089]	[1089]	[1089]

Notes:

Table 2: Shares model for effects of ecological indices in slave states (300-mile buffer)

	(1)	(2)	(3)	(4)	(5)
Outcomes (in natural logarithms):	Rural population per county acre	Farm value per county acre	Farm value per total farm acre	Total farm acres per county area	Improved acres per total farm acre
Control variables:					
Panel A: OLS					
Index calibrated to free states * (1 – slave fraction of population)	0.160 (0.0420)	-0.003 (0.0725)	0.004 (0.0473)	-0.008 (0.0348)	0.120 (0.0415)
Index calibrated to slave states * (slave fraction of population)	0.664 (0.0853)	1.141 (0.176)	0.717 (0.126)	0.424 (0.0864)	0.999 (0.129)
	[696]	[695]	[695]	[695]	[695]
Panel B: 2SLS, use regional indices as instruments					
Index calibrated to free states * (1 – slave fraction of population)	-0.027 (0.121)	-0.224 (0.132)	-0.110 (0.0834)	-0.114 (0.0734)	-0.122 (0.145)
Index calibrated to slave states * (slave fraction of population)	0.977 (0.151)	1.380 (0.287)	0.720 (0.175)	0.660 (0.165)	1.347 (0.249)
	[696]	[695]	[695]	[695]	[695]
Panel C: 2SLS, add indices for slave density and population fraction as instruments					
Index calibrated to free states * (1 – slave fraction of population)	0.047 (0.102)	-0.155 (0.0888)	-0.058 (0.0657)	-0.097 (0.0683)	-0.005 (0.0991)
Index calibrated to slave states * (slave fraction of population)	0.864 (0.126)	1.294 (0.224)	0.650 (0.140)	0.644 (0.145)	1.180 (0.174)
	[696]	[695]	[695]	[695]	[695]
Panel D: 2SLS, shrink slavery coefficient					
Index calibrated to free states * (1 – slave fraction of population)	0.037 (0.0876)	-0.109 (0.146)	-0.050 (0.104)	-0.059 (0.0571)	-0.010 (0.106)
Index calibrated to slave states * (slave fraction of population)	[fixed at 20% of value in Panel B.]				
	[696]	[695]	[695]	[695]	[695]
Panel E: 2SLS, indices include interaction of variables with climate polynomial					
Index calibrated to free states * (1 – slave fraction of population)	-0.080 (0.0899)	-0.281 (0.112)	-0.160 (0.0748)	-0.122 (0.0441)	-0.189 (0.112)
Index calibrated to slave states * (slave fraction of population)	1.191 (0.158)	1.632 (0.295)	0.861 (0.198)	0.771 (0.166)	1.580 (0.255)
	[696]	[695]	[695]	[695]	[695]
Panel F: 2SLS, expand to full sample of counties in slavery-legal region					
Index calibrated to free states * (1 – slave fraction of population)	0.329 (0.275)	-0.173 (0.138)	-0.078 (0.0743)	-0.095 (0.135)	-0.001 (0.134)
Index calibrated to slave states * (slave fraction of population)	1.109 (0.0815)	1.706 (0.227)	0.362 (0.142)	1.344 (0.289)	1.715 (0.239)
	[1100]	[1089]	[1089]	[1089]	[1089]

Notes:

Table 3: Log Output per Farm Value in the Kentucky and Bateman-Foust Samples

	(1)	(2)	(3)
KY farms with no slaves	0.709 (0.042)	0.709 (0.072)	0.459 (0.047)
KY farms with slaves		[omitted category]	
Farms in IL/IN/OH	0.144 (0.037)	---	---
Cluster for microfilm roll & page	No	Yes	Yes
Fixed effect for microfilm roll & page	No	No	Yes
Sample	KY & B/F	KY only	KY only
Number of observations	[6141]	[1931]	[1931]
Adjusted R^2	{0.08}	{0.12}	{0.32}

Notes: authors' calculations using random sample of pages from 1860 Agricultural Schedule in Kentucky and extract for Illinois, Indiana, and Ohio from Bateman-Foust sample of farms. Free farms, having no slaves, made up 74.6 percent of the total sample from Kentucky.

Table 4: Comparison of Farm Value and Output Per Farm Value in Parker-Gallman Sample

	(1)	(2)
Outcomes (in natural logarithms):	Farm value per acre	Output per farm value
Farms with no slaves	-0.146 (0.023)	0.077 (0.035)
Farms with no slaves	[omitted category]	
Cluster for microfilm roll & page	Yes	Yes
Fixed effect for microfilm roll & page	Yes	Yes
Number of observations	[5053]	[4992]
Adjusted R^2	{0.65}	{0.43}

Notes: authors' calculations using Parker-Gallman sample of farms in the Cotton South. Free farms, having no slaves, made up 50.5 percent of the total sample.

Appendix Table 1: Results for various sample splits based on predicted values from ecological models

	(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: Baseline				
Baseline	1.899	-0.644	-0.511	-0.024	-0.405	-0.582	-0.558
	(0.485)	(0.142)	(0.157)	(0.146)	(0.140)	(0.252)	(0.177)
	[1280]	[1362]	[1357]	[1356]	[1356]	[1356]	[1356]
			Panel B: Predicted fraction enslaved				
Below median	0.332	-1.352	-1.285	-0.346	-0.863	-1.572	-1.226
	(0.524)	(0.335)	(0.320)	(0.326)	(0.222)	(0.458)	(0.232)
	[652]	[730]	[727]	[727]	[727]	[727]	[727]
Above median	2.274	-0.364	-0.147	0.180	-0.077	-0.050	-0.230
	(0.530)	(0.194)	(0.151)	(0.117)	(0.112)	(0.340)	(0.262)
	[628]	[632]	[630]	[629]	[629]	[629]	[629]
			Panel C: Predicted density of enslaved population				
Below median	1.444	-0.897	-0.788	-0.112	-0.618	-0.947	-0.834
	(0.629)	(0.380)	(0.377)	(0.361)	(0.209)	(0.457)	(0.204)
	[612]	[678]	[675]	[675]	[675]	[675]	[675]
Above median	2.173	-0.346	-0.248	0.057	-0.251	-0.316	-0.373
	(0.486)	(0.183)	(0.166)	(0.116)	(0.114)	(0.273)	(0.204)
	[668]	[684]	[682]	[681]	[681]	[681]	[681]
			Panel D: Predicted density of rural population, calibration from slavery-legal region				
Below median	0.272	-1.586	-1.550	-0.588	-1.005	-2.043	-1.455
	(0.454)	(0.490)	(0.476)	(0.491)	(0.231)	(0.630)	(0.250)
	[611]	[678]	[676]	[674]	[674]	[674]	[674]
Above median	1.897	-0.336	-0.199	0.101	-0.241	-0.155	-0.256
	(0.516)	(0.207)	(0.174)	(0.104)	(0.131)	(0.253)	(0.194)
	[669]	[684]	[681]	[682]	[682]	[682]	[682]
			Panel E: Predicted density of rural population, calibration from free-soil region				
Below median	2.690	-0.402	-0.327	-0.013	-0.248	-0.254	-0.241
	(0.433)	(0.204)	(0.215)	(0.217)	(0.147)	(0.290)	(0.191)
	[599]	[678]	[677]	[673]	[673]	[673]	[673]
Above median	1.285	-0.755	-0.538	0.039	-0.456	-0.680	-0.719
	(0.585)	(0.117)	(0.128)	(0.0979)	(0.169)	(0.262)	(0.225)
	[681]	[684]	[680]	[683]	[683]	[683]	[683]

Notes:

Appendix Table 2: Interaction of slavery with ecological indices

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: Baseline							
Baseline	1.899	-0.644	-0.511	-0.024	-0.405	-0.582	-0.558
	(0.485)	(0.142)	(0.157)	(0.146)	(0.140)	(0.252)	(0.177)
	[1280]	[1362]	[1357]	[1356]	[1356]	[1356]	[1356]
Panel B: Interacted with predicted fraction enslaved							
Slavery region	1.887	-0.810	-0.545	-0.036	-0.275	-0.544	-0.508
	(0.437)	(0.159)	(0.160)	(0.191)	(0.111)	(0.274)	(0.180)
Predicted index	6.440	-0.078	0.621	0.655	-1.453	1.067	0.413
	(3.210)	(1.298)	(1.228)	(1.491)	(0.822)	(2.083)	(1.411)
Interaction of the two	-2.882	-4.594	-1.225	-0.620	4.205	0.522	1.142
	(7.919)	(3.445)	(3.057)	(2.985)	(1.745)	(5.321)	(3.614)
	[1275]	[1357]	[1352]	[1351]	[1351]	[1351]	[1351]
Panel C: Interacted with predicted density of enslaved population							
Slavery region	2.031	-0.589	-0.440	0.040	-0.384	-0.468	-0.509
	(0.399)	(0.157)	(0.145)	(0.145)	(0.129)	(0.232)	(0.164)
Predicted index	0.476	0.084	0.173	0.147	0.077	0.281	0.134
	(0.124)	(0.071)	(0.057)	(0.071)	(0.039)	(0.096)	(0.055)
Interaction of the two	0.698	-0.301	-0.017	-0.067	0.173	0.035	0.101
	(0.218)	(0.252)	(0.207)	(0.180)	(0.082)	(0.285)	(0.118)
	[1275]	[1357]	[1352]	[1351]	[1351]	[1351]	[1351]
Panel D: Interacted with predicted density of rural population, calibrated in slavery region							
Slavery region	1.285	-0.681	-0.661	-0.137	-0.580	-0.842	-0.704
	(0.409)	(0.180)	(0.158)	(0.110)	(0.144)	(0.273)	(0.204)
Predicted index	0.688	0.127	0.249	0.187	0.135	0.308	0.121
	(0.112)	(0.063)	(0.044)	(0.073)	(0.053)	(0.080)	(0.065)
Interaction of the two	1.400	0.044	0.311	0.237	0.446	0.608	0.370
	(0.286)	(0.227)	(0.198)	(0.162)	(0.108)	(0.273)	(0.173)
	[1275]	[1357]	[1352]	[1351]	[1351]	[1351]	[1351]
Panel E: Interacted with predicted density of rural population, calibrated in free-soil region							
Slavery region	1.955	-0.633	-0.479	-0.008	-0.364	-0.564	-0.556
	(0.430)	(0.211)	(0.212)	(0.206)	(0.140)	(0.302)	(0.165)
Predicted index	0.487	0.477	0.448	0.338	0.182	0.558	0.220
	(0.123)	(0.066)	(0.064)	(0.060)	(0.029)	(0.086)	(0.054)
Interaction of the two	-0.464	-0.738	-0.587	-0.469	-0.113	-0.829	-0.360
	(0.151)	(0.177)	(0.171)	(0.153)	(0.056)	(0.186)	(0.045)
	[1275]	[1357]	[1352]	[1351]	[1351]	[1351]	[1351]

Notes:

Appendix Table 3: Replicate Table 1 (regional differences in index effects) with calibration of index by OLS instead of Ridge

	Free-soil states					Slavery-legal states				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Outcomes (in natural logarithms):	Rural population per county acre	Farm value per county acre	Farm value per total farm acre	Total farm acres per county area	Improved acres per total farm acre	Rural population per county acre	Farm value per county acre	Farm value per total farm acre	Total farm acres per county area	Improved acres per total farm acre
Control variables:										
Panel A: Index from Own Region										
Index calibrated to free states	0.524	0.703	0.191	0.512	0.648					
	(0.120)	(0.122)	(0.0515)	(0.125)	(0.116)					
Index calibrated to slave states						0.508	0.757	0.388	0.369	0.714
						(0.0592)	(0.132)	(0.0664)	(0.105)	(0.105)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel B: Index from Other Region										
Index calibrated to free states						0.108	0.078	0.030	0.048	0.139
						(0.0318)	(0.0726)	(0.0519)	(0.0248)	(0.0458)
Index calibrated to slave states	0.075	0.047	0.047	0.000	-0.074					
	(0.0761)	(0.129)	(0.0703)	(0.0694)	(0.0820)					
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel C: Index from Both Regions										
Index calibrated to free states	0.521	0.704	0.188	0.516	0.660	0.049	-0.020	-0.021	0.001	0.053
	(0.122)	(0.123)	(0.0562)	(0.125)	(0.117)	(0.0202)	(0.0489)	(0.0378)	(0.0163)	(0.0280)
Index calibrated to slave states	0.032	-0.011	0.031	-0.042	-0.128	0.474	0.771	0.402	0.368	0.677
	(0.0593)	(0.0990)	(0.0655)	(0.0427)	(0.0504)	(0.0654)	(0.137)	(0.0688)	(0.106)	(0.107)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel D: Omit Spatial Controls										
Index calibrated to free states	0.876	1.105	0.380	0.725	0.999	0.088	0.035	-0.027	0.062	0.116
	(0.114)	(0.106)	(0.0167)	(0.114)	(0.126)	(0.0229)	(0.0319)	(0.0267)	(0.0237)	(0.0286)
Index calibrated to slave states	0.017	0.002	-0.063	0.065	0.016	0.521	0.832	0.401	0.431	0.723
	(0.0418)	(0.0733)	(0.0598)	(0.0334)	(0.0410)	(0.0897)	(0.163)	(0.0606)	(0.166)	(0.139)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel E: Index has Interactions with Temperature and Rainfall										
Index calibrated to free states	0.025	0.027	0.004	0.023	0.028	0.000	0.000	0.000	0.000	0.000
	(0.0216)	(0.0260)	(0.00572)	(0.0207)	(0.0244)	(8.15e-05)	(7.17e-05)	(2.74e-05)	(5.80e-05)	(7.72e-05)
Index calibrated to slave states	0.006	0.007	0.000	0.007	0.010	0.442	0.635	0.343	0.292	0.595
	(0.00766)	(0.0101)	(0.00265)	(0.00858)	(0.0115)	(0.182)	(0.272)	(0.157)	(0.129)	(0.244)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel F: Leave Out Own State from Estimation of Indices										
Index calibrated to free states	0.108	0.173	0.063	0.110	0.152	0.065	0.002	-0.004	0.006	0.072
	(0.0281)	(0.0422)	(0.0367)	(0.0426)	(0.0550)	(0.0221)	(0.0563)	(0.0457)	(0.0158)	(0.0291)
Index calibrated to slave states	0.042	-0.006	0.028	-0.033	-0.120	0.265	0.455	0.203	0.251	0.399
	(0.0598)	(0.103)	(0.0691)	(0.0510)	(0.0572)	(0.0627)	(0.120)	(0.0528)	(0.0935)	(0.0949)
	[656]	[656]	[656]	[656]	[656]	[696]	[695]	[695]	[695]	[695]
Panel G: Sample Restricted to Counties Within 150 miles of Free-Slave Border										
Index calibrated to free states	0.352	0.511	0.226	0.285	0.409	0.063	0.086	0.046	0.041	0.134
	(0.0484)	(0.0635)	(0.0535)	(0.0518)	(0.0597)	(0.0595)	(0.0855)	(0.0640)	(0.0436)	(0.0834)
Index calibrated to slave states	-0.152	-0.247	-0.099	-0.148	-0.199	0.589	0.911	0.515	0.396	0.823
	(0.0648)	(0.0818)	(0.0512)	(0.0555)	(0.0825)	(0.0569)	(0.147)	(0.0770)	(0.0947)	(0.109)
	[409]	[411]	[411]	[411]	[411]	[404]	[405]	[405]	[405]	[405]
Panel H: Sample Expanded to All Counties										
Index calibrated to free states	0.377	0.669	0.155	0.514	0.677	0.062	0.018	0.002	0.017	0.088
	(0.0435)	(0.110)	(0.0514)	(0.0747)	(0.0879)	(0.0250)	(0.0478)	(0.0434)	(0.0259)	(0.0228)
Index calibrated to slave states	-0.031	-0.117	0.109	-0.226	-0.311	0.625	0.842	0.030	0.812	0.807
	(0.0602)	(0.0505)	(0.0701)	(0.0588)	(0.0629)	(0.100)	(0.0622)	(0.112)	(0.0888)	(0.0435)
	[765]	[749]	[749]	[749]	[749]	[1100]	[1089]	[1089]	[1089]	[1089]

Notes:

Appendix Table 4: Replicate Table 2 (shares model) with ecological index calibrated with OLS ins

Outcomes (in natural logarithms):	(1) Rural population per county acre	(2) Farm value per county acre	(3) Farm value per total farm acre	(4) Total farm acres per county area	(5) Improved acres per total farm acre
Control variables:					
Panel A: OLS					
Index calibrated to free states * (1 – slave fraction of population)	0.102 (0.0332)	0.042 (0.0627)	0.007 (0.0434)	0.035 (0.0255)	0.121 (0.0457)
Index calibrated to slave states * (slave fraction of population)	0.482 (0.0829)	0.975 (0.149)	0.598 (0.100)	0.377 (0.0900)	0.803 (0.113)
	[696]	[695]	[695]	[695]	[695]
Panel B: 2SLS, use regional indices as instruments					
Index calibrated to free states * (1 – slave fraction of population)	0.064 (0.0573)	-0.043 (0.0552)	-0.042 (0.0363)	-0.002 (0.0336)	0.057 (0.0635)
Index calibrated to slave states * (slave fraction of population)	0.756 (0.127)	1.172 (0.234)	0.641 (0.127)	0.532 (0.155)	1.081 (0.200)
	[696]	[695]	[695]	[695]	[695]
Panel C: 2SLS, add indices for slave density and population fraction as instruments					
Index calibrated to free states * (1 – slave fraction of population)	0.089 (0.0492)	-0.022 (0.0579)	-0.035 (0.0391)	0.013 (0.0308)	0.083 (0.0584)
Index calibrated to slave states * (slave fraction of population)	0.664 (0.101)	1.125 (0.205)	0.631 (0.113)	0.494 (0.139)	1.002 (0.162)
	[696]	[695]	[695]	[695]	[695]
Panel D: 2SLS, shrink slavery coefficient					
Index calibrated to free states * (1 – slave fraction of population)	0.070 (0.0467)	-0.021 (0.0878)	-0.029 (0.0626)	0.009 (0.0329)	0.078 (0.0582)
Index calibrated to slave states * (slave fraction of population)	[fixed at 20% of value in Panel B.]				
	[696]	[695]	[695]	[695]	[695]
Panel E: 2SLS, indices include interaction of variables with climate polynomial					
Index calibrated to free states * (1 – slave fraction of population)	-0.001 (0.000630)	-0.001 (0.000959)	0.000 (0.000598)	0.000 (0.000365)	-0.001 (0.000919)
Index calibrated to slave states * (slave fraction of population)	1.202 (0.124)	1.729 (0.230)	1.003 (0.148)	0.726 (0.160)	1.607 (0.208)
	[696]	[695]	[695]	[695]	[695]
Panel F: 2SLS, expand to full sample of counties in slavery-legal region					
Index calibrated to free states * (1 – slave fraction of population)	0.060 (0.144)	0.151 (0.0907)	-0.080 (0.0644)	0.231 (0.121)	0.278 (0.0819)
Index calibrated to slave states * (slave fraction of population)	0.787 (0.0862)	1.246 (0.217)	0.511 (0.0954)	0.736 (0.254)	1.168 (0.226)
	[1100]	[1089]	[1089]	[1089]	[1089]

Notes: