Appendix A: Definition of Free/Slave Boundary and Spatial Extent of Data

We use standard definitions of the U.S. states where slavery was legal in 1860. This excludes territories, e.g. Kansas and Nebraska. We classify as 'free' those states, e.g. New Jersey and Illinois, where general emancipation had taken place well before 1860, but there remained some former slaves bonded under transitional indentureship, for example. This gives the following 'slave' states: Alabama, Arkansas, Delaware, the District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia. This set of states gives a clearly defined border that separates the country into two sections, one slave and one free. The resulting free/slave boundary is defined, from west to east, as follows:

- The Missouri/Iowa border
- The Missouri/Illinois border, which largely follows the Mississippi River down to Cairo, Illinois
- The northern border of Kentucky from Cairo, Illinois, to Ashland, Kentucky, which follows the Ohio River
- The northern border of (West) Virginia, along the Ohio River
- The western border of Pennsylvania with the northern (West) Virginia panhandle
- The southern border of Pennsylvania with (West) Virginia and Maryland, which follows the Mason-Dixon Line
- The Delaware/Pennsylvania border
- The midline of the Delaware River, between New Jersey and contiguous Delaware

We use spatial data from the NHGIS project (Minnesota Population Center, 2011) to map the free/slave boundary and to measure counties' proximity to said boundary. We present this boundary in Figure 1 of the paper and here in Appendix Figure A.1. To this map, we add the 1860 county boundaries, per NHGIS, for reference. In the paper, we use two distinct concepts of proximity: adjacency and distance. Adjacency refers to a county directly touching the free/slave boundary. For example, the 1860 counties that are adjacent to the free/slave boundary are shown with dark-gray shading. (The proximity measures are computed separately for each year of data.) We also construct a buffer of 150 and 300 miles from the boundary. Counties adjacent to the boundary fall within these two buffers. Additional areas within the 150-mile buffer are shaded in medium gray in Appendix Figure A.1. In addition to those two, areas within 300 miles are shaded in light gray. Counties with any portion thereof lying within these buffers are categorized in the relevant buffer zones. As a control variable, we also compute the distance from the border for each county's centroid and the *average* distance of a county to the free/slave border by computing distance to the boundary for a high-dimensional (10kx10k) raster over the contiguous US and then by calculating the average value within each county. As another control, we have the latitude and longitude of each county's centroid, as supplied by NHGIS.

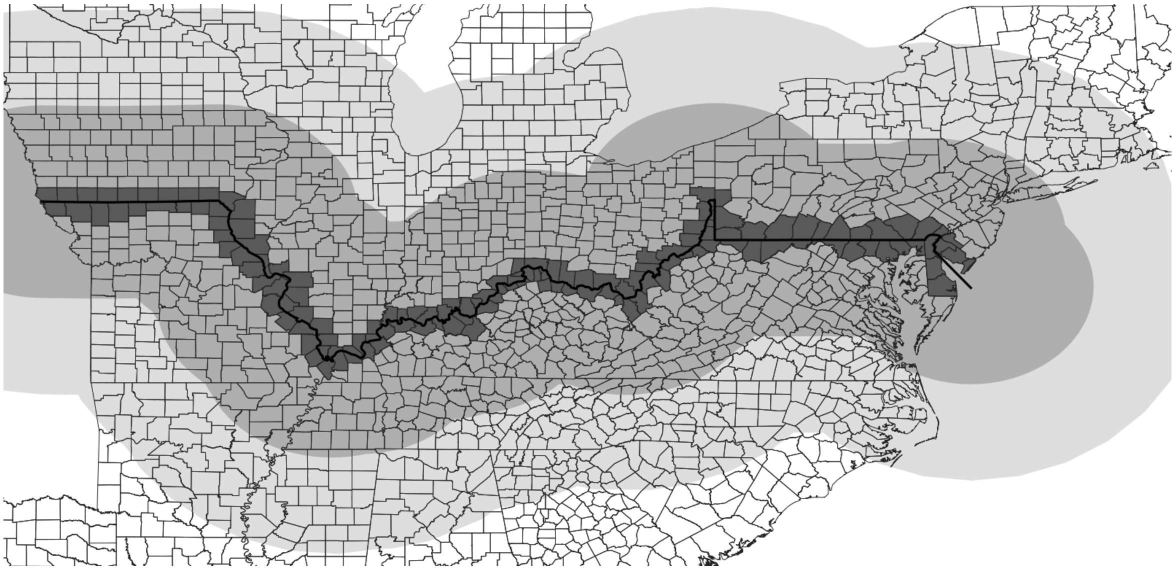
The presence of riverine boundaries necessitates further discussion. Boundaries on rivers are typically defined on a specific side of a river, or perhaps at a midpoint. Changes in the course of a river over time or poor surveying at the time of setting the border might generate discrepancies between a boundary and the current course of a river, even to the point of generating exclaves. For example, Kaskaskia is an exclave of Illinois created by a change in the course of the Mississippi River. We rely not on the contemporary river course, but rather the NHGIS definition of the historical (1860) boundary to set state borders. For the most part, the rivers are sufficiently narrow and their historical meanders sufficiently small so as to make little difference for our classification of counties with respect to the free/slave boundary. Counties that are adjacent to an above-named river segment will be adjacent to the free/slave border as well, for example. The major exception is the Delaware River, which turns into a bay between Delaware and New Jersey. The statutory boundary between New Jersey and Delaware lies on the New Jersey side of the Delaware River, except for a small exclave of Delaware on the New Jersey side. We choose the midpoint of the river instead to better calibrate the measure of distance to the boundary. This does not change the adjacency concept for counties on either side of the Delaware River, but it brings the distance measurement into better balance between sides of the river.

Appendix Figure A.2 presents the median locations within the slavery-legal outcomes from the 1860 Census. We take the county centroids from NHGIS and each of several outcomes as weights for the computation of the median. The 150- and 300-mile buffers are drawn for reference. The median location by area (meaning the median county lat/long when weighting by county area) is in the middle of Mississippi. As the region was less developed in the southwestern part (e.g. West Texas), the remaining medians are to the northeast. Indeed the remaining medians are clustered in middle Tennessee and northern Georgia. The median white person and median dollar of farm value are within 150 miles of the free-slave boundary. The median person (regardless of race) and the median improved farmland was just outside the 150-mile buffer. The median black person and the median enslaved person was less than 300 miles from the free-slave boundary. The median farmland acre (improved or not) was somewhere in between these other outcomes.

References

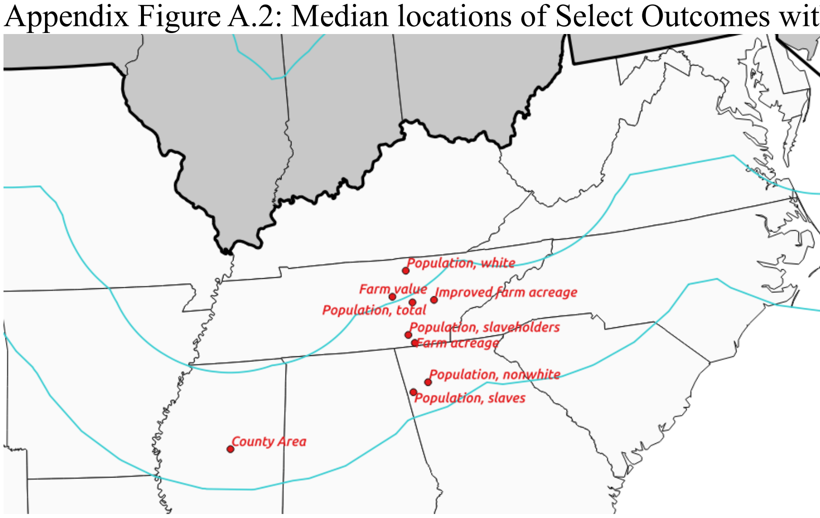
Minnesota Population Center. National Historical Geographic Information System: Version 2.0. Minneapolis, MN: University of Minnesota 2011.

Appendix Figure A.1: The 1860 Free/Slave Boundary and Several Measures of Proximity



Notes: this map displays 1860 county boundaries (thin black lines), the free/slave boundary (thick black line), and three measures of proximity to said boundary. The counties that touch the free/slave boundary are shaded in dark gray. Additional areas that lie within a buffer of 150 miles from the boundary have medium gray shade. Further areas within a buffer of 300 miles from the free/slave boundary are denoted with a light gray shade.

Appendix Figure A.2: Median locations of Select Outcomes within Slave States, 1860



Notes: this map gives the median locations in the 1860 Census for the indicated outcomes within the states where slavery was legal. The underlying data are the county-level tabulations from the 1860 Census, as reported in the ICSPR #2896 and #35206. Latitudes and longitudes are county centroids from NHGIS. We compute the median weighted by each of the variables labeled next to the red dots. State boundaries are seen as thin black lines; the free-slave boundary is a dark black line. The 150- and 300-mile buffers are shown as light blue lines.

Appendix B: Measurement of Glacial Extent

We digitized the location of the terminal moraine using maps published by George Frederick Wright (1884, 1890, 1892). This geological feature is a "well defined southern limit to the marks of glacial action in the United States" (Wright, 1884, page 203). We worked with the most detailed maps provided for each mapping segment. We also used the NHGIS files for 1860-1890 to help georeference points on Wright's maps.

Going from east to west, segments within a given area were digitized using the indicated maps.

- Massachusetts and New York: Wright, 1884, Plate 1 and text on page 203.
- New Jersey: Wright, 1884, plate 2.
- Pennsylvania: Wright, 1884, plate 3.
- Ohio: Wright, 1884, Plates 8 through 16.
- Kentucky: Wright, 1884, Plates 5, 16 and 17. The latter two plates were more detailed, but only covered the Cincinnati area. Plate 5 was used for the area around Madison, Indiana.
- Indiana: Wright, 1890, Figure 3.
- Illinois: Wright, 1890, Plate 5.
- Driftless region: Wright, 1892, unnumbered map, facing page 68.
- Missouri: Wright, 1892, text on page 96 and unnumbered map facing page 68.

Appendix Figure B.1 displays the terminal moraine (glacial boundary) as a dashed line. For comparison, the free/slave boundary is shown as a thick, solid line, and contemporary state boundaries are displayed as thin, black lines. In general terms, the glacial and free/slave boundaries are both oriented in an east/west direction, but they do not precisely coincide. The southern extent of the glacier is to the north of the free/slave boundary, with three exceptions. The greatest exception is in the state of Missouri, which is approximately split in half by the terminal moraine. This moraine crosses the Mississippi river near St. Louis, and generally follows the course of the Missouri River and then the Osage River. Somewhat downriver of St. Louis, the moraine is close to the Mississippi River, but stays on the Illinois side. (Of the areas with greatest slaveholding in Missouri, the 'Little Dixie' region is largely in the glaciated region, while the 'Bootheel' region is not at all.) The terminal moraine also cuts into Kentucky for a short stretch across the river from Madison, Indiana, and for a longer stretch across the river from Cincinnati, Ohio. (See Appendix Figure B.2, Panel A, for detail.) Away from these areas, the southernmost glacial extent cuts a path significantly to the north of the free/slave border. Apart from those noted above, the closest approach of the terminal moraine to the free/slave boundary is at the Wabash River and at the northern panhandle of West Virginia. (See Appendix Figure B.2, Panel B, for example.)

In some areas, the terminal moraine is superficially noteworthy as a ridge. In others, it is less noticeable to a casual, surface observer. In all areas, however, the extent of the glacier can be determined by the presence or absence of rock striations and glacial till, and other features well understood by geologists.

We also digitized the location of the 'Driftless Region,' an area north of the terminal moraine that was nevertheless not subject to glaciation. It is mostly found in Southwest Wisconsin. (See Appendix Figure B.2, Panel C, and note the rotation of the map, such that north points right.)

References

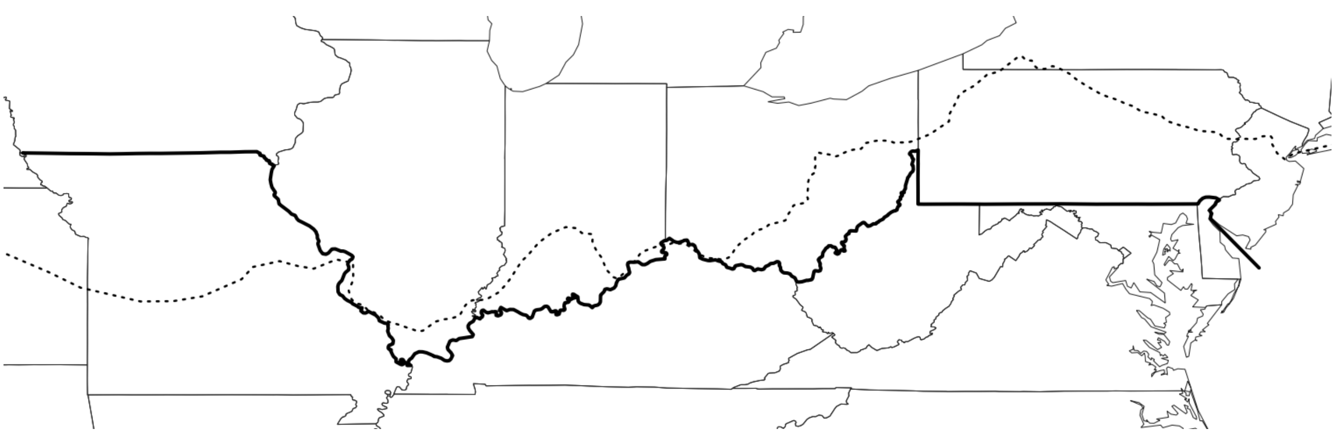
Minnesota Population Center. *National Historical Geographic Information System: Version 2.0.* Minneapolis, MN: University of Minnesota 2011.

Wright, G. Frederick (1884). The glacial boundary in Ohio, Indiana and Kentucky. Cleveland, Ohio: Western Reserve Historical Society.

Wright, G. Frederick (1890). The glacial boundary in western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois. Bulletin of the United States Geological Survey No. 58. Washington, D.C.: Department of the Interior, United States Geological Survey.

Wright, G. Frederick (1892). Man and the glacial period. Akron, Ohio: The Werner Company.

Appendix Figure B.1: Terminal Moraine, as compared to Free/Slave Boundary and State Borders

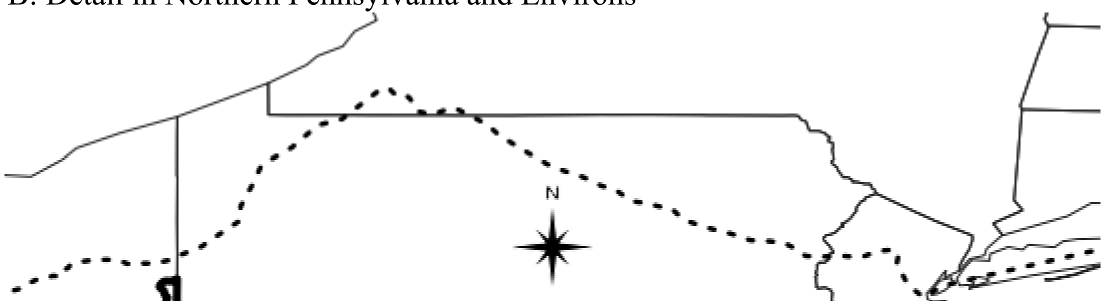


Sources: NHGIS (2011) for state boundaries, plus authors' calculations for free/slave boundary; Wright (1884, 1890, 1896) for terminal moraine, plus authors' digitization. See text of Appendix B for detailed sources.

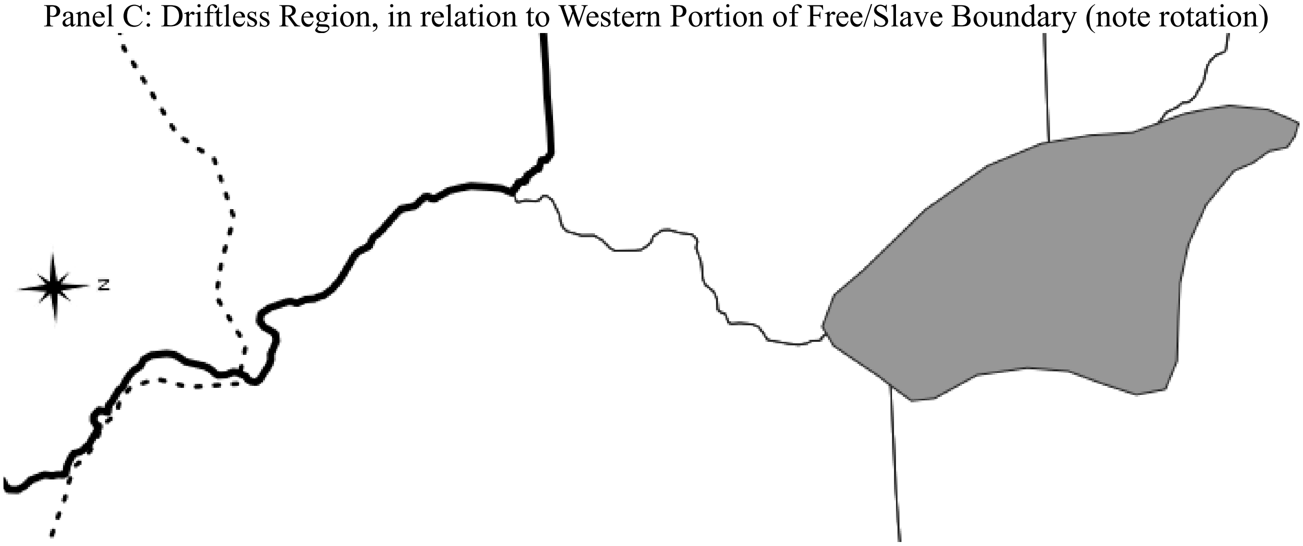
Appendix Figure B.2: Three Close-up Views of Terminal Moraine

Panel A: Crossing Points into Kentucky and Missouri

Panel B: Detail in Northern Pennsylvania and Environs



Panel C: Driftless Region, in relation to Western Portion of Free/Slave Boundary (note rotation)



Notes: see note for Appendix Figure B.1. The Driftless Region is graded in gray in Panel C.

Appendix C: Land Values and the Scarcity of a Variable Factor

C.1. The Basic Problem and a First-Order Solution:

How does the price of the fixed input (e.g., land) respond to a change in price of a variable input (e.g., a type of labor)? To fix ideas, let inputs $x_i, i \in \{2 \ldots k\}$, be supplied perfectly elastically at fixed prices p_i. In contrast, input $i = 1$ is in fixed supply locally and has endogenous price p_1. Inputs are defined to be positive: $x_i \geq 0 \; \forall \; i$.

Assume that factor markets are perfectly competitive, including the land market. This implies zero profits in equilibrium. One could equivalently adopt a 'Ricardian' approach: land owners earn the residual (rent) once other factors have been paid. If there is an open market for land, then land rents at a location should be capitalized into the price of land. Therefore, profits earned on variable factors should equal the opportunity cost of land.

In response to a parameter change, the variable factors adjust, as does the price of the fixed factor. Let $\mathrm{d}p_2 > 0$ be given. What is $\mathrm{d}p_1$? Consider the profit function for a particular location: $\pi(\vec{p})$. This gives the maximum profits attainable for a given price vector. We take full differentials of $\pi = 0$ and invoke the Envelope Condition to obtain

$$\pi_1 \mathrm{d}p_1 + \pi_2 \mathrm{d}p_2 = 0, \qquad (*)$$

which gives the following equilibrium relationship:

$$\frac{\mathrm{d}p_1}{\mathrm{d}p_2} = -\frac{\pi_2}{\pi_1}$$

Recall Hotelling's Lemma: the derivative of the profit function w.r.t. p_i is factor demand $-x_i$. Therefore $\frac{\mathrm{d}p_1}{\mathrm{d}p_2} = -\frac{x_2}{x_1}$, which is negative (strictly so if $x_2 > 0$). In terms of elasticities,

$$\epsilon_{12} \equiv \frac{p_2}{p_1}\frac{\mathrm{d}p_1}{\mathrm{d}p_2} = -\frac{p_2 x_2}{p_1 x_1},$$

the negative of the ratio of the expenditure shares.

It is intuitive that the prices are related in this way. When p_2 changes, it affects the net worth of the firm. The firm/farm's net worth shrinks more if the expenditure share on x_2 is large. This decline in net worth is spread more widely if the expenditure share on x_1 is itself large.

C.2. The case of Cobb-Douglas

Assumptions are as above, except that output is determined by a Cobb-Douglas. The ith factor has share $\alpha_i \in (0,1)$. The FOCs define the relative factor inputs, e.g.,

$$\frac{p_1 x_1}{\alpha_1} = \frac{p_i x_i}{\alpha_i} \quad \forall \; i = 1, \ldots, k.$$

As the first factor is fixed in size, we can define the others in terms of x_1:

$$x_i = \frac{p_1}{p_i}\frac{\alpha_i}{\alpha_1}x_1$$

The price of output is the numeraire. Output (Y) and cost (C) are as follows:

$$Y \equiv \prod_{i=1}^{k} x_i^{\alpha_i} = \prod_{i=1}^{k}\left(\frac{p_1}{p_i}\frac{\alpha_i}{\alpha_1}x_1\right)^{\alpha_i} = \frac{p_1 x_1}{\alpha_1}\prod_{i=1}^{k}\left(\frac{\alpha_i}{p_i}\right)^{\alpha_i}$$

$$C \equiv \sum_{i=1}^{k} p_i\, x_i = \sum_{i=1}^{k} p_i\left(\frac{p_1}{p_i}\frac{\alpha_i}{\alpha_1}x_1\right) = \frac{p_1 x_1}{\alpha_1}\sum_{i=1}^{k}\alpha_i$$

Competitive markets for factors imply a zero-profit condition: $\pi = Y - C = 0$, or

$$\frac{p_1 x_1}{\alpha_1}\prod_{i=1}^{k}\left(\frac{\alpha_i}{p_i}\right)^{\alpha_i} = \frac{p_1 x_1}{\alpha_1}\sum_{i=1}^{k}\alpha_i$$

which can be written more compactly as $\vec{\alpha}\cdot[\log(\vec{p})] = \vec{\alpha}\cdot[\log(\vec{\alpha})] - \log\left(\sum_{i=1}^{k}\alpha_i\right)$, in which prices and factor shares appear in vector form. The left-hand side is constant (and the final term is zero for CRS). Therefore a proportional change in any price must be met with an offsetting proportional change in other prices to stay on the zero-profit locus. The ratios of these responses are determined by the relative factor shares. This is an exact result that mirrors the first-order approximation above.

We could also derive this price and elasticity from optimal land use (i.e., the demand curve for land as a productive factor) under CRS. The FOC is

$$\begin{aligned} p_1 &= \frac{\alpha_1}{x_1}\mathrm{Y} \\ &= \frac{\alpha_1}{x_1}\left(\frac{p_1 x_1}{\alpha_1}\prod_{i=1}^{k}\left(\frac{\alpha_i}{p_i}\right)^{\alpha_i}\right) \\ &= \alpha_1\prod_{i=2}^{k}\left(\frac{\alpha_i}{p_i}\right)^{\frac{\alpha_i}{\alpha_1}} \end{aligned}$$

which is the same as the price derived from the zero-profit condition. This is as predicted by Euler's Theorem.

C.3. Second-order effects:

Why does the first-order approximation not depend on the extent of substitution between factors? Hotelling's Lemma is a first-order result that follows an application of the Envelope Theorem. A small change in price will occasion a set of small quantity changes. But the effect on profits of small quantity changes is approximately zero near the optimum, which is where the profit function is evaluated.

Accordingly, the dependence on factor substitutability only appears when considering second-order changes. The first derivative, $\mathrm{d}p_1/\mathrm{d}p_2$ is negative, so that the increase in p_2 decreases p_1. Does the second derivative amplify this effect, $\frac{\mathrm{d}^2 p_1}{\mathrm{d}p_2^2} < 0$, or attenuate it?

The zero-profit condition ($\pi(\vec{p}) = 0$) still holds, even for large changes, because p_1 adjusts to absorb any surplus generated by the other factors. Taking full differentials of the zero-profit conditions to first and second order yields the following equations:

$$[\nabla\pi(\vec{p})]\overrightarrow{\mathrm{d}p} = 0 \; ; \; \overrightarrow{\mathrm{d}p}'[\nabla^2\pi(\vec{p})]\overrightarrow{\mathrm{d}p} = 0$$

where $\overrightarrow{\mathrm{d}p} = [\ \mathrm{d}p_1\ \mathrm{d}p_2\ 0 \ldots\ 0\ ]'$ and ∇ is the operator that takes derivatives w.r.t. the price vector $\vec{p}$. The first-order equation reproduces equation $(*)$ from above. The second-order equation has a matrix pre- and post-multiplied by the infinitesimal-change-in-price vector:

$$[\ \mathrm{d}p_1\ \mathrm{d}p_2\ 0\ \cdots\ 0\ ]\begin{bmatrix} \pi_{11} & \pi_{12} & \pi_{13} & \cdots & \pi_{1k} \\ \pi_{21} & \pi_{22} & \pi_{23} & \cdots & \pi_{2k} \\ \pi_{31} & \pi_{32} & \pi_{33} & \cdots & \pi_{3k} \\ \pi_{41} & \pi_{42} & \pi_{43} & \cdots & \pi_{4k} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \pi_{k1} & \pi_{k2} & \pi_{k3} & \cdots & \pi_{kk} \end{bmatrix}\begin{bmatrix} \mathrm{d}p_1 \\ \mathrm{d}p_2 \\ 0 \\ \vdots \\ 0 \end{bmatrix} = 0$$

Turn the crank once:

$$[\ \mathrm{d}p_1\ \mathrm{d}p_2\ 0\ \cdots\ 0\ ]\begin{bmatrix} \mathrm{d}p_1 \sum_{i=1}^{k} \pi_{i1} \\ \mathrm{d}p_2 \sum_{i=1}^{k} \pi_{i2} \\ 0 \\ \vdots \\ 0 \end{bmatrix} = 0$$

Turn the crank again:

$$(\mathrm{d}p_1)^2 \sum_{i=1}^{k} \pi_{i1} + (\mathrm{d}p_2)^2 \sum_{i=1}^{k} \pi_{i2} = 0$$

which gives us

$$\frac{\mathrm{d}^2 p_1}{\mathrm{d}p_2^2} = -\left(\sum_{i=1}^{k} \pi_{i2}\right) \Big/ \left(\sum_{i=1}^{k} \pi_{i1}\right) \qquad (\dagger)$$

The second derivative is negative if the two sums have the same sign. Do they? Recall that the profit function has a Hessian ($\mathbf{H} \equiv \nabla^2\pi$) that is negative semi-definite.[1] Therefore, for any non-zero vector w,

$$w'\mathbf{H}w \leq 0. \qquad (\ddagger)$$

Consider the two vectors $w_1 = [\ 1\ 0\ 0\ \cdots\ 0\ ]'$ and $w_2 = [\ 0\ 1\ 0\ \cdots\ 0\ ]'$. Notice that using w_i in the inequality (‡) constructs the ith column sum. This allows us to rewrite equation (†) as follows:

$$\frac{\mathrm{d}^2 p_1}{\mathrm{d}p_2^2} = -\frac{w_2{}'\mathbf{H}w_2}{w_1{}'\mathbf{H}w_1},$$

which, by (‡), is weakly negative (strictly so, as long as $w_2{}'\mathbf{H}w_2$ is not zero).

Because the second derivative (of p_1 w.r.t. p_2) is negative, allowing for substitution among the x_i when $p_2 \uparrow$ amplifies the reduction in p_1, as compared to the first-order effect. Intuitively, there are contrasting parts of the second-order effect of $p_2 \uparrow$. If the first two inputs are substitutes, the decrease in x_2 shifts out the demand for x_1, *ceteris paribus*. But the decline in profits also spurs the flight of other mobile factors from the area. This latter effect dominates the former one for any interior solution at which we can take derivatives.

C.5. The case of perfect substitutes:

Here substitutability is cranked up to the max, and the relevant functions are not differentiable at an interior solution. If all factors are perfect substitutes, then we can write output as $Y = \sum_{i=1}^{k} \alpha_i\, x_i$. This case is, in fact, quite uncomplicated. The price of land (input 1) is independent of the other factors. The marginal product of x_1 is α_1, which determines the price p_1. The effect of other factor prices on p_1 is nil. We have to careful with this case, though, because it is easy to scale up in spite of a fixed supply of land. If any of the other factors, $i > 1$, have $p_i < \alpha_i$, then one could increase those factors and increase profits. The fixed factor is in no way a constraint to unlimited growth.

Then again, that land is always at an interior solution for agricultural uses during this time suggests that we can rule out perfect substitutability. What if, instead, land is an imperfect substitute for other inputs, but x_2 is a perfect substitute for some other input, WLOG x_3? Generically, we are at a corner solution, with either $\{x_2 > 0, x_3 = 0\}$ or $\{x_2 = 0, x_3 > 0\}$ strictly preferred. In the first case, the first and second derivatives of $p_1\ w.r.t. p_2$ are as above. In the second case, these derivatives are zero. There also exists a measure-zero case of indifference between x_2 and x_3. A change in p_2 will cause a jump to the corner solution and there will be no impact on p_1. As every county has some non-zero amount of free labor, in the data, the case of perfect substitutes is not a compelling case.

[1] Inputs were defined positively above. If we had defined a net-output vector instead, the Hessian would be positive semi-definite. What matters is the ratio (left-hand side of (†), in which this sign convention cancels out.

C.6. The Demand for Labor in General Equilibrium:

We characterize how much labor demand should adjust to a higher wage in this Appendix. Recall that we estimated, on the slavery-legal side of the border, approximately 9% higher wages and 50% lower rural population density in the main results (ref. Table 2 or Figure 3). Under the simplest interpretation that the disamenity premium is the only thing that drives differences in labor demand, this would imply an elasticity of labor w.r.t. the wage of 5.7, in general equilibrium. This is comparable to, albeit somewhat higher than, the predictions of a simple model, as we show below.

We start with a few standard assumptions for a local economy that is a price-taker on national markets. Thus, a county faces a perfectly elastic supply of labor (L) and capital (K) from the rest of the country. The prices of these inputs are w and r, respectively. There is also a fixed factor (land) that has a local price. (See above for the effect of wages on land prices.) Land, labor and capital markets clear in the county. The production function is Cobb-Douglas,

$$Y = A\, L^{\alpha}\, K^{\beta}\, F^{(1-\alpha-\beta)}$$

in which factor share of labor is α, capital β, and fixed factor $(1-\alpha-\beta)$. Unlike above, we need to assume something here about elasticities of substitution between factors, as this calculation is specifically about how much labor changes when its price goes up. Cobb-Douglas is a standard choice and implies an elasticity of substitution of one. Production exhibits constant returns to scale in all factors, but only decreasing returns to scale in the reproducible ones (L and K). This implies that a reduction in labor will reduce the marginal product of capital, so we will need to account for the endogenous response of capital to the wage.

We first compute the factor demand curves. The First-Order Conditions (FOC) w.r.t L and K are as follows.

$$w = MPL = \alpha\, A\, L^{\alpha-1}\, K^{\beta}\, F^{(1-\alpha-\beta)}$$

$$r = MPK = \beta\, A\, L^{\alpha}\, K^{\beta-1}\, F^{(1-\alpha-\beta)}$$

In partial equilibrium, the labor-demand elasticity is $1/(1-\alpha)$, which is seen from solving for L in the first equation and taking logarithmic derivatives. To get to general equilibrium, we first solve for the optimal K, given L: $K^* = (\, \beta\, A\, L^{\alpha}\, F^{(1-\alpha-\beta)} / r\,)^{1/(1-\beta)}$. Dropping this into the labor FOC yields the demand curve in general equilibrium:

$$w = \alpha\, A\, L^{\alpha-1}\, (\, \beta\, A\, L^{\alpha}\, F^{(1-\alpha-\beta)} / r\,)^{1/(1-\beta)}\, F^{(1-\alpha-\beta)}$$

This gives a labor-demand elasticity of $1 / (\, 1 - \alpha / (1 - \beta)\,)$. Thus the elasticity is a simple function of observable factor shares.

In the main text, we report estimates from the cliometrics literature for Antebellum factor shares in agriculture. We repeat these in Appendix Table C.1 for the reader's convenience. The estimates of the labor share range from 0.58 to 0.704, while the estimates for capital range from 0.1 to 0.2. The average implied elasticity for general equilibrium is almost four. These estimates are of a similar magnitude, though somewhat smaller than the empirical elasticity. This bolsters the idea that the wage differential is a plausible explanation for most of the difference in rural population density.

C.7. Land Value per Capita, instead of Per Acre:

Above, we saw that the elasticity of land value to the wage was the negative of the ratio of the factor shares. This was for land value per unit land. How does this compare to land value per unit of labor? If we again make the standard assumption of Cobb-Douglas, we can compute this easily. The relevant components were computed above.

$$
\begin{aligned}
d \ln (pF/L) / d \ln w &= \\
&= d (\ln p + \ln F - \ln L) / d \ln w \\
&= -(\alpha / (1-\alpha-\beta)) \quad + 0 \quad + 1 / (1 - \alpha / (1 - \beta)) \\
&= -(\alpha / (1-\alpha-\beta)) \quad\quad + (1 - \beta) / (1 - \alpha - \beta)) \\
&= -1
\end{aligned}
$$

Recall that the effect of slavery legality on farm value per capita was approximately 10%, as was the effect on wages. So, a simple model in which a disamenity affects the equilibrium accounts for the change in farm value per capita.

Appendix Table C.1: Cliometrics estimates of factor shares in Antebellum agriculture and implied elasticities of labor w.r.t. the wage.

	Factor shares:				Implied elasticities:	
Sources:	α (L)	$1-\alpha-\beta$ (F)	β (K)		partial	total
Fogel & Engerman 1974	0.58	0.25	0.17		2.38	3.32
Fogel & Engerman 1971	0.6	0.2	0.2		2.50	4.00
Gallman 1972	0.704	0.225	0.071		3.38	4.13
Gallman 1972	0.704	0.169	0.127	* bldgs to K	3.38	5.17
Atack & Bateman 1987	0.6	0.3	0.1		2.50	3.00
Average of column	0.64	0.23	0.13		2.83	3.92

Appendix D: Type of Land Survey

We construct two measures of the original land survey, as described in this appendix. Our principal focus is on whether or not the land was in the Public Land Survey System (PLSS). The PLSS is a rectilinear grid. The grid defines six-mile square townships, which are subdivided into 36 square sections each, and further subdivided into half sections, quarter sections, etc. There are numerous deviations from a perfect grid where natural features or preceding claims or grants intervene. Much of the Old Northwest was surveyed and demarcated using the PLSS. (Notably, significant sections of Southern Ohio were not included in the PLSS.) In contrast, a large fraction of the Upper South was demarcated using metes and bounds. There is a smattering of other systems in the sample as well, such as several colonial land claims that predate incorporation of such land into the United States.

The underlying data are in a shapefile produced by the US Geological Survey (2010). We use this file to produce two distinct variables in the 1860 county data.

1. What fraction of the 1860 County was covered by the PLSS? We construct the high-dimensional raster coded as a binary variable indicating the presence of the PLSS in a given pixel of the raster. We then take an average of these pixels within each 1860 County. The distribution of the resulting variable is highly bimodal. Over 90% of counties have either less than 5% or more than 95% of the land area in the PLSS.

2. Is the free-slave border segment nearest to a given county associated with the change in land survey to or from the PLSS? We took our constructed shape file for the free-slave boundary and split it into nodes, each of which we coded according to whether there was a change in land survey system at that point. For most of the boundary, there are large stretches over which this coding is clear and constant. For example, the Missouri/Iowa border sees no change, because both states are on the PLSS in that neighborhood. Similarly, no point on the Mason-Dixon line is associated with a change, as the adjoining states predate the PLSS. Almost all of the Ohio River is associated with a change, with Kentucky and Virginia being principally metes and bounds and the Old Northwest being almost exclusively under PLSS. There are a few exceptions, however. There are several land allocations north of the Ohio River that predate the PLSS, such as Ohio's Virginia Military District, which was allocated using metes and bounds. (A comparison of this area with the rest of the state of Ohio figures prominently in the work by Libecap and Leuck, 2011.) The most complicated boundary is between Missouri and Illinois, where there were colonial land claims (French and Spanish) that predate the PLSS. Near St. Louis, these claims are almost entirely on the Missouri side, and thus the free-slave boundary is associated with a change in survey system. Farther downriver, however, such claims tend to be either on both or on neither side of the river, and therefore not reflecting a change in survey system. (Because we are using this variable to split the sample, we use a broad-brushstroke coding of the boundary rather than a hyper-local one. This gives us stretches of the border as described.)

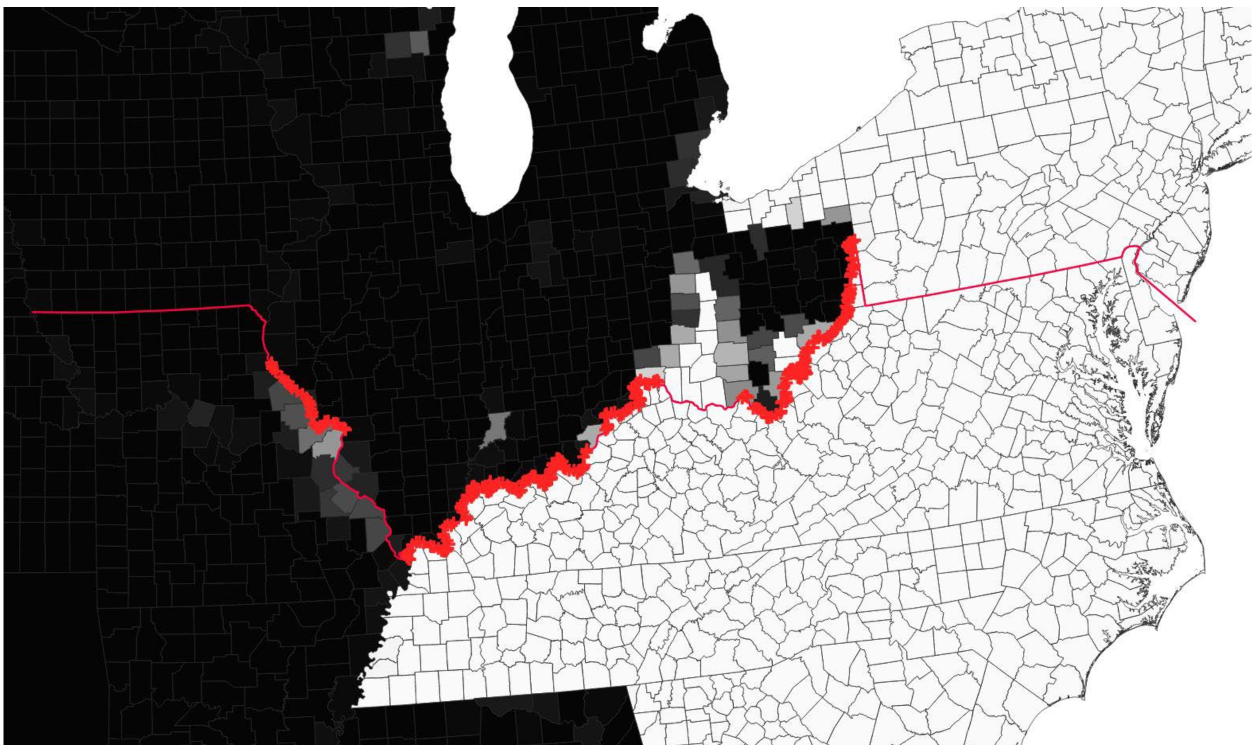
One might be concerned about a confound between the PLSS and federal grants of land to support public schools. Both policies were part of the Northwest Ordinances. But the opportunity to use sales of federal lands to support local education was made available to all territories admitted as states after 1803 (Knight 1951, p. 145; Miller 1972, pp. 241-52).

References:

U.S. Geological Survey (USGS), 2010. Public Land Survey System of the United States. Reston, VA: USGS. Accessed from http://nationalatlas.gov/atlasftp.html, December 2, 2010.
Appendix Figure D.1: Coverage of PLSS and Change to PLSS at Free-Slave Boundary

Knight, Edgar W. 1951. Education in the United States 3rd Ed. New York: Gunn & Co.

Miller, Thomas L. 1972. The Public Lands of Texas, 1519-1970.Norman, OK: Oklahoma Univ. Press.



Notes: this map displays 1860 counties shaded by the fraction of land in the PLSS. The free-slave boundary is a solid red line. Additional cross-hatching is present when there is a change between a PLSS and a non-PLSS system at this boundary. PLSS status is measured using USGS (2010). Other features are described in Appendix A.

Appendix E: Soil Characteristics

Soil variables are drawn from Miller and White (1998), who base their data on the U.S. Department of Agriculture's STATSGO soil database. We use the numerical variables (e.g. fraction of the soil that is sand or soil pH) in their database. The data come as spatial raster files. These files and the quotes below are from the web site that accompanies Miller and White: http://www.soilinfo.psu.edu/, accessed December 17, 2020.

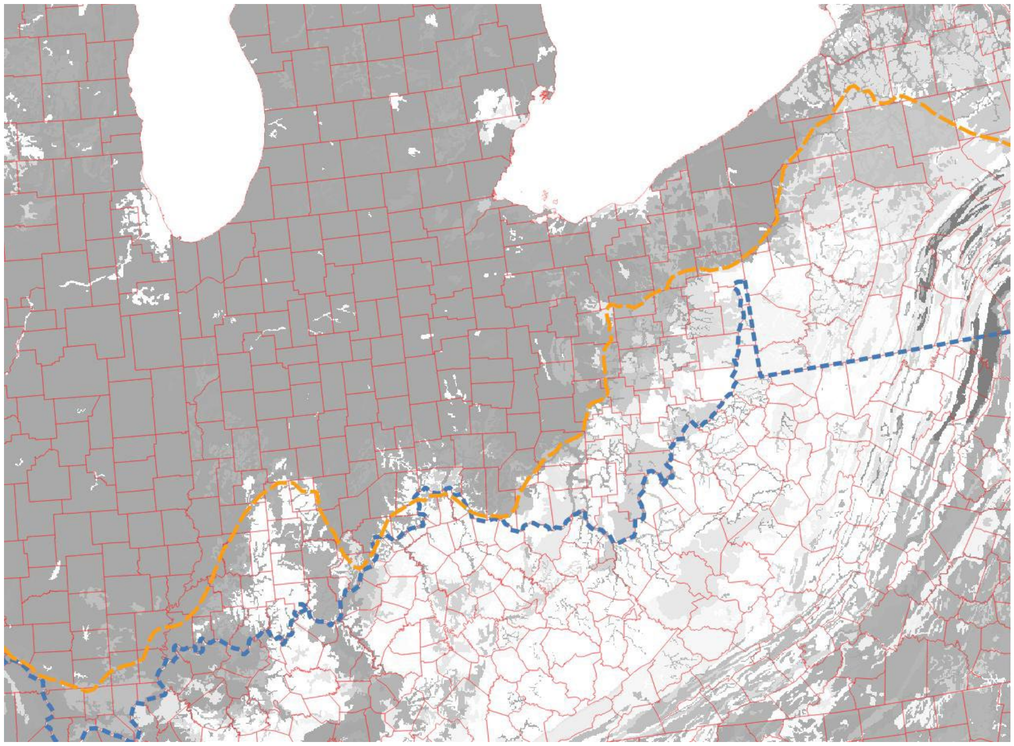
Variables are defined as follows:

- Available water capacity: water volume available to plants if the soil is at capacity. "The mean available water capacity for each STATSGO map unit was computed for three column lengths, 100, 150, and 250 cm, measured from the surface."
- Bulk density: ratio of the mass of the moist soil to its total volume.
- Fractions of clay, sand, and silt. Continuous variables built from underlying information about discrete soil types in USDA's STATSGO.
- k−factor: "a relative index of susceptibility of bare, cultivated soil to particle detachment and transport by rainfall."
- pH: measure of the acidity or alkalinity of the soil.
- Porosity: "a measure of the volume of air and water-filled pores in the soil," computed from bulk density and particle density.
- Depth to bedrock: distance from surface to bedrock. This measure is effectively top-coded at 60 inches.

The following variables are defined for the eleven soil layers: bulk density, fractions of {clay, sand, silt}, porosity, and pH. Soil layers, in inches from the surface, are as follows: 0-2, 2-4, 4-8, 8-12 12-16, 16-24, 24-31, 31-39, 39-59, 59-79, 79-98.

Appendix Figure E.1 provides an example of these data in relation to the free-slave boundary and to the terminal moraine. We display the depth to bedrock, with a darker color indicating more soil on top of bedrock. We zoom in to the neighborhood of the Ohio River, as this is where the terminal moraine (maximum glacial extent) and free-slave boundary are most coincident. These boundaries are displayed on the map, as are 1860 county boundaries. The relationship between soil depth and the glacier's footprint is evident in the map. Areas north of the terminal moraine have deeper soil and this seems to be a function of the glacial extent and not of some smooth spatial trend. It is also apparent that the partial coincidence of a change in depth and change in slavery legal status is more plausibly related to the glacial rather than institutional history.

Appendix Figure E.1: Depth to Bedrock in the Neighborhood of the Ohio River



Notes: this map uses gray shading to denote the depth of soil above bedrock, according to the Miller & White (1998) database. The orange line with long dashes shows the terminal moraine, the blue line with short dashes shows the free-slave boundary, and the thin red lines display the 1860 county boundaries. (See Appendices A and B for further information on these boundaries.)

Appendix F: Additional Sets of Results (Sensitivity Analysis for Main Results)

F-1. Population (z-score instead of log)

F-2. Land use and value (z-score instead of log)

F-3. Age composition

F-4. Race and gender

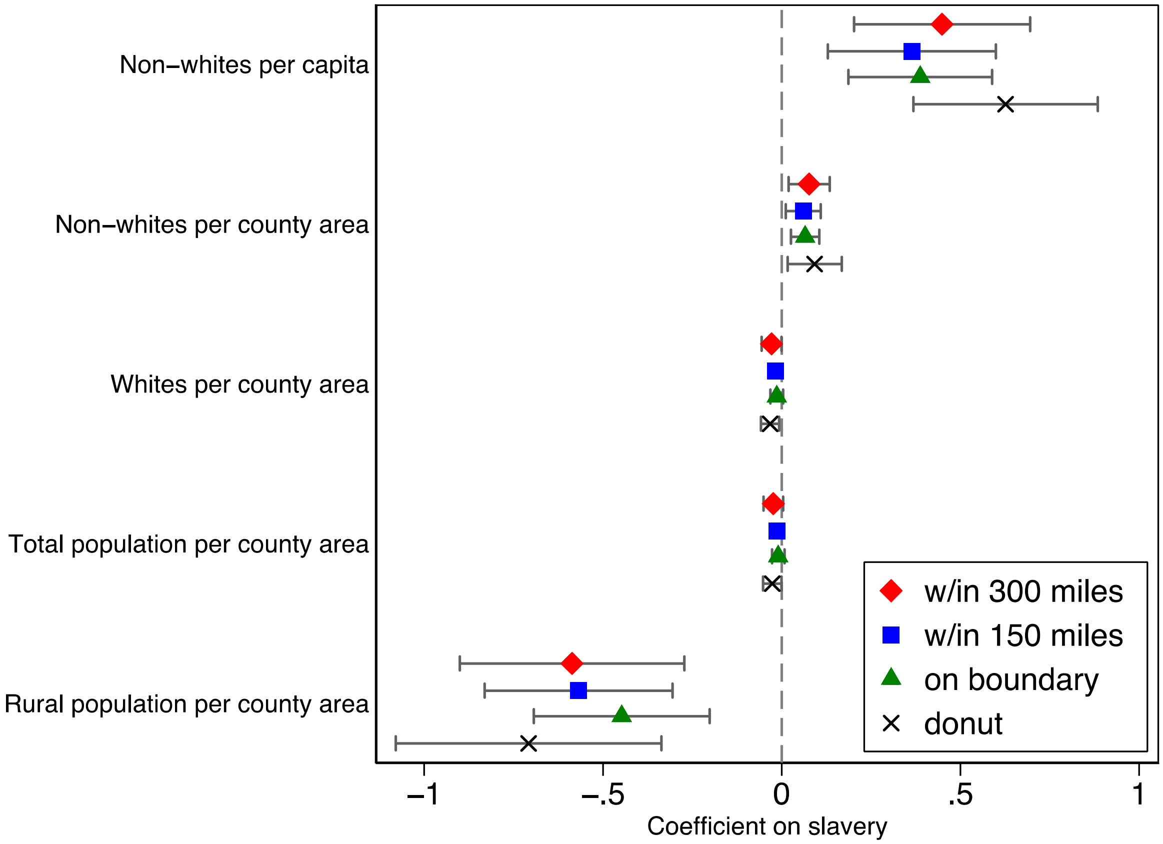
F-5. Crops (asinh instead of log)

F-6. Farm sizes(asinh instead of log)

F-7. Structural transformation (log and asinh)

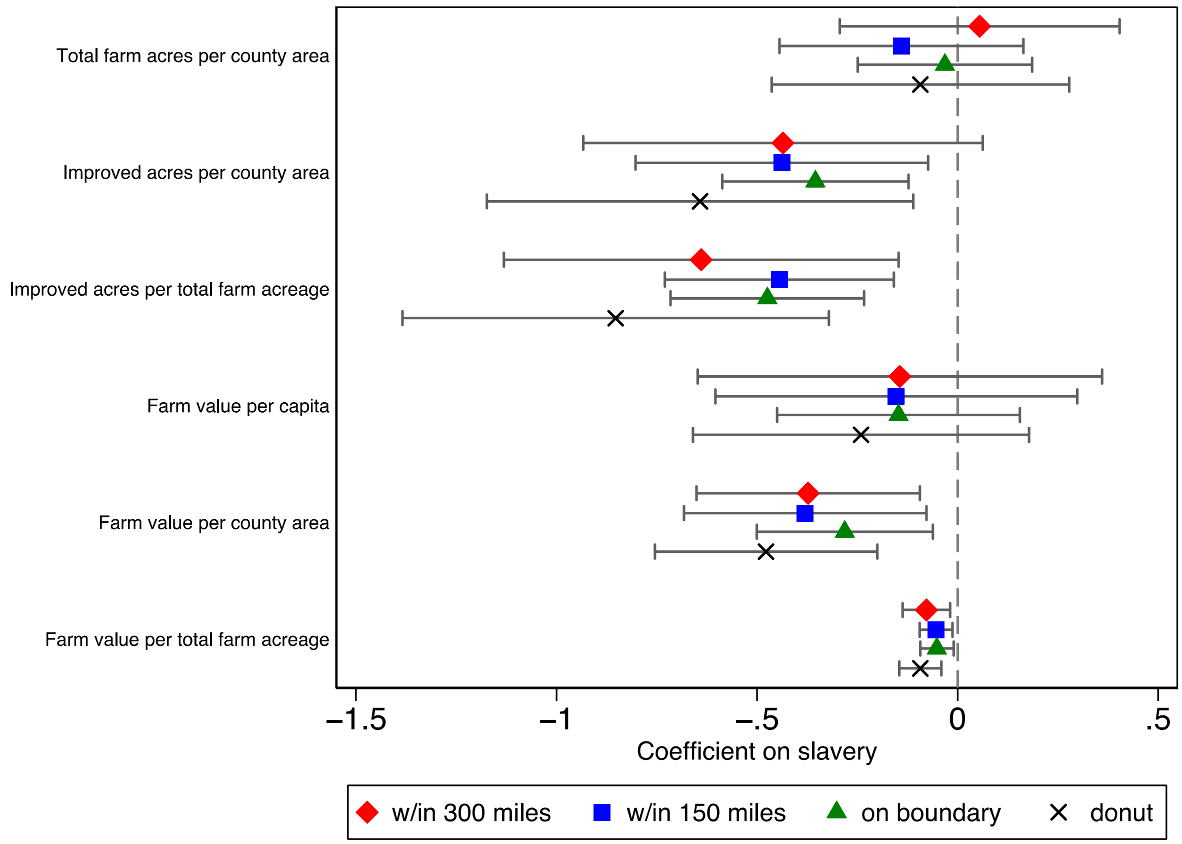
F-8. Wages (levels instead of logs)

Appendix Figure F-1: Population (z-score)



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 the notes 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. The outcomes are transformed into z-scores.

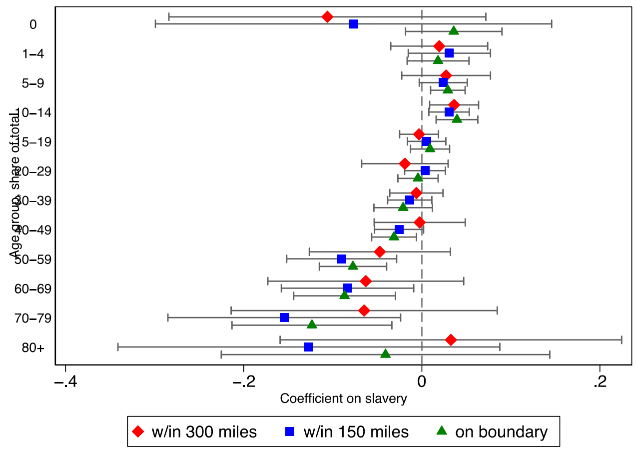
Appendix Figure F-2: Land Use and Land Value (z-score)



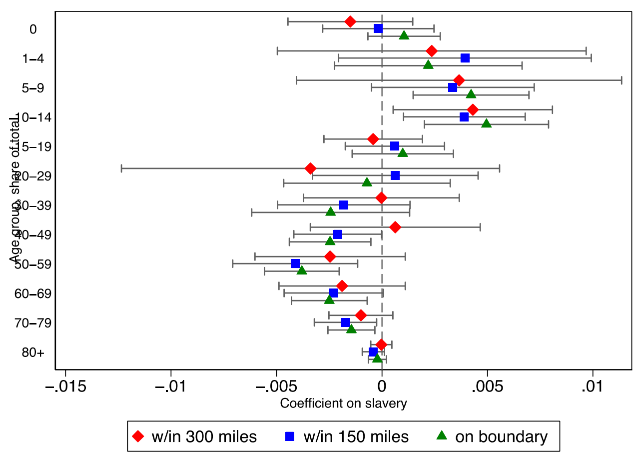
Notes: This figure presents point estimates and confidence intervals for the coefficient on slavery for the outcomes indicated in the row label and for various samples of counties. Point estimates are denoted with symbols within horizontal bands denoting 95-percent-confidence intervals. Standard errors are estimated using 15 quantiles of longitude as clusters. Each symbol type the notes 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. The outcomes are transformed into z-scores.

Appendix Figure F-3: Age Composition

Panel A: Logarithm



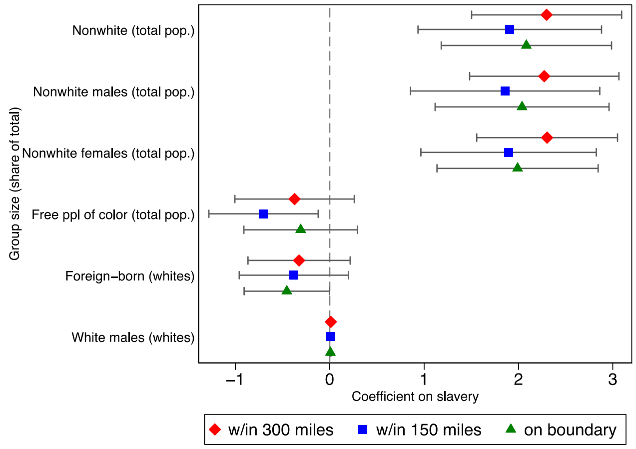
Panel B: Inverse Hyperbolic Sin



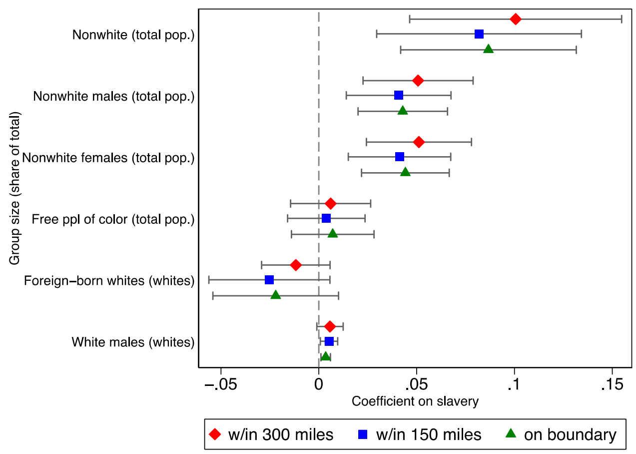
Notes: This figure presents point estimates and confidence intervals for the coefficient on slavery for the outcomes indicated in the row label and for various samples of counties. Point estimates are denoted with symbols within horizontal bands denoting 95-percent-confidence intervals. Standard errors are estimated using 15 quantiles of longitude as clusters. Each symbol type the notes 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. For the top panel, the outcomes are transformed into natural logarithms. For the bottom panel, the outcomes are transformed with the inverse hyperbolic sin (asinh).

Appendix Figure F-4: Race and Gender

Panel A: Logarithm

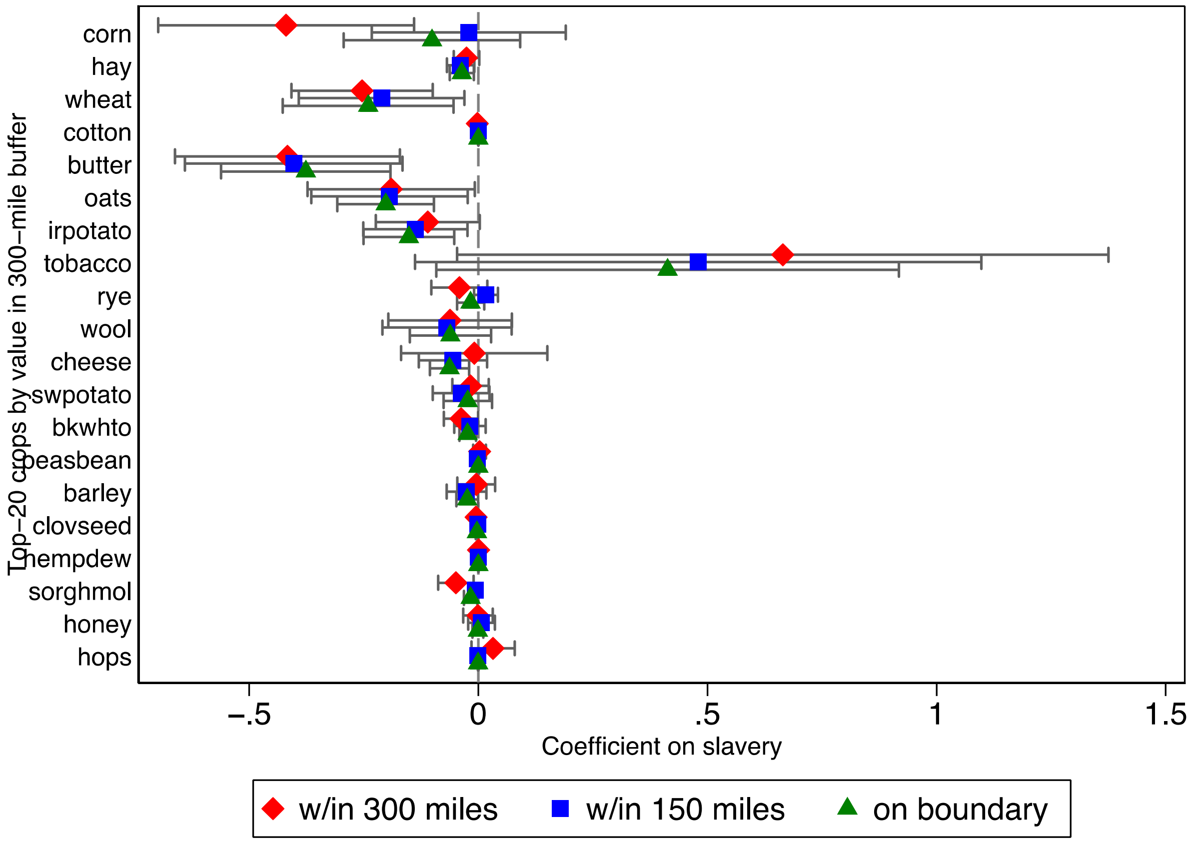


Panel B: Inverse Hyperbolic Sin



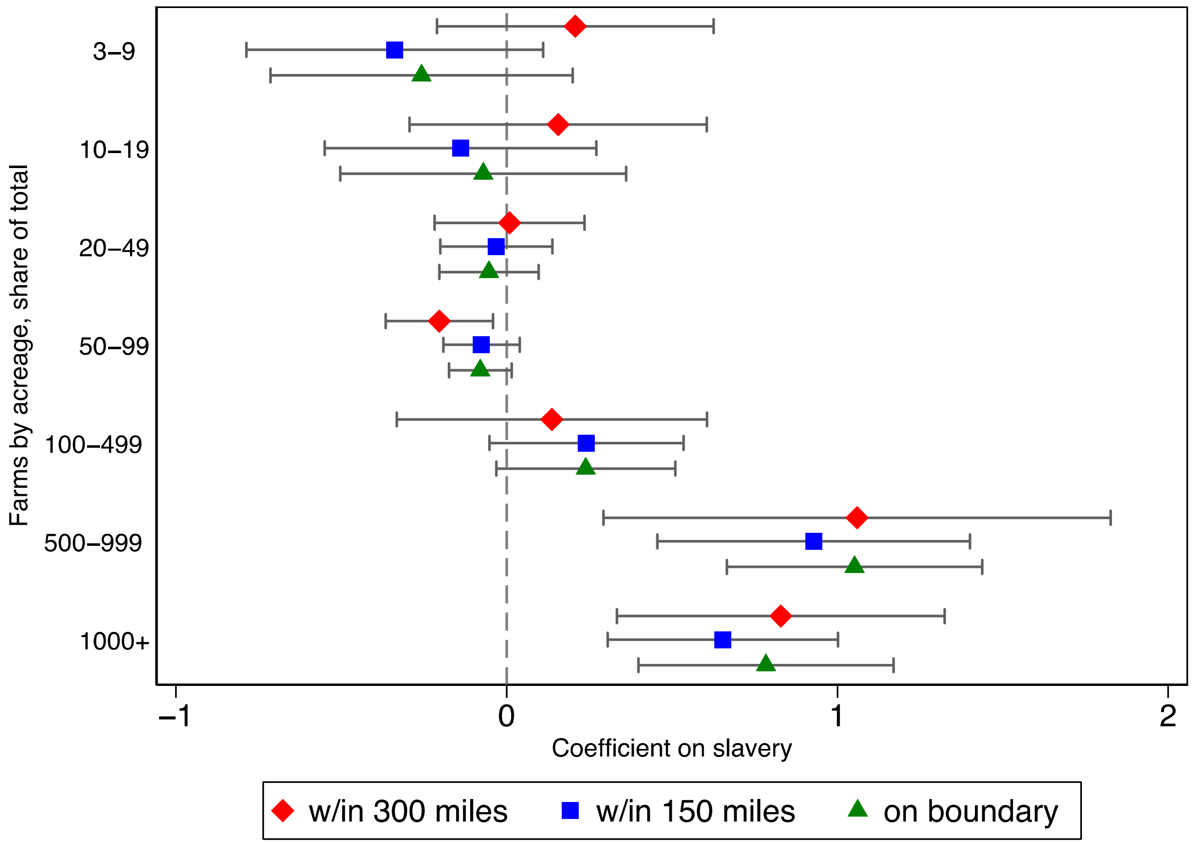
Notes: This figure presents point estimates and confidence intervals for the coefficient on slavery for the outcomes indicated in the row label and for various samples of counties. Point estimates are denoted with symbols within horizontal bands denoting 95-percent-confidence intervals. Standard errors are estimated using 15 quantiles of longitude as clusters. Each symbol type the notes 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. For the top panel, the outcomes are transformed into natural logarithms. For the bottom panel, the outcomes are transformed with the inverse hyperbolic sin (asinh).

Appendix Figure F-5: Crops (asinh transform)



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 the notes 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. The outcomes are transformed with the inverse hyperbolic sin (asinh).

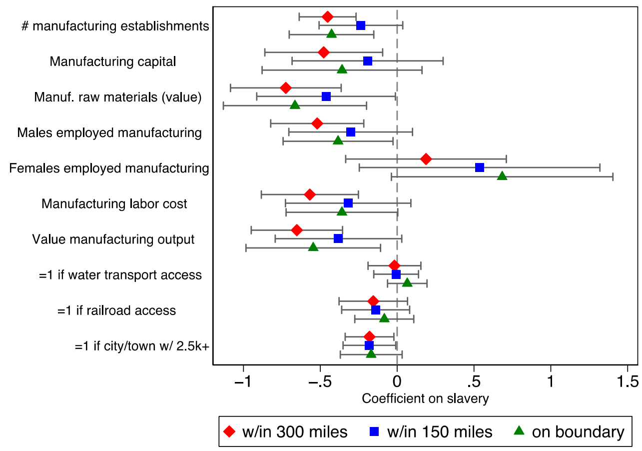
Appendix Figure F-6: Farm sizes (asinh transform)



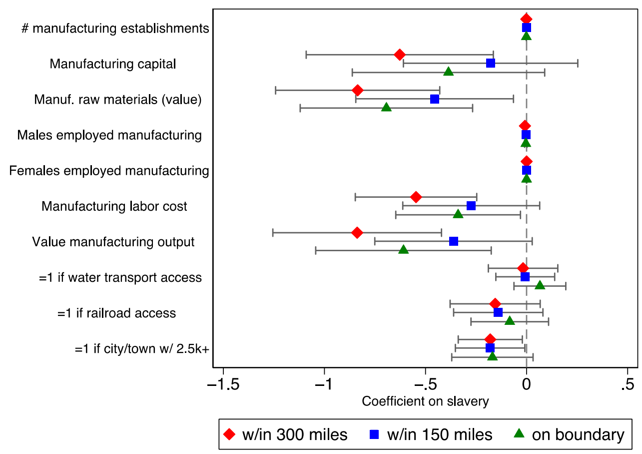
Notes: This figure presents point estimates and confidence intervals for the coefficient on slavery for the outcomes indicated in the row label and for various samples of counties. Point estimates are denoted with symbols within horizontal bands denoting 95-percent-confidence intervals. Standard errors are estimated using 15 quantiles of longitude as clusters. Each symbol type the notes 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. The outcomes are transformed with the inverse hyperbolic sin (asinh).

Appendix Figure F-7: Structural Transformation

Panel A: Logarithm

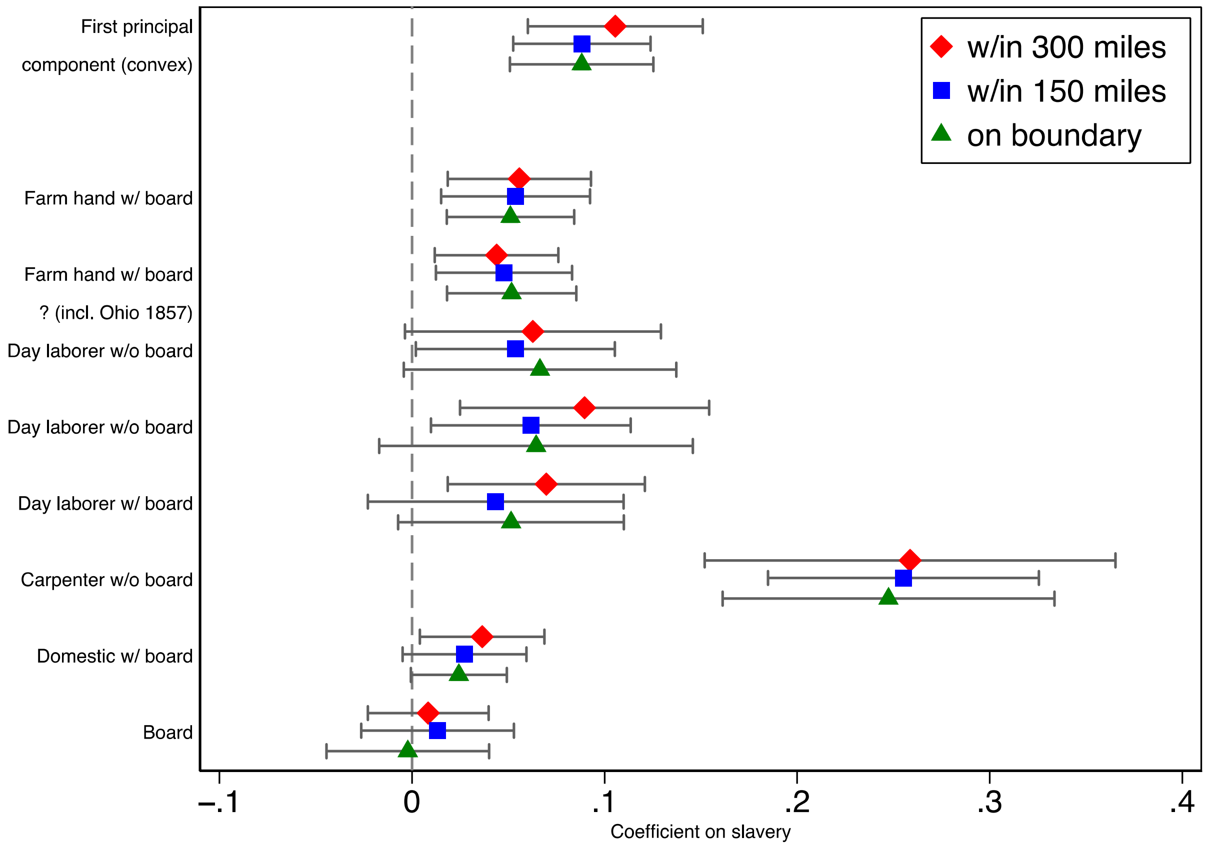


Panel B: Inverse Hyperbolic Sin



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 the notes 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. For the top panel, the outcomes are transformed into natural logarithms. For the bottom panel, the outcomes are transformed with the inverse hyperbolic sin (asinh).

Appendix Figure F-8: Wages (levels)



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 the notes 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.

Appendix G: Data on Wages

The Census of Social Statistics reported wages. Stanley Lebergott (1964) reported the state-level data. Robert Margo (2000) analyzed a large sample of county-level data that he collected from the surviving manuscript records. The Census Marshalls reported information on the average monthly wages of farmhands (with board), daily wages of day laborers (with and without board), daily wages of carpenters (without board), the weekly wages (with board) of female domestics, and the price of board to laboring men per week. The reports were sometimes separate by township, and we used an unweighted average to construct the county data.

We have sought to use all the data available. We benefited from the data collection efforts of Robert Margo (highest honors), John Clegg, and Vasily Rusanov. We thank these scholars for sharing and making the analysis much easier. We have added data where possible.

Secondary sources for 1860:

- Robert Margo: DC, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Massachusetts, Mississippi, Michigan, Nebraska, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia.
- John Clegg: Arkansas, Delaware.
- Vasily Rusanov: Minnesota, Wisconsin.
- Bleakley, Rhode: Alabama, California, Connecticut, Maryland, Maine, Missouri, New Hampshire, New York, New Jersey, Ohio (4 counties), Oregon, Rhode Island, Vermont.

Secondary sources for 1850:

- Robert Margo: Arkansas, DC, Florida, Georgia, Indiana, Iowa, Kentucky, Louisiana, Massachusetts, Mississippi, Michigan, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia.
- John Clegg: Delaware.
- Vasily Rusanov: Wisconsin.
- Bleakley, Rhode: Alabama, California, Connecticut, Illinois, Maryland, Maine, Missouri (2 counties), New Hampshire, New Jersey, Ohio (1 county), Oregon, Rhode Island.

The Social Statistics schedules for all but for Ohio counties are apparently lost. We supplemented US Census Social Statistics with 1857 state data for Ohio for the wages of daily labor and farm hands. These are reported in:

- Ohio Commissioner of Statistics. 1858. Annual Report for 1857. Public Doc. No. 8. Columbus, OH: Richard Bevins, State Printer, pp. 555-65.
- Ohio Board of Agriculture. 1858. *1857* Annual Report. Columbus, OH: Richard Bevins, State Printer, pp. 210-11.

Appendix H: Adaptation of Rosen/Roback Model

The standard Rosen-Roback model has a system of equations involving homogenous firms and households and multiple locations. Both firms and households create the demand for land at each location; firms demand labor and households supply labor. Firms enter until a zero-profit control holds. Households pick the location generating the highest utility.

In the most commonly used variant of the model, land values do not directly enter in the firm's profits, only in the household's utility through a cost-of-housing effect. A higher density of households leads to higher land values. A firm's profits are determined by productivity (positively) and wages (negatively). A household's utility is affected by amenities (positively), wages (positively), and land values (negatively, via housing costs). Prices and quantities adjust to leave firms with zero profit and households with utility equal to their next-best alternative (U^*). The system of equations is:

(1) Profits (Productivity$^+$, Wages$^-$) = 0
(2) Utility (Amentity$^+$, Wages$^+$, Land Values$^-$) = U^*

In spatial equilibrium, these two conditions combine to determine the local factor returns. Local land values are higher in places with higher Productivity or higher Amenities. If Productivity is higher, then local labor demand shifts out. The resulting higher wages attract more workers to the area and this raises the land price. If the Amenity is higher, local labor supply shifts out. This reduces the local wage, but bids up the land price. Local wages are higher in places with higher Productivity or lower Amenities (equivalently, higher disamenities). These summarize the reduced-form relationships:

(3) Land Values (Productivity$^+$, Amentity$^+$)
(4) Wages (Productivity$^+$, Amentity$^-$)

We can use the comparative statics of this model to infer the (predominant) shocks. A combination of higher land value and higher wages is associated with the dominance of higher productivity of local firms. A combination of higher land value and lower wages is associated with the dominance of higher amenity values for households.

A variation more suitable to our case switches the source of the demand for land from households to firms (farms). Farms use land and households choose locations based on amenities (positively), wages (positively). Wages here are a measure of the returns (e.g. marginal product) to labor. Farmland rents and values will depend on productivity (positively) and wages (negatively). In equilibrium, the following relationships hold:

(5) Farm Rents (Productivity$^+$, Wages$^-$)
(6) Indirect Utility (Amenity$^+$, Wages$^+$)

This framework leads to the same result as before. A combination of high land value and high wages is still associated with higher productivity of local farms. Amentities could be higher or lower in this case, but not so high that equilibrium wages are lower. In contrast, a combination of high land value and low wages is associated with higher amenity values for households. The model's summary interpretation is that the observed combination of lower land prices and higher wages is consistent with a household-side disamenity for free people associated with living and working on the slave side.

We can readily add a second set of households who choose locations based on land values and amenities, instead of wages and amenities. These households may have an autarkic relationship to the labor market, being neither buyers nor sellers of labor. An example would be self-sufficient farm household that depends on its own labor. They do desire cheaper land to increase their holdings.

For these households, locational choice is determined by an alternative utility function without wages.

(7) Alt_Utility (Amentity^{+}, Land Values^{-})

The same equilibrium relations of factor returns remains the same as in (3) and (4). Land values are lower on the slave side. This could arise because of the higher wages for those active in the labor market or because migrants intending to be farmers require a higher land/labor ratio on their farm in order to move there. This is still a sign of household-side disamenities for free people on the slave side.

Appendix I: Population Movements

The appendix section documents several pertinent patterns related to migration to the border region. See Bleakley-Rhode (2023a) for additional evidence on population flows.

Table I-1 compares the retention rates of heads-of-household and total free population between the free and slave states. The retention rate is the percent remaining in the region of birth; those not retained obviously shifted between regions. The measured shifts are much higher for heads-of-households (about 1 in 8) than for the total free population (1 in 20). The fraction of household heads born in a slave state who moved to reside in a free state – coming close to 1 in 4 – is especially notable. The fraction is substantially higher than that for moves in the opposite direction, born in a free state and residing in a slave state. The difference in retention rates is sufficiently large to create a net movement of household heads from slave states to free states despite the larger fraction of household heads born in free states.

The preference of movers for the free states is evident if one examines longer distance moves, to the border counties from either non-border states or foreign counties. The destination choices for such moves were not constrained from the desire to move along given latitude. Tables I-2 and I-3 present data of the free-side/slave-side choices for male heads of households, ages 25 years or more, residing in the border counties in 1860. The border states are indicated in italics and the slave states are indicated in bold type. The second panel in Table K-2 reports results separately for free persons of color.

The ratios report the prevalence of residence on the free side relative to the slave side. Four results stand out. (i) it is uncommon for persons born in free states to reside to reside on the slave side. Those born in free states tended to live on the free side; the ratio of own to other was 6 to 1. Those born in slave states tended to live on the slave side, the ratio of own to other was 2 to 1. Thus, switching was more common for those born on the slave side than those born on the free side. (2) for longer distance moves (from states not on the border), both southerners and northerners tended to live the free side; (3) it is very uncommon for free persons on color from non-border states to reside on the slave-side; (4) the foreign-born also tended to the free side, but the ratios actually closer to parity than for US born male HHs from the non-border region. These patterns were not new to 1860, and indeed predate the sharp regional conflicts of the 1850s. Table J-4 present data of the free-side/slave-side choices for US born male heads of households, ages 25 years or more, residing in the border counties in 1850. (The Census of 1850 is the first to include information on state of birth.) At this date, it is already uncommon for those born in free states to reside on the border counties on the slave side.

The source for the 1850 and 1860 Full Count Census data used in Figure 1 and Tables 1-3 is Steven Ruggles, Sarah Flood, Sophia Foster, Ronald Goeken, Jose Pacas, Megan Schouweiler and Matthew Sobek. IPUMS USA: Version 11.0 [dataset]. Minneapolis, MN: IPUMS, 2021. https://doi.org/10.18128/D010.V11.0

Appendix Table I-1: Comparison of Retention Rates for Heads of Households and Free Population

Birth\Resident	Slave State	Free State	Total	% Retained
Heads of Household				
1850				
Slave State	896,944	264,469	1,161,413	77.2
Free State	85,638	1,849,185	1,934,823	95.6
Total	982,582	2,113,654	3,096,236	88.7
1860				
Slave State	1,114,557	304,173	1,418,730	78.6
Free State	143,615	2,428,648	2,572,263	94.4
Total	1,258,172	2,732,821	3,990,993	88.8
Free Population				
1850				
Slave State	5,966,230	648,168	6,614,398	90.2
Free State	227,239	10,505,338	10,732,577	97.9
Total	6,193,469	11,153,506	17,346,975	95.0
1860				
Slave State	7,481,837	760,965	8,242,802	90.8
Free State	390,151	14,703,287	15,093,438	97.4
Total	7,871,988	15,464,252	23,336,240	95.1

Compiled from Census Full Count for 1850 and 1860.

Appendix Table I-2: 1860 Residents in Border Countries by State of Birth

Male HH Age 25 and over				Free People of Color		
Birth\Reside	Free	Slave	Ratio	Free	Slave	Ratio
Total	204,066	111,541	1.83	6,127	5,831	1.05
Birth-State Slave	41,237	84,622	0.49	3,371	5,682	0.59
Birth-State Free	162,829	26,919	6.05	2,756	149	18.50
Not-Border	21,317	11,891	1.79	501	88	5.69
Birth-State Slave	8,152	6,334	1.29	462	59	7.83
Birth-State Free	13,165	5,557	2.37	39	29	1.34
Individual States						
Delaware	1,616	11,393	0.14	324	2278	0.14
Kentucky	10,968	27,201	0.40	427	384	1.11
Maryland	6,545	26,257	0.25	709	2,692	0.26
Missouri	823	3755	0.22	33	53	0.62
Virginia	12,991	9,531	1.36	1,391	211	6.59
DC	142	151	0.94	25	5	5.00
Illinois	5194	809	6.42	102	8	12.75
Indiana	10,911	2088	5.23	67	4	16.75
Iowa	445	261	1.70	1	1	1.00
New Jersey	12,371	1,211	10.22	522	12	43.50
Ohio	36,065	5,404	6.67	285	15	19.00
Pennsylvania	84,678	11,589	7.31	1,740	80	21.75
Alabama	198	135	1.47	20	1	20.00
Arkansas	37	36	1.03	3	0	
Florida	5	10	0.50	0	0	
Georgia	238	175	1.36	35	6	5.83
Louisiana	116	132	0.88	24	12	2.00
Mississippi	102	72	1.42	36	4	9.00
North Carolina	2,792	2,014	1.39	140	17	8.24
South Carolina	697	442	1.58	42	6	7.00
Tennessee	3,955	3,310	1.19	159	13	12.23
Texas	12	8	1.50	3	0	
Connecticut	1,214	477	2.55	1	1	1.00
Maine	762	333	2.29	0	0	
Massachusetts	1,948	989	1.97	5	24	0.21
Michigan	66	49	1.35	1	0	
Minnesota	2	4	0.50	0	0	
Nebraska	2	0		0	0	
New Hampshire	737	241	3.06	0	0	
New York	6,169	2,958	2.09	29	4	7.25
Rhode Island	265	99	2.68	2	0	
Vermont	1962	400	4.91	0	0	
Wisconsin	38	7	5.43	1	0	

Appendix Table I-3: 1860 Foreign-Born Residents in Border Counties by Country of Birth

Male HH Age 25 and over

Birth\Reside	Free	Slave	Ratio
Total	79,745	57,666	1.38
Britain (incl. Ireland)	28,193	24,233	1.16
German-Austrian-Swiss	45,473	28,832	1.58
Other	6,079	4,601	1.32
Canada	636	508	1.25
West Indies	641	411	1.56
Denmark	84	102	0.82
Norway	33	12	2.75
Sweden	94	71	1.32
England	7,197	4,740	1.52
Scotland	1,812	1,101	1.65
Wales	1,088	473	2.30
Ireland	18,096	17,919	1.01
Belgium	135	88	1.53
France	3,452	2,137	1.62
Netherlands	500	255	1.96
Switzerland	2,029	1,104	1.84
Italy	183	221	0.83
Austria	263	232	1.13
Czechoslovakia	126	625	0.20
Germany	43,181	27,496	1.57
Hungary	46	35	1.31
Poland	149	136	1.10

Source for Tables I-1 and I-2: Compiled from IPUMS 1860 Full Count Census

Appendix Table I-4: 1850 Residents in Border Countries by State of Birth

Male HH Age 25 and over	Free	Slave	Ratio
Total	169,737	97,130	1.75
Birth-State Slave	40,142	80,766	0.50
Birth-State Free	129,595	16,364	7.92
Not-Border	19,187	10,486	1.83
Birth-State Slave	7,735	5,421	1.43
Birth-State Free	11,452	5,065	2.26
Individual States			
Delaware	1,659	10,176	0.16
Kentucky	9,768	18,847	0.52
Maryland	7,204	33,350	0.22
Missouri	479	2,576	0.19
Virginia	13,181	10,039	1.31
DC	116	357	0.32
Illinois	2,297	273	8.41
Indiana	4,846	549	8.83
Iowa	491	136	3.61
New Jersey	11,895	1,188	10.01
Ohio	22,685	1,794	12.64
Pennsylvania	75,929	7,359	10.32
Alabama	135	79	1.71
Arkansas	15	12	1.25
Florida	4	12	0.33
Georgia	312	238	1.31
Louisiana	100	163	0.61
Mississippi	76	81	0.94
North Carolina	2,864	2,242	1.28
South Carolina	1,120	576	1.94
Tennessee	3,105	2,010	1.54
Texas	4	8	0.50
Connecticut	1,339	423	3.17
Maine	722	334	2.16
Massachusetts	1,940	1,076	1.80
Michigan	27	24	1.13
Minnesota	-	8	0.00
Nebraska	2	1	2.00
New Hampshire	709	264	2.69
New York	5,412	2,448	2.21
Rhode Island	259	155	1.67
Vermont	1,039	327	3.18
Wisconsin	3	5	0.60

Source: Compiled from IPUMS 1850 Full Count Census

Appendix Table I-5: 1860 Residents in Border Counties by State of Birth, Rural Only

25+ Male HH	Free	Slave	Ratio
Birth\Reside	181,031	106,002	1.71
POB Slave	36,589	86,183	0.42
POB Free	144,442	19,819	7.29
Non-Border	16,769	8,570	1.96
POB Slave	7,675	5,790	1.33
POB Free	9,094	2,780	3.27
Individual States			
Delaware	1,331	11,328	0.12
Kentucky	9,643	24,000	0.40
Maryland	5,604	24,145	0.22
Missouri	732	2,995	0.24
Virginia	11,604	17,925	0.65
Illinois	4,988	648	7.70
Indiana	9,872	1,808	5.46
Iowa	425	194	2.19
New Jersey	10,385	892	11.64
Ohio	32,289	4,224	7.64
Pennsylvania	77,389	9,273	8.35
Alabama	174	95	1.83
Arkansas	28	30	0.93
DC	86	83	1.04
Florida	3	4	0.75
Georgia	195	130	1.50
Louisiana	64	58	1.10
Mississippi	73	29	2.52
North Carolina	2666	1,910	1.40
South Carolina	641	395	1.62
Tennessee	3,737	3,053	1.22
Texas	8	3	2.67
Connecticut	867	228	3.8
Maine	583	171	3.41
Massachusetts	1,303	466	2.80
Michigan	42	15	2.80
Minnesota	1	3	0.33
Nebraska	2	0	
New Hampshire	557	121	4.60
New York	4670	1,470	3.18
Rhode Island	194	54	3.59
Vermont	842	244	3.45
Wisconsin	33	8	4.13

Foreign Born			
Birth\Reside			
Total	45,951	22,384	2.05
Great Britain	17,146	10,644	1.61
Germany-Austria-Switzerland	25,138	10,442	2.41
Other	3,667	1,318	2.78
Canada	474	189	2.51
West Indies	324	64	5.06
Denmark	52	23	2.26
Norway	28	3	9.33
Sweden	63	25	2.52
England	4,969	2,539	1.96
Scotland	1,308	595	2.20
Wales	796	324	2.46
Ireland	10,073	67,186	1.40
Belgium	117	36	3.25
France	2,285	805	2.84
Netherlands	127	51	2.49
Switzerland	1,484	305	4.87
Italy	23	27	0.85
Austria	123	74	1.66
Czechoslovakia	106	68	1.56
Germany	23,531	10,043	2.34
Hungary	25	6	4.17
Poland	43	21	2.05

Source: Compiled from IPUMS 1860 Full Count Census

Appendix J: Adjusting for Buildings and Improvement and

Building Values and Clearing

To adjust farm values for differences in the value of buildings and improvements, we follow the practices laid out by Tostlebee (1957), Primack (1975), Lindert (1989a, 1989b) and Gallman (1972).

Building Values

These authorities report structures as being almost one-fifth of farm value. Subtracting the estimated value of buildings from the farm values yields an estimate of the value of "land alone" (see Primack 1975; Lindert 1989a, 1989b). For 1860, Gallman (1975) reports a national structure share of 0.23 whereas Gallman and Rhode (2019, pp. 19, 29) have this proportion at 0.19. Primack (1965, Table 1) reports the structure share in farm value is 0.18 in 1860, with the ratio varying by state. We use the Primack's building-farm value ratios reported at the state level. (County-level data are available in the Census in 1900, but these appear less relevant to conditions in the antebellum period than the estimates Primack provides.) Using the state-level parameters makes comparisons in the border sample somewhat problematic. The changes may be artificially sharp at the points where the parameters shift as in the border counties. State-level comparisons are not affected.

Land Clearing

The literature offers various ways to adjust for differences in land clearing. Removing the estimated value of land improvements from that of "land alone" yields an estimate of the site value of "raw" land. to create a value for "raw" land.[2] One approach to model the ratio of the value of improved to unimproved land. Gallman (1972) puts the 1860 national ratio at 2, which would imply that the per acre value of unimproved land is (1/(1+fraction improved)) times the per acre value of "land alone."

A second approach is to estimate the value of labor applied to land clearing (see Primack 1975; Gallman and Rhode 2019). The subtraction method produces a rather noisy measure. In some counties, the estimated cost of clearing an acre (required labor times daily wage) exceeds the value of "land alone"; the estimated value of "raw" land there was negative. Based on the subtraction approach, Gallman estimated the national ratio of improved-to-unimproved land in 1860 was around 2.5 (=12.50/5.01). See Table 7.12 in Gallman and Rhode 2019, p. 198. Gallman considered this ratio to be upward biased because off-peak family labor was deployed and may have lower value than the farm wage used in the calculation and the actual clearing was likely less thorough and requires less land than what was assumed.

Tostlebe (1957, p. 179) put the improved-to-unimproved ratio at 3 in the humid east and 1.5 in Illinois, Iowa, and the Great Plains. His assumptions were based on the lower cost of land clearing in prairie land than in woodland. Lindert (1989a, 1989b) adopts Tostlebe's approach. This approach does allow for environmental variability.

[2] An alternative, older approach was to regress farm values on the share of land improved. This analysis suffers, in obvious ways, from potential omitted variable biases.

Appendix K: Calculating Total Factor Productivity in Agriculture

To calculate TFP in agriculture, we follow the approach of Fogel and Engerman (1971, 1974). The main differences are two-fold. We conduct the estimation at the county level as opposed to the regional level (North versus South). And as a result of our more local focus, we use Thomas Weiss's county-level estimates of the agricultural labor force, as discussed below.

Output

The approach starts with the allocation to national agricultural output from Towne and Rasmussen (1960) across the subunits. This exercise assumes uniform national prices and well as seeding and feeding rates (to generate net outputs). We use gross farm output (from Table 1, p. 265), livestock outputs (Table 5, p. 282), crop outputs (Table 6, p. 291) and add the value of home manufactures and of improvements to land.

For most of the commodities, we can allocate the Towne and Rasmussen output values in straightforward ways, based on the county-level shares of national production from the US Census. (See ICPRS Study No 35206). The procedure is applied for Sheep and lambs, Hogs, Wheat, Rye, Corn, Oats, Rice, Tobacco, Cotton Lint, Wool, Peas and Beans, Irish Potatoes, Sweet Potatoes, Barley, Buckwheat, Fruits, Truck Crops, Hay, Hops, Hemp, Flax, Flaxseed, Maple, Sugar Cane, Maple Molasses, Cane Molasses, Sorgo, and Home Manufactures. For Miscellaneous Animal Products, the production of Honey is used to allocate the total. For Dairy Products, the distribution of milk cows was used. For Cattle and related produces, the distribution of other cattle and oxen was used. For Horse Production, the distribution of horses and mules was used. The Census data provided no straight-forward way to allocate the production of Chickens, Eggs, and Other Poultry, Forest Products, Nursery Production, and therefore these products were ignored. As noted by Engerman (1972), allocating the Towne and Rasmussen output yields output estimates using uniform national prices. (This contrasts with the income originating approach using state level prices.)

The value of farm improvement was allocated on the basis of estimated land clearing, construction, and fencing. As with Fogel and Engerman (1971), the approach was inspired by the work of Martin Primack (1977). Gallman's work on Agricultural Capital as represented in Gallman and Rhode (2019) was also informative. The county level sums were generated from three estimates:

(1) Land clearing: value estimated as the positive change in improved acreage by county between the 1850 and 1860 censuses times the Primack's labor requirement per acre (which depended on whether forest or prairie) times the state-level daily farm wage.
(2) Farm construction: value estimates as the positive change in number of farms reported by county in the 1850 and 1860 census times the building-to-total-value ratio times 1860 farm values divided by 1860 number of farms. The building-to-total-value ratio is based on Primack's state-level building-to-land estimates as reported on pp. 164-65, 174-76 of his dissertation.
(3) Fencing: value estimated as the positive change in total acres reported by county in the 1850 and 1860 census times Primack's labor requirements per newly fenced acres times the state-level daily farm wage.

These three values were summed for each county, and the county's share of the total was used to allocate the national figure for improvements to farms reported in Towne and Rasmussen. The daily farm wage was estimated as the monthly wage divided by 26.

Capital

The stock was the sum of equipment value, livestock values, and building values. The first two were taken directly from the US Census (1864). Following Fogel and Engerman (1971), building values were estimated based on 1860 Farm Values (from the Census) and Primack's State-Level Building-to-Land Ratio, introduced above. Following Fogel and Engerman (1971), the capital stocks were converted to flows assuming ratio of 0.2 for equipment, 0.1 for livestock, and 0.12 for buildings.

Land

Following Fogel and Engerman (1971), the stock of land was the sum of improved and unimproved acreage was reported in the US Census (1864) and ICSPR No. 32206. We also create an alternative index for land upweighting the contribution of improved land. Following Gallman (1972), we treat improved land as twice (2 times) as valuable as unimproved land.

Labor

The county-level labor stock was the sum of four components from the work of Thomas Weiss: Rural Agricultural Free Males, under 15; Rural Agricultural Free Males, 16 years and older; Rural Agricultural Slave Males, 10 years and over; and Rural Agricultural Slave Females, 10 years and over. (See Craig and Weiss.) These series were created after Fogel and Engerman (1971, 1974) and differ somewhat from the estimates based on Lebergott (1966) used therein. Weiss assumed a lower fraction (0.74) of enslaved workers in rural areas worked in agriculture than Lebergott did (0.90); Weiss took the share devoted to domestic service to be higher. Weiss does employ certain state-level parameters, which may affect the sharpness of changes at the border. We create two estimates of the county-level agricultural labor forces, the first using Weiss's numbers reflecting his preferred labor force participation rates and the second adjusting the slave labor force upward to reflect Lebergott's higher estimate (that is, Weiss's slave labor force in agriculture is boosted by 1.216216=0.90/0.74, everywhere). The two alternatives yield different estimates of the input bundles and of productivity.

Inputs and TFP

Following Fogel and Engerman (1971), capital (K), land (T), and labor (L) was combined in a Cobb-Douglas function with weights of 0.2, 0.2, and 0.6. That is, input bundle=$K^{0.2}T^{0.2} L^{0.6}$. Fogel and Engerman (1974) use slightly different weights. Total Factor Productivity is measured as output divided by the input bundle, or TFP=$Q/(K^{0.2}T^{0.2} L^{0.6})$. There are two estimates, the first reflecting Weiss's approach and the second, Lebergott's. In each case, Q, K, T, and L are normed to the national total, and thus are shares of the national aggregates. The county-level TFP estimates are relative to the national mean of 1, that is unity.

References

Craig, Lee and Thomas Weiss. 1998. "Rural Agricultural Workforce by County, 1800-1900." https://eh.net/database/u-s-agricultural-workforce1800-1900/

Engerman, Stanley. 1971. ”Some Factors in Southern Backwardness in the Nineteenth Century.” Essays in Regional Economics, ed. by John F. Kain and John R. Meyer. Cambridge MA: Harvard Univ. Press. 279-308.

Fogel, Robert W., and Stanley L. Engerman. 1971. “The Relative Efficiency of Slavery: A Comparison of Northern and Southern Agriculture in 1860.” Explorations in Economic History 8 (Spring): 353-67.

Fogel, Robert W., and Stanley L. Engerman. 1974. Time on the Cross: The Economics of American Negro Slavery. Vol. I and II. Boston: Little, Brown.

Gallman, Robert E., 1972. “Changes in Total U.S. Agricultural Factor Productivity in the Nineteenth Century.” Agricultural History 46: 1 (Jan.):191-210.

Gallman, Robert and Paul W. Rhode. 2019. Capital in the Nineteenth Century. Chicago: Univ. of Chicago Press.

Haines, Michael, Fishback, Price, and Rhode, Paul. United States Agriculture Data, 1840 - 2012. Inter-university Consortium for Political and Social Research [distributor], 2018-08-20. https://doi.org/10.3886/ICPSR35206.v4

Lebergott, Stanley. 1966. “Labor Force and Employment, 1800-1960.” Output, Employment, and Productivity in the United States After 1800. Dorothy S. Brady, ed. Princeton, NJ. Princeton Univ. Press.

Lindert, Peter H. 1988a. “Long-run Trends in American Farmland Values.” Agricultural History 92:3 (Summer): 45-85.

Lindert, Peter H. 1988b. “Long-run Trends in American Farmland Values.” UC Davis Agricultural History Center Working Paper No. 45.

Primack, Martin L., 1965. “Farm Construction as a Use of Farm Labor in the United States, 1850-1910.” Journal of Economic History 25:1 (March): 114-25.

Primack, Martin L., 1975. Farm Formed Capital in American Agriculture, 1850 to 1910. Arno Press. Published version of 1961 Univ. of North Carolina Ph.D. dissertation.

Tostlebe, Alvin S., 1957. Capital in Agriculture: Its Formation and Financing since 1870. Princeton, NJ: Princeton Univ. Press.

Towne, Marvin, and Wayne Rasmussen. 1960. “Farm Gross Product and Gross Investment in the Nineteenth Century.” Trends in the American Economy in the Nineteenth Century. Princeton, NJ. Princeton Univ. Press.

US Census Office. 1864. Agriculture of the United States in 1860. Washington, DC: GPO.

Appendix L: Discussion of Glacial Coverage and Land-Survey Systems

The free-slave boundary has a rough correspondence to the terminal moraine (southern extent of glacial coverage) and to the extent of the Public Land Survey System (PLSS). To some degree, the glacier and the PLSS are both positively correlated with Free Soil. If these are desirable features of the land, then this could account for the higher development north of the free-slave border. We discuss these possible confounds throughout the paper, and give a summary in this Appendix for the reader with this particular interest. We contend that the legality of slavery has effects, even accounting for the PLSS and glacial coverage.

Detailed discussion of the location of the terminal moraine is found in Appendix B. As the glacier affected soil characteristics, we call the reader's attention to Appendix E as well, which describes our use of summary information from the USDA's STATSGO soil database. Appendix Figure E.1 compares the free-slave boundary, glacial extent, and depth to bedrock. It is evident from this figure that that glacier and soil depth are tightly related, while the free-slave border has substantial independent variation from the other two phenomena. These two variables stand out from the other geological variables, nonetheless, as strongly significantly related to the free-slave border in the balancing tests in Section III (also reported in Figure 2). This latter finding is at the county level. We construct county-level data on glaciation by coding the fraction of the county on either side of the terminal moraine. This variable is continuous, but most of the observations are near or at either zero or one.

As noted in Appendix B, "in general terms, the glacial and free/slave boundaries are both oriented in an east/west direction, but they do not precisely coincide." At the free-slave border, the strongest correspondence with the moraine is along the Ohio River between Cincinnati and Louisville. This is a stretch where the differences in development are comparatively small, however. Upriver from Cincinnati, the moraine and the free-slave boundary are quite separate, yet the border development differences are quite pronounced. (See Figure 1.)

In Section VI (Sensitivity Analysis), we examine the effect on the slavery-legal coefficient when controlling for glacial coverage. The pertinent estimates appears in Panel B of Table 2 and a reproduced below in Appendix Table L.1. In Panel L.1.A, we first present baseline estimates. As we say in Section VI,

> The next two rows control for the fraction of the county covered by the most recent glacier. The second row of this pair leaves out 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.

Table 2 also contains results controlling for soil characteristics, for example depth to bedrock. Estimates of the coefficient on slavery legality are not materially affected by these controls.

For reference, we also report the effect of the glacier itself by comparing counties on either side of the terminal moraine. This results is seen in Table 2 and reproduced in Panel L.1.B of Appendix Table L.1. Again quoting from the paper,

> For counties adjacent to the terminal moraine, having been glaciated is beneficial. Such places have higher population density, more land farmed, more improvement per

farmland, and higher farm values. Per county acre, farms have over 60 percent higher value, an amount comparable to what we estimate for being Free Soil.

How do we understand the relative unimportance of this confound? There are two pieces:

i. the difference in fraction glaciated at the free-slave border is not overwhelming. Among the border counties, the fraction covered by the glacier was 36 percent on Free Soil and 28 percent where slavery was legal. (Relatedly, the average depth to bedrock in the border counties is 132cm on the northern side and 129cm on the southern side.)
ii. The effect of the glacier is large (of similar magnitude to the slavery-legal effect for farm-value variables), but this effect would be multiplied by the smallish difference reported in (i). Multiplying the glacier coefficient of 60% times a difference at the free-slave border of 8 percent glacial coverage would leave a contribution that is a small fraction of the estimates for slavery legality.

So, glacial coverage is an important variable in determining land demand, but differences in glaciation are unlikely to be responsible for the differences in farm values and population density of the magnitude estimated at the free-slave border.

Next we summarize the paper's attempted to incorporate the PLSS in the analysis. We discuss the types of land surveys across the country in Appendix D. Appendix Figure D.1 maps the fraction of each 1860 county that is covered by the PLSS. This is clearly related to the free-slave boundary, but imperfectly so. In the final block of Appendix Table L.1, Panel L.1.A, we reproduce estimates from Table 2 in which we control for the fraction of the county that uses PLSS. As can be seen, the coefficients on slavery legality are not materially affected.

We can also test whether the jump at the free-slave border is different if there is a switch in the land survey at the same time. Appendix Figure D.1 also presents our coding of where the free-slave border is associated with a change between a PLSS and a non-PLSS survey system. (Point 2 of Appendix D describes these places in detail.) Each county in the sample is associated with a closest point on the free-slave border. We can create subsamples based on the set of counties that are closest to a point with a change (versus not) to a PLSS at the free-slave border. Estimates for these two subsamples are reported in Table 3 (reproduced here in Appendix Table L.2). Results are similar to the baseline.

Thus, the partial coincidence of the change to PLSS and the change to Free Soil does not appear to generate the estimated negative effect of the legality of slavery.

Appendix Table L.1: Select estimates from Table 2 (Sensitivity Analysis).

	(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 L.1.A: Effect of slavery legality, with and without controls for glacier and PLSS							
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]
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 L.1.B: Effect of glacial coverage							
Terminal moraine (glacier = 1)	0.234 (0.357) [121]	0.409 (0.163) [122]	0.374 (0.172) [121]	0.310 (0.185) [122]	0.232 (0.080) [122]	0.637 (0.227) [122]	0.328 (0.104) [122]

Notes: see notes from Table 2.

Appendix Table L.2: Select estimates from Table 3 (results from 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
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]
Change to PLSS at Free/Slave Boundary	1.834	-0.697	-0.533	0.015	-0.535	-0.529	-0.544
	(0.725)	(0.224)	(0.235)	(0.126)	(0.238)	(0.378)	(0.275)
	[694]	[706]	[706]	[706]	[706]	[706]	[706]
No chg. to PLSS at Free/Slave Boundary	1.987	-0.573	-0.501	-0.054	-0.290	-0.635	-0.581
	(0.517)	(0.123)	(0.148)	(0.223)	(0.150)	(0.284)	(0.232)
	[586]	[656]	[651]	[650]	[650]	[650]	[650]

Notes: see notes from Table 3.

Appendix M: Pseudo-Regional Boundaries

For sensitivity analysis, we employ several sets of boundaries that do not mark a transition from Free Soil to slavery legality. As the free-slave border runs roughly east-west and spans the eastern half of the country, we constructed other sets of boundaries that do the same. We call them pseudo-regional boundaries, as they are nowhere associated with a change in slavery legality. These are, by definition, removed from the free-slave border itself, although a few come close by.

Three sets of borders incorporate state boundaries only. One boundary uses rivers that are not state borders, but attempts to replicate the free-slave border's mix of state and riverine boundaries. Appendix Figure M.1 contains maps of these pseudo-regional boundaries, with the free-slave border drawn for reference.

The first two, seen in Panel A are

1. The southern borders of Missouri, Kentucky, and Virginia.
2. The southern borders of Minnesota, Wisconsin, Michigan, and New York. We use land borders only, as the lacustrine borders would separate quite distant counties and/or not have a counterpart in the US data.

The next two, seen in Panel B, are as follows.

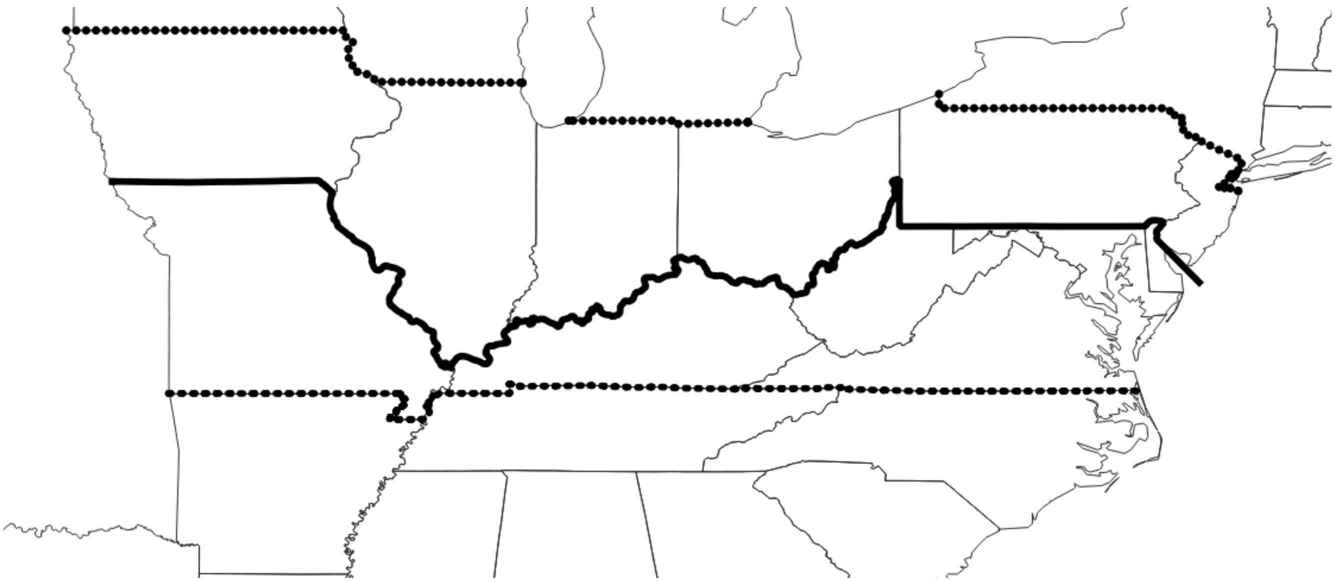
1. (a) the northern border of Arkansas, (b) down the Mississippi River to the southern border of Tennessee, and (c) the southern borders of Tennessee and North Carolina. (dotted line)
2. (a) down the Arkansas River to the Mississippi River, (b) up the Mississippi River to the southern border of Tennessee, (c) along the southern border of Tennessee, east to Tennessee River, (d) up the Tennessee River and then up the Middle Holston River to southern border of Virginia, and (e) east on the southern border of Virginia to the Atlantic Ocean. (gray line)

Finally, in Panel C, we present the northern extent of the cotton belt.

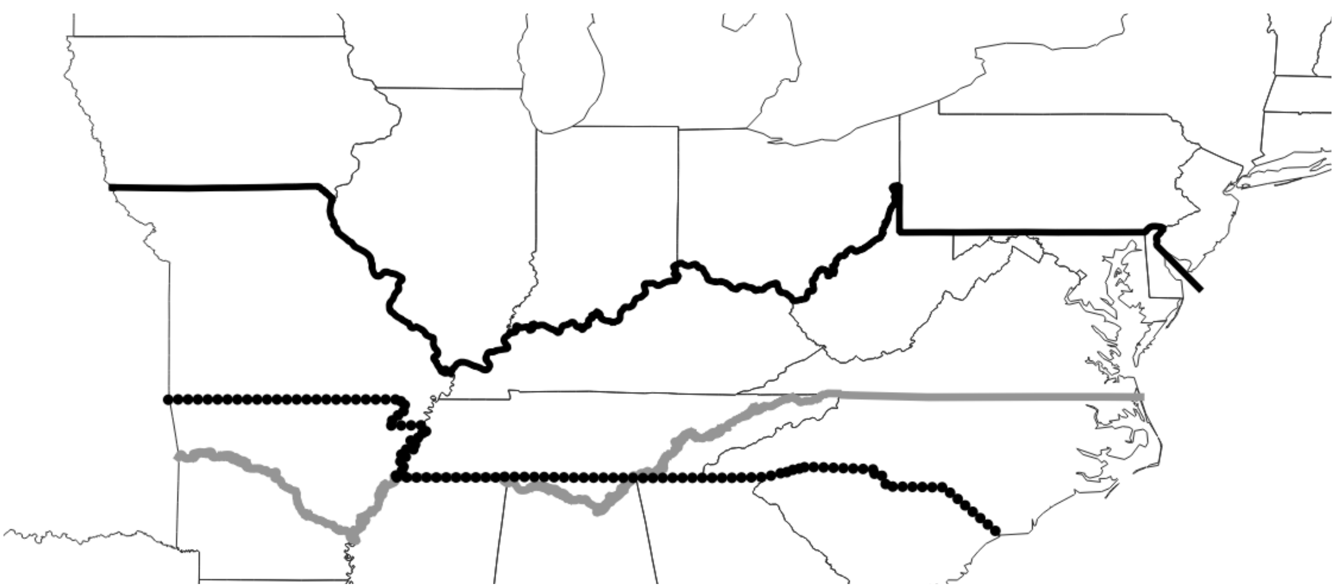
Regressions using these are boundaries to estimate equation (2) are founds in Table 2.

Appendix Figure M.1: Locations of Pseudo-Regional Borders, with Free-Slave Border for Reference

Panel A: Southern Borders of {MO KY VA} and of {MN WI MI NY (Land Only)}



Panel B: Borders of {AR TN NC} and State/River Mix



Panel C: Northern Limit of Cotton Belt