The Economic Geography of American Slavery*

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Abstract

What would the antebellum American economy have looked like without slavery? Using new micro-data on the U.S. economy in 1860, we document that where free and enslaved workers live and how much they earn correlates strongly—but differently—with geographic proxies for agricultural productivity, disease, and ease of slave escape. To explain these patterns, we build a quantitative spatial model of slavery, where slaveholders coerce enslaved workers into supplying more labor, capture the proceeds of their labor, and assign them to sectors and occupations that maximize owner profits rather than worker welfare. Combining theory and data, we then quantify how dismantling the institution of slavery affected the spatial economy. We find that the economic impacts of emancipation are substantial, generating welfare gains for the enslaved of roughly 1,200%, while reducing welfare of free workers by 0.7% and eliminating slaveholder profit. Aggregate GDP rises by 9.1%, with a contraction in agricultural productivity counteracted by an expansion in manufacturing and services driven by an exodus of formerly enslaved workers out of agriculture and into the U.S. North.

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1 Introduction

American racial slavery legally enforced restrictions on Black labor and life. Scholars have long debated whether enslaved labor fundamentally altered the antebellum U.S. economy, broadly focusing on three key characteristics of the institution: (1) slaveholders coerced enslaved workers to work harder than they would have otherwise chosen (Fogel and Engerman, 1974; Ransom and Sutch, 1977); (2) slaveholders captured the proceeds of enslaved workers' labor (David and Temin, 1974; Darity and Mullen, 2020); and (3) slaveholders assigned enslaved workers to locations and sectors that they may not have otherwise chosen (Fleisig, 1976; Wright, 2006). Given the size of the institution—a full third of the U.S. Southern population was enslaved—these restrictions not only had large direct impacts on enslaved labor but also likely had large indirect impacts on prices, wages, and the allocations of free labor. Quantifying the economic impacts of slavery then requires a comprehensive analysis of the economy as a whole, incorporating the key margins of labor supply controlled by slaveowners as well as the myriad ways in which free and enslaved labor interacts across sectors and space.

In this paper, we undertake a general equilibrium analysis quantifying how slavery shaped the spatial economy of the antebellum U.S. We first build a rich database of the antebellum U.S. economy to document that where enslaved and free people lived and how much value their labor generated correlates strongly—but in different ways—with geographic factors. To explain these patterns, we then develop a model of slavery that incorporates the three aspects of slavery highlighted by previous scholars—coercion, markdowns, and misallocation—into a many-location, many-sector general equilibrium model of the U.S. economy. The model is built on the assumption that—were it not for the institution of slavery—free and enslaved workers would act identically and the economy would be efficient, providing a natural benchmark for the effect of property rights in other people's labor. Combining theory and data, we then quantify the impacts of slavery. We find that complete emancipation has large effects on the U.S. economy, inducing an expansion of manufacturing (26.5%) and services (21.0%) and a contraction of agriculture (-5.4%). The welfare of formerly enslaved workers increases by almost 1,200%, whereas free worker welfare declines 0.7% and slaveholders' profits are erased. Finally, we show that the counterfactual changes in labor allocations from emancipation are strongly correlated with observed patterns of White and Black reallocations across all sectors following the Civil War, although the comparison offers suggestive evidence of substantial migration frictions for recently emancipated Black workers.

We first assemble a comprehensive dataset of the spatial and sectoral distribution of economic activity in the U.S. in the year 1860. Combining the 100% count U.S. free census

(Ruggles et al., 2024, 2025) with the newly digitized 100% count U.S. slave census (Hacker et al., 2025), we calculate the number of free and enslaved workers employed in each sector (agriculture, manufacturing, and services) in every U.S. county. This same linking also provides a proxy for slave prices at the county-sector level using the observed slave-holders' personal property per enslaved person, which we show correlates as expected with the demographic composition of the enslaved persons owned. To measure economic output, we use three additional datasets: the Census Social Statistics (compiled by Robert Margo, Paul Rhode and John Clegg), the Agricultural and Manufacturing Censuses (Haines et al., 2010; Hornbeck and Rotemberg, 2024), and the U.S. Army Fort quartermaster records (Margo, 2009; Margo and Villaflor, 1987). Combining the first two datasets allows us to construct measures of the wages of workers (including incomes of farmers) in each sector in each U.S. county, which we show correlates strongly with the spatial variation in literacy of (free) workers employed in these sector. The quartermaster records allow us to obtain new estimates of the differential compensation paid to enslaved workers, augmenting a longstanding approach of comparing within-occupation slave hire rates with free worker wages (Lindert and Williamson, 2012; Engerman, 1973) by controlling for detailed occupation, year, and fort fixed effects.

We proceed by documenting three stylized facts. First, we show that free and enslaved workers are differentially allocated across space. While both free and enslaved workers tend to live in more productive locations (as proxied by agro-climatic cotton suitability), free workers are more likely to live in higher amenity locations (as proxied by lower malarial agro-climatic suitability), whereas enslaved workers are less likely live in such locations. Similarly, free workers sort into locations with less coercion (as proxied by the distance to the northern border), whereas enslaved workers are sorted into locations with more coercion. Second, we show that similar patterns exist across sectors within locations: for example, free workers are less likely to be employed in agriculture in areas with greater malaria, whereas enslaved workers are more likely to be employed in agriculture in such areas. Third, we show that the spatial patterns of wages and slave prices also exhibit distinct geographic patterns. For example, free worker wages are lower in locations with higher amenities, whereas slave prices are higher in such locations.

Next, we develop a new micro-founded spatial model of slavery. The premise of the model is straightforward: unlike free workers who choose where to live, what to do, and how hard to work in order to maximize their own welfare, enslaved workers are not afforded such choice. Instead, slaveholders assign them a location and job and coerce their effort in order to maximize profits. The model not only offers explanations for the stylized facts, it also highlights three distinct margins through which slavery reduces the welfare of the enslaved:

first, enslaved workers are coerced to provide greater labor supply than they would have themselves chosen; second, slaveholders capture the proceeds of the enslaved labor, optimally marking-down enslaved workers' compensation in order to maximize their own profits; third, slaveholders assign the enslaved to locations and occupations that have lower amenities and a higher capacities for coercion than they would have chosen on their own. We derive partial equilibrium expressions for the welfare costs of each of these margins as functions of model parameters and the underlying geography.

In general equilibrium, however, the sectoral and geographic reallocation of newly emancipated workers will alter the prices for the outputs of different places and induce reallocation of the already free population, which can have complex effects on both the welfare of the newly emancipated as well as the already free. For example, if enslaved workers are (as we find) disproportionately located in remote, disease-ridden locations, then emancipation will result in them leaving such locations. But this will drive down wages in more attractive locations and drive up wages in those sectors and locations where the recently emancipated depart, causing the free population to reallocate as well. The incidence of these wage and price changes will be propagated throughout the economy (depending on e.g. the trade costs between slave-intensive areas and other population centers). As another example, enslaved workers will be disproportionately located in agriculture far from free states (to deter fugitives as in Allen (2015)) in order to more easily coerce enslaved labor. With emancipation, those workers will be free to move to more productive manufacturing or agricultural sectors in locations closer to the North. The incidence of the resulting wage and price changes will again be propagated throughout the economy. Quantifying these complex effects is the task we set our model to.

In order to do so, we begin by estimating three model parameters that the model highlights are crucial for the welfare implications of slavery: the intensive labor supply elasticity within sector, the extensive labor supply elasticity across sectors, and the extensive labor supply elasticity across locations. The intensive labor supply within sector determines the optimal markdown, which we estimate using the U.S. Army forts data, comparing the payments made to free and enslaved workers for doing the same task at the same U.S. Army fort. The quartermaster reports have payments made to slave owners, and we present evidence that these payments are net of subsistence expenses directly borne by the fort, so the 18% penalty we estimate for hired slave workers reflects slave owners appropriating 82% of the marginal product. This implies an intensive labor supply elasticity of 0.22, well within the range of contemporary estimates and consistent with historical estimates of enslaved worker subsistence baskets. To estimate the extensive labor supply elasticities across sectors and locations, we compare the relative wages and slave prices within a county-sector to the relative free and enslaved labor shares, instrumenting relative shares with amenity proxies, as suggested by the model. The resulting extensive supply elasticities—3.3 across locations and 2.5 across sectors—are comparable to those estimated in other settings.

Given these parameters, we then use the detailed spatial data on labor allocations and output to "invert" the model to recover the underlying productivities, amenities, and degree of coercion of each location-sector. We show that these recovered productivities, amenities, and coercion parameters correlate well with the proxies we employed in the stylized facts. We then simulate a series of counterfactuals that dismantle the institution of slavery to estimate the welfare and spatial economic impacts for both free and enslaved workers. Unsurprisingly, we find that removing the institution of slavery leads to substantial welfare gains for enslaved workers. In equivalent variation terms, slaveowners would have to pay an enslaved worker 1,192% more to get voluntary consent to the allocation of labor induced under slavery. As we cannot account for level shifts in utility that differ between all free and all enslaved, e.g. physical protection from violence and abuse or psychic costs and benefits of standing and status, these welfare gains ought to be seen as a lower bound. Each of the three sources of misallocation play an important role: allowing enslaved individuals to choose their own labor supply while remaining in slavery (i.e. removing coercion) yields a welfare gain equivalent to a 361% increase in wages; allowing enslaved workers to retain all of their earnings yields a welfare gain equivalent to a further 81% wage increase; and allowing enslaved workers to choose any occupation in any location in the U.S. (so that they act identically to free workers) leads to a welfare gain equivalent to a 55% wage increase. Conversely, emancipation causes the welfare of free workers to decline by 0.7%, as the reallocation of the formerly enslaved drives down equilibrium wages in more attractive locations and sectors. These results highlight that even restricting the accounting of slavery to neoclassical labor supply margins and omitting many plausible economic externalities and non-pecuniary dimensions of racial domination and servitude still yields very large welfare impacts.[1]

Emancipation also has large general equilibrium impacts on the economy. The movement of formerly enslaved workers out of agriculture causes services and manufacturing sectors to expand: for example, manufacturing output increases by 29% in the North, 19% in the South, and 27% overall. Agriculture expands in the U.S. North by 24%, but contracts in the U.S. South by 29%, for a modest decline of 5.4% overall. All told, aggregate GDP rises by

[1]While we are not directly engaged with the large literature on reparations (Darity and Mullen, 2020), one philosophical and legal perspective on reparations relies on computing counterfactual economic welfare to measure historical harm (Nozick, 1974; Posner and Vermeule, 2003). We view our estimates of compensation for unpaid labor in the spirit of Dr. Martin Luther King's claim "No amount of gold could provide an adequate compensation for the exploitation and humiliation of the Negro down through the centuries. Not all the wealth in this affluent society could pay the bill. Yet a price can be placed on unpaid wages." (King Jr, 2000).

9.1%, with the reallocation of labor toward higher amenity locations offset by a combination of this structural transformation and the ability of the formerly enslaved to move to the (more productive) U.S. North.

Finally, we compare our quantitative predictions of the effects of emancipation to the actual experience in the U.S. South after the Civil War. We show that the patterns of labor reallocations in the theory—of both Black and White populations across both sectors and locations—closely matches what occurred in reality. The one exception to this is for the change in the total Black population across locations, where we only find a positive correlation after conditioning on the initial antebellum Black population, suggesting that the post Civil War experience of Black workers may have entailed substantial additional mobility constraints not captured by our model, for example due to social networks, family ties, Black Codes, or ongoing racial violence, attenuating the potential gains from emancipation.

The primary contribution of our paper is to construct and estimate a model of the antebellum U.S. economy to quantify the impacts of the institution of slavery. In doing so, our paper contributes to several strands of literature. Most directly, our paper builds on the vast literature examining the economics of slavery, a recent survey of which can be found in Wright (2022). Hornbeck and Logan (2023) calculate welfare gains from emancipation, analogizing slavery to an externality imposed on the enslaved. They employ a Hulten (1978)-type intuition: starting from a competitive slave economy with no other distortions, marginal economic benefit from emancipating an enslaved worker is equal to the difference between what slave owners pay for enslaved labor and the costs borne by those workers. They then calculate bounds on the missing "compensating differential" using both value of statistical life estimates as well as data on wages for gang-labor after emancipation. Our model incorporates this idea into a general equilibrium micro-founded model of slavery, where slaveholders optimally choose employment and compensation for enslaved workers, constrained by a coerced labor supply curve. Ultimately, our estimated welfare gains to enslaved workers from emancipation fall near the center of the range of estimates they report. In a simple, partial equilibrium description, Naidu (2020) suggests that free labor is monopsonistically competitive, with idiosyncratic tastes for employers, while the enslaved labor market is closer to perfect competition, implying less allocative inefficiency in the slave labor market. Bleakley and Rhode (2022) analyze discontinuities at the Mason-Dixon line. They present evidence that slavery itself was a disamenity for free workers, with the slave side of the border characterized by low land values, high free wages, and few free whites. These recent papers contribute to a large economics literature on slavery going back to Conrad and Meyer (1958), and we review the relevant work alongside stylized facts in the next section. Relative to these papers, our approach brings new data and uses recent advances in quantitative spatial general equilibrium modeling to analyze multiple facets of the institution of slavery while accounting for the substantial general equilibrium effects the institution had on the economy.[2]

Our approach is motivated by the difficulty in forming a convincing counterfactual for the slave economy. Virtually all of the economics literature on American slavery has implicitly or explicitly specified counterfactuals. Beginning with Alexis De Tocqueville comparing agriculture on the left and right banks of the Ohio River, scholars have examined the spatial discontinuities between slave and free states in the hopes of recovering a counterfactual in the absence of slavery. However, such local spatial comparisons are intrinsically limited in their ability to recover the general equilibrium effects of emancipating the third of the Southern U.S. population that was enslaved. A natural aggregate counterfactual also exists in the pre/post Civil War comparison. But emancipation after 1860 is confounded by both the destruction of the Civil War (Feigenbaum et al., 2022) as well as the rapid imposition of both military Reconstruction (Frieden et al., 2024) and incipient Jim Crow (Althoff and Reichardt, 2024). Constructing a plausible counterfactual to the antebellum economy requires detailed modeling of the ways in which enslaved and free workers interacted with the economic geography of comparative advantage in the antebellum US South.

Methodologically, our paper builds on a recent literature on spatial general equilibrium models, and their application to economic history. Studying the 20th century Black migration, both Takahashi (2022) and Yang (2024) build quantitative spatial models to quantify the contribution of the Great Migration of African-Americans to economic growth. Heblich et al. (2022) use a quantitative trade model to study the contribution of the slave trade to industrialization in England, emphasizing the role of frictional capital markets. Donaldson and Hornbeck (2016) study the effects of the 19th century US railroad through the lens of a spatial equilibrium model, while Allen and Donaldson (2020) study multiple equilibria in a quantitative dynamic spatial model of the United States back to 1790. A theoretical contribution of our paper to this literature is to integrate a static spatial general equilibrium model with the key insight of coercive labor markets highlighted by Acemoglu and Wolitzky (2011). The study of coercion in labor markets has also received considerable attention, with recent papers including Bobonis and Morrow (2014); Naidu and Yuchtman (2013);

[2] A large empirical literature studies long-term persistence of U.S. slavery along multiple dimensions. Ager et al. (2021) study persistent effects of emancipation on slave owners, finding that slaveowner descendants had largely converged to non-slaveowner wealth levels by 1900. Althoff and Reichardt (2024) look at individual intergenerational persistence of slavery, and find that much of the persistent legacy of slavery (compared to African Americans emancipated before the civil war) can be explained by differential exposure to more intensive Jim Crow laws in the deep South. Nunn (2007), building on Sokoloff and Engerman (2000), shows persistent effects of slavery on contemporary economic outcomes in both the U.S. and the New World more broadly.

Dippel et al. (2020); Saleh (2024); Helper et al. (2025); Miller et al. (2025), but none have considered spatial heterogeneity in coercion, nor its integration with a quantitative spatial equilibrium model. A paper that is comparable in terms of estimating short-run impacts of eliminating coerced labor is Markevich and Zhuravskaya (2018), who study the effects of serf emancipation in Russia. They find, in a partial equilibrium calculation, that both agricultural and manufacturing productivity increase in areas differentially affected by the elimination of serfdom. Finally, we build on the recent literature quantifying misallocation in labor markets with general equilibrium models of heterogeneous workers, beginning with Hsieh et al. (2019).

The remainder of the paper is organized as follows. We begin by presenting the data and three stylized facts. In Section 3, we present a spatial model of slavery, which we then use to derive analytical expression for the welfare gains from emancipation in Section 4. Section 5 then estimates the key model parameters and quantifies the impacts of emancipation. Section 6 concludes.

2 Data and Stylized Facts

We motivate our model by documenting a series of stylized facts about the U.S. slave economy.

2.1 Data

We begin by describing the data sources we use to document these facts.

Free and enslaved worker counts by county×sector: For free persons, we use the 100% Count 1860 Free Census (Ruggles et al., 2024, 2025). For individuals age 16-50 who report being in the labor force, we use their reported occupation to assign them to one of three occupational categories (constructed by IPUMS), which we refer to as sectors: agriculture, professional and personal services ("services"), and manufacturing, mechanical, and mining industries ("manufacturing") in each county in the U.S.

For enslaved workers, we use the 100% Count 1860 Slave (schedule 2) Census compiled by Hacker et al. (2025), who link the enslaved persons to their slaveholders in the Free Census using a machine learning algorithm based on name and location matching, achieving over 80 percent match rates (although by construction neglecting matches to absentee slaveholders). Despite being the most comprehensive data on enslaved workers available, the slave schedules have many missing entries (e.g. fugitives are underreported), and leave many details unreported, notably their occupations.[3] Our approach, while admittedly imperfect, is to follow Lockley (2014) and assign all enslaved workers age 16-50 to the sector of their (co-located) slaveholder. Of the 1.94 million enslaved workers, this procedure yields 1.60 million employed in agriculture, 77,000 employed in manufacturing, and 259,000 employed in services. In Appendix A.3, we show our aggregate figures are quite close to estimates in the literature, particularly recent estimates by Rhode (2024), as well as offering additional validation tests on this assumption.

Wages by county×sector: We use four sources to construct measures of economic activity: (1) the 1860 Census County Level Social Statistics, digitized by Robert Margo, Paul Rhode and John Clegg, for wages of free workers by occupation and county;[4] (2) the industry-level manufacturing census data compiled by Hornbeck and Rotemberg (2024); (3) the 1860 county-level agricultural and manufacturing censuses compiled by Michael Haines; and (4) the 100% count 1860 free census.

We combine these data sources to estimate the agricultural, services, and manufacturing wages in each county as follows. For agricultural wages, we take a weighted average of the observed agricultural wages without board from the Social Statistics data and 5% of the real property value for farmers for agricultural wages to get farmer incomes from the 100% count free census, where the weight is the share landless among farmers observed in the free census. For manufacturing wages, we use the observed wages in the industry-level manufacturing census data, excluding construction and other non-manufacturing industries. For services, we take the average of the domestic worker and carpenter wages from the Social Statistics data.

To interpolate wages for sector-locations which are not observed, we predict wage data by projecting (log) observed wages at observed county×sector level on (log) free and enslaved worker counts, (log) land area, state fixed effects, and (log) agricultural and manufacturing output. As verification for this procedure, Appendix Figures B.9 and B.10 show that the resulting county×sector wages correlate strongly and positively with the observed spatial variation in literacy rates and per capita wealth observed in the 100% Free Census, conditional on state fixed effects.

Payments made to free and enslaved workers for the same jobs: We use the U.S. Army Fort quartermaster records (Margo, 2009) to observe payments made to both free and enslaved workers for the same jobs. Slaves were rented for employment in a variety of occupations on U.S. army forts prior to 1865, doing many tasks alongside free labor.

[3] A line of literature in African-American history and critical archival studies has looked at what traditional archival sources on slavery, particularly slave censuses, exclude (Hartman, 1997; Fuentes, 2016).

[4] We thank the authors for sharing these with us.

The historical evidence suggests that the recorded payments from the military are rental payments made to the slave owner. The virtue of the fort data is that it is all from the same organization, and allows us to control for occupation, thus comparing wage rates to enslaved and free workers doing the same job in the same fort. While unrepresentative of the whole slave economy, the quartermaster reports enable detailed controls for unobserved heterogeneity, and we discuss them more fully below and in Appendix A.4.

Slave prices by county×sector: Finally, we construct a new proxy of slave prices that vary at the county×sector level. To do so, we use the linked 100% free and slave censuses to calculate the slave-holder value of personal estate per enslaved person. Because the personal estate captures the value of all non real-estate assets of a slaveholder (not just the value of their slaveholdings), it does not allow us to identify the level of slave prices. As a result, we only use the measure as a proxy for slave prices in the stylized facts and estimation that follows (where fixed effects can absorb this missing intercept) and do not use them directly in the quantitative exercise. However, Appendix Table B.1 reassuringly shows that the proxy correlates as expected with the demographic composition of slaveholders' slaveholdings, e.g. slave prices are lower for slaveholders with more elderly or younger enslaved persons and that there is a slight premium for prime-age female enslaved persons over prime-age male enslaved persons. Further, Appendix Table B.4 shows, in the Parker-Gallman sample of linked farm-slave schedules for cotton plantations, that additional measures of personal property for farmers, such as farm equipment and livestock, are much more weakly correlated with personal property per slave, and do not alter the demographic coefficients.

Geography: We construct proxies of the productivity, amenity, and degree of coercion of slaveholders over enslaved based on the innate geography of each county in the U.S. South. For a measure of productivity, we consider the (low fertilizer, no irrigation) agroclimatic cotton suitability of each county as measured by the FAO-GAEZ database (see Fischer et al. (2021)). Cotton was one of the most important cash crops in the U.S. South; as panel (a) of Appendix Figure B.1 highlights, there existed substantial spatial heterogeneity across the U.S. South in how suitable the climate was for production.[5] For a measure of

[5]Recent papers have argued that the FAO-GAEZ measures are poor proxies for historical crop yields (Rhode, 2024) and rife with measurement error (Araujo and Possebom, 2025). In Appendix Table B.2 we present a regression table showing that in our sample and specification, all three of an indicator for any cotton production, the log of cotton yield per county acre (among counties that produce cotton), and the inverse hyperbolic sine of cotton per county acre are strongly and significantly correlated with our cotton suitability measure in our baseline specification as well as a specification including quadratic latitude and longitude controls. We have also confirmed that our stylized facts remain robust whether other proxies are used, such as cotton over wheat (as in Masera and Rosenberg (2021)) or indices of plantation crop (sugar, cotton, tobacco, and rice) suitability, with results available on request.

the (dis)amenity of a location, we consider the climatic suitability for malaria as measured by Kiszewski et al. (2004). Locations with higher incidence of malaria resulted in greater mortality rates, and Esposito (2022) has previously shown that enslaved persons with greater resistance to malaria garnered higher prices; panel (b) of Appendix Figure B.1 shows that warmer and lower elevation areas of the U.S. South were more suitable to malaria. Finally, to proxy for the degree of coercion a slaveholder has over enslaved workers, we construct a measure of the distance to the North, as depicted in panel (c) of Appendix Figure B.1. It was more difficult for enslaved workers to escape from locations further away from the North, reducing their outside option (see Allen (2015)).

Given the substantial spatial correlation in our proxies evident in Appendix Figure B.1, there exists the possibility that there are unobservable variables correlated with our measures. While our goal is to only provide suggestive evidence of the existence of inefficiencies in the allocations of enslaved workers rather than causal relationships, to attenuate the concerns of spurious correlations in the stylized facts that follow we include state fixed effects and condition each variable on the other two. Appendix Figure B.2 depicts the resulting residual variation that we use in our empirical exercises below, which exhibits less obvious spatial correlations.

To validate that our county-specific geographic proxies for productivity, disamenities (malaria suitability), and coercion (distance to freedom) make sense, we check that they are correlated with direct measures of economic activity, health, and ease of slave escape. Panel (a) of Appendix Figure B.3 shows that agricultural revenue and cotton output is indeed differentially higher in high cotton-suitability counties. Panel (b) shows that malaria intensity is negatively correlated with the share of old people among free persons. Owing to either differential mortality or out-migration, elderly individuals are significantly under-represented in high malaria areas, as would be expected. Panel (b) also uses the individual mortality census schedules to show that the slave mortality level from malaria, relative to free, is higher in high malaria areas. Panel (c) shows the share of enslaved workers reported as fugitives, as well as the reward in fugitive ads relative to the value of the worker, are both declining in the distance to the North. All of these correlations are conditional on state fixed effects and the other two geographic proxies and all are statistically significant at conventional levels, lending credence to their use in the stylized facts that follow.

2.2 Stylized Facts

We now present three stylized facts. The first two focus on quantities, documenting different patterns of allocations for free and enslaved worker across locations and sectors, respectively.

The third focuses on prices, documenting different patterns of wages for free workers and slave values for enslaved workers. In the following section, we will show how each of these stylized facts can be explained by the theory. In Appendix Table B.3 we show the robustness of these facts to controls for flexible polynomials of latitude and longitude, in addition to the state fixed effects and controls we include in this section.

2.2.1 Stylized Fact #1: Enslaved and free workers sort differently across locations

We begin by showing that the fact that free workers chose where to live whereas enslaved workers were assigned a location resulted in significant differences in their respective allocations across space.

Stylized Fact #1(a): Free workers sort into higher productivity locations, enslaved workers are sorted even more so into higher productivity locations. Panel (a) of Figure 1 documents that the population density of both free and enslaved workers was increasing with the productivity of a location, as measured by the geographic proxy of cotton suitability (conditional on state fixed effects and the other two geographic proxies). However, the slope of enslaved population density is steeper, showing that enslaved labor is much more responsive, at least in the cross-section, to agricultural productivity. Columns (1) and (2) of Table 1 confirm that the difference in elasticities between the free and enslaved populations is highly statistically significant.

Stylized Fact #1(b): Free workers sort into higher amenity locations, enslaved workers are sorted into *lower* amenity locations. Panel (b) of Figure 1 documents that the population density of free workers is declining in the malaria suitability of an area, whereas the population density of enslaved workers is increasing in the malaria suitability of an area. As Esposito (2022) argues, disease-intensive locations were difficult and unpleasant for free workers to reside in, so instead enslaved workers were allocated to these locations. Again, columns (1) and (2) of Table 1 confirm that these differential responses to our proxy for the (dis)amenity of a location for the free and enslaved populations is highly statistically significant.

Stylized Fact #1(c): Free workers sort into locations with less coercion, enslaved workers are sorted into places with *more* coercion. Panel (c) of Figure 1 documents that while the population density of free workers is declining with the distance to the North, the population density of enslaved workers is increasing with the distance to the North.

This is consistent with coercion of slaveholders over the enslaved being easier at further distances, as escape is more difficult. As coercion does not directly impact free labor, the fact that free labor is declining with distance to the north suggests the possibility that free and enslaved workers may be substitutes. Again, columns (1) and (2) of Table 1 confirm that these differences are highly statistically significant.

2.2.2 Stylized Fact #2: Enslaved and free workers sort differently across sectors within location

We now consider the allocation of free and enslaved workers across sectors within a location, asking how the fraction of free and enslaved workers employed in agriculture (instead of services or manufacturing) in a location varies with our geographic proxies. Columns (3) and (4) of Table 1 undertake a similar analysis as Stylized Fact #1, but rather than comparing the free and enslaved population densities at the county level, they examine the sectoral choice of free and enslaved workers by regressing a dummy variable equal to one if a worker is employed in agriculture on county level geographic proxies and their interactions with the status (free or enslaved) of the individual. This procedure allows us to show similar differential sorting patterns between free and enslaved workers across sectors within a location.

Stylized Fact #2(a): There is no correlation between cotton suitability and agricultural employment share for either enslaved or free workers. Columns (3) and (4) of Table 1 show that there is no relationship between the cotton suitability of a location and the fraction of workers employed in agriculture for either the free or enslaved population. The estimated coefficients are small and, while precisely estimated, are statistically indistinguishable from zero.

Stylized Fact #2(b): Free workers sort out of agriculture in high malaria areas, whereas enslaved workers are sorted *into* agriculture in high malaria areas. Columns (3) and (4) of Table 1 report that while the number of free workers employed in agriculture is decreasing in a location's malaria suitability, there is an overall positive relationship between malaria suitability and the fraction of enslaved workers employed in agriculture, with the interaction term being highly statistically significant. This is consistent with agricultural work being especially unpleasant in locations with high malarial incidence, causing free workers to choose to avoid such work and enslaved workers being forced into such work.

Stylized Fact #2(c): Both free and enslaved workers are more likely to be employed in agriculture the greater the distance to freedom, but this is especially true for enslaved workers. Columns (3) and (4) of Table 1 show that the fraction of workers employed in agriculture is increasing in the distance to freedom for both free and enslaved workers, but this impact is larger for enslaved workers.

2.2.3 Stylized Fact #3: Wages of free workers and the prices of enslaved workers differed with each other and across space.

We now examine how wages of free workers and prices of enslaved workers vary across locations.

Stylized Fact #3(a): Both free workers' wages and the price of enslaved workers are higher in locations with higher productivities. Panel (a) of Figure 2 shows that both free workers' wages and enslaved workers' prices are higher in locations with better cotton suitability with approximately equal slopes. The first row of Table 2 shows that this positive relationship is statistically significant for both free and enslaved workers with equal (and statistically indistinguishable) slopes. The observed positive relationship is unsurprising, as wages increase with labor productivity.

Stylized Fact #3(b): free workers' wages are *lower* in locations with better amenities, whereas the price of enslaved workers are *higher* in locations with better amenities. Consistent with free workers' wages offering compensating differentials for poor amenities, panel (b) of Figure 2 shows that free workers' wages are higher in locations with greater malaria suitability. Again, column (1) of Table 2 shows this positive relationship is highly statistically significant. Enslaved workers' prices show the *opposite* relationship, with slave prices falling with malaria suitability. Columns (2) and (3) of Table 2 show that both relationships and their difference are statistically significant. We will provide an explanation of why we observe this opposite relationship for free wagers and enslaved prices with malaria below.

Stylized Fact #3(c): free workers' wages are *lower* in locations with greater coercion, whereas the price of enslaved workers is (slightly) *higher* in locations with greater coercion. Finally, panel (c) of Figure 2 shows that free workers' wages are slightly declining with the distance to the North, whereas enslaved workers' prices are slightly increasing. Column (3) of Table 2, however, shows that the difference in slopes is not statistically significant at conventional levels ($p = 0.235$).

3 A Spatial Model of the Slave Economy

We now present a spatial equilibrium model of slavery that matches the stylized patterns of labor allocation and pricing documented in the previous section. The model allows us to disentangle how the coercion, market power, and misallocation inherent to the institution of slavery shaped the American antebellum economy. Further, our model allows us to calculate how emancipation would impact the sectoral and spatial composition of the U.S. economy and the welfare of free and enslaved workers.

3.1 Setup

We begin with a quantitative economic geography model as in Allen and Arkolakis (2014), extended to include multiple sectors (as in Costinot et al. (2012)), heterogeneous productivities (as in Bryan and Morten (2019)), and endogenous labor supply (as in Allen et al. (2020)). As is standard, there is a free labor population that chooses its labor supply, location, and sector to maximize its own welfare. More novel is the inclusion of enslaved workers, whose labor supply is *coerced*, the proceeds of their labor is appropriated by slaveholders and who are *assigned* to locations and sectors to maximize the profits of slaveholders rather than the welfare of the enslaved workers. Otherwise, we assume that free and enslaved workers are identical, i.e. they share the same preferences and distributions and productivity, which implies they would act identically but for the presence of the institution of slavery.

Formally, consider a world with $\mathcal{N} \equiv \{0, 1, ..., N\}$ locations and $\mathcal{O} \equiv \{1, \ldots, O\}$ sectors, where $\mathcal{N}^N$ is the set of counties in the U.S. North, $\mathcal{N}^S$ is the set of counties in the U.S. South, $\mathcal{N}^{US} \equiv \mathcal{N}^N \cap \mathcal{N}^S$, and location 0 represents the rest of the world (ROW), with which U.S. locations are able to trade. Locations are characterized by a sector specific productivity A_{io}, a sector-specific amenity U_{io}, and a "coercion" parameter c_{io}, which captures the efficiency of coercing enslaved labor (and will be discussed below). As is standard, each location-pair is endowed with (iceberg) trade cost $\tau_{ij} \geq 1$. The *geography* of the world is the set $\{A_{io}, u_{io,}c_{io}, \tau_{ij}\}_{i,j\in\mathcal{N},o\in\mathcal{O}}$.

Each location produces a differentiated variety in each sector. Final consumption follows a nested constant elasticity of substitution (CES) structure in which location-specific varieties (discounted by trade costs) are first aggregated to the sector level with sector-specific elasticity of substitution $\sigma_o > 0$ and then across sectors with elasticity of substitution $\rho > 0$. Workers, indexed by ω, receive an idiosyncratic location-sector productivity shock given by $\varepsilon_{io}(\omega) = \varepsilon_i(\omega)\,\varepsilon_o(\omega)$, where $\varepsilon_i(\omega)$ and $\varepsilon_o(\omega)$ follow independent Frechet distributions with shape parameters θ and η, respectively.

3.2 The Allocation of Free Labor

Free laborers choose their labor supply, location (within the U.S.), and sector, accounting for consumption, amenities, and idiosyncratic shocks. The opportunity cost of work (either leisure or home production) is a constant elasticity function such that the overall utility for free workers in location-sector io is given by:

$$W_{io}\left(\omega, l\right) = \frac{w_{io}u_{io}}{P_i} A_{io}\varepsilon_{io}(\omega) l - \frac{\phi}{1+\phi} l^{\frac{1+\phi}{\phi}}, \tag{1}$$

where $\sigma > 1$ is the elasticity of substitution across aggregate location goods, $\phi > 0$ is the labor supply elasticity, and the CES aggregate price index $P_i = \left(\sum_{o\in\mathcal{O}} P_{io}^{1-\rho}\right)^{\frac{1}{1-\rho}}$ is a function of sector-level price indices $P_{io} = \left(\sum_{j\in\mathcal{N}} \tau_{ji}^{1-\sigma_o} p_{jo}^{1-\sigma_o}\right)^{\frac{1}{1-\sigma_o}}$, which are functions of trade costs τ_{ji} and location-sector prices p_{jo}.

Given their choice of location and occupation, free workers choose their labor supply l, yielding:

$$l_{io}(\omega) = \left(\frac{w_{io}u_{io}}{P_i} A_{io}\varepsilon_{io}(\omega)\right)^{\phi}, \tag{2}$$

i.e. free workers choose to work more the greater their marginal utility of labor. This in turn implies that the free laborer's indirect utility from choosing location i and occupation o is:

$$W_{io}(\omega) = \left(\frac{1}{1+\phi}\right)\left(\frac{u_{io}}{P_i} w_{io} A_{io}\varepsilon_{io}\left(\omega\right)\right)^{1+\phi}. \tag{3}$$

Free-workers thus choose a location and occupation to maximize W_{io}. Given the assumed distribution of their idiosyncratic productivities, the occupational shares within a location are given by:

$$\pi_{io,f|i} = \frac{\left(w_{io}A_{io}u_{io}\right)^{\eta}}{\sum_{o'\in\mathcal{O}}\left(w_{io'}A_{io'}u_{io'}\right)^{\eta}}, \tag{4}$$

i.e. free workers sort into occupations within location that have higher wages, productivities, and amenities.

Using the nested structure of the location-specific occupation utility, the expected utility of a free worker who chooses to reside in location i is given by:

$$\Pi_{i,f} = \left(\frac{1}{1+\phi}\right)\Gamma\left(\tfrac{\eta-1-\phi}{\eta}\right)\left(\sum_{o\in\mathcal{O}}\left(\tfrac{u_{io}}{P_i} w_{io}A_{io}\right)^{\eta}\right)^{\frac{1+\phi}{\eta}}, \tag{5}$$

which in turn implies that the share of free workers who choose to reside in location i is given by:

$$\pi_{i,f} = \frac{\Pi_{i,f}^{\theta}}{\sum_{i' \in \mathcal{N}^{US}} \Pi_{i',f}^{\theta}}. \tag{6}$$

3.3 The Allocation of Enslaved Labor

As with free workers, we assume enslaved workers get utility from consumption and disutility from providing labor with the same utility function given in equation (1).[6] However, there are three important differences in their labor allocations. First, the quantity of labor supplied by enslaved workers is chosen by the slaveholder, who behaves as a perfect monopsonist able to extract all surplus from the enslaved. Second, the labor supply of enslaved workers is coerced by slaveholders, following Acemoglu and Wolitzky (2011), distorting the labor-supply curve faced by a monopsonistic owner away from that preferred by the enslaved. Finally, the enslaved worker is misallocated, as the slaveholder chooses an enslaved worker's sector and location (within the U.S. South) to maximize his own profits rather than the welfare of the enslaved.

Formally, suppose a slaveholder chooses an enslaved person's location i, occupation o, labor supply l and a remuneration $w_{io,s}$ (which in reality was largely paid in the form of in-kind subsistence and housing) to maximize their own profits, i.e. the product of the effective labor and the difference between the market wage and the enslaved remuneration:

$$\max_{i,o,l,w_{io,s}} \left(w_{io} - w_{io,s}\right) A_{io} \varepsilon_{io,s}(\omega)\, l, \tag{7}$$

subject to a participation constraint:

$$\frac{w_{io,s} u_{io}}{P_i} A_{io} \varepsilon_{io,s}(\omega)\, l - \frac{\phi}{1+\phi} \frac{l^{\frac{1+\phi}{\phi}}}{c_{io}} \geq 0, \tag{8}$$

where we refer to $c_{io} \geq 0$ as the *coercion parameter*.

Equation (8) deserves some discussion. The necessity of some sort of participation constraint is clear: absent such a constraint, the solution to the slaveholder's problem is unbounded, with the enslaved worker forced to provide an infinite amount of labor with no remuneration. The particular functional form of constraint (8) has the intuition that the coercion parameter c_{io} captures the "productivity" of the slaveholder in extracting labor from the enslaved relative to the disutility incurred by the enslaved person in providing that labor.

[6] This abstracts from coercion of enslaved persons in terms of consumption, e.g. being forced to consume lower quality food, clothing, and shelter. See Rockman (2024) for a recent historical account.

The constraint of equation (8) can also be micro-founded as follows. Suppose enslaved persons can choose to either remain in slavery or they can attempt to escape, which if successful earns them a (positive) outside option but if unsuccessful incurs punishment. Then an enslaved person will choose to remain in slavery if:

$$V_{io,s}^{slavery} \geq Pr(escape)_{io,s} V_{io,s}^{free} - (1 - Pr(escape)_{io,s})\, c_{io}, \tag{9}$$

where $V_{io,s}^{slavery}$ is the value of remaining in slavery, $Pr(escape)_{io,s}$ is the probability of a successful escape, $V_{io,s}^{free}$ is the value of freedom, and c_{io} is the exogenous cost of punishment.[7] Substituting in the utility function given in equation (1), constraint (9) can be written as in equation (8), where $c_{io} = 1 - (Pr(escape)_{io,s}\nu_{io,s} - (1 - Pr(escape)_{io,s})\, \psi_{io,s})$, i.e. c_{io} is increasing with the (proportional) cost of a failed escape attempt $\psi_{io,s} \equiv \frac{c_{io}}{\frac{w_{io,s}u_{io}}{P_i} A_{io}\varepsilon_{io,s}(\omega) l}$, decreasing in the (proportional) value of freedom $\nu_{io,s} \equiv \frac{V_{io,s}^{free}}{\frac{w_{io,s}u_{io}}{P_i} A_{io}\varepsilon_{io,s}(\omega) l}$, and decreasing in the probability of escape $Pr(escape)_{io,s}$.

In this environment, the slaveholder ensures the participation constraint binds and chooses an enslaved labor supply of:

$$l_{io,s} = \left(\frac{u_{io}}{P_i} w_{io} \left(A_{io} c_{io} \right) \varepsilon_{io} \left(\omega \right) \right)^{\phi}. \tag{10}$$

The slaveholder's maximization problem also yields a choice of enslaved remuneration that is a constant markdown from the market wage:

$$w_{io,s} = \frac{\phi}{1+\phi} w_{io}, \tag{11}$$

capturing a constant fraction $1/(1+\phi)$ of the value of the enslaved workers' output.

When the coercion parameter is equal to the markdown, i.e. $c_{io} = \phi/(1+\phi)$, then the framework is isomorphic to one in which the slaveholder acts as a monopsonist yet the enslaved worker chooses their own labor supply, i.e. the slaveholder is not able to coerce additional labor supply from the enslaved. However, when $c_{io} > \phi/(1+\phi)$, the slaveholder is able to compel additional labor supply from the enslaved at a given wage over and above what the enslaved would have chosen to supply. When $c_{io} = 1$, equations (2) and (10) are equal, implying that enslaved workers are coerced to supply the same amount of labor as free workers (even though they only receive a fraction of the earnings from their produce).

[7] Acemoglu and Wolitzky (2011) allow the degree of coercion to be a costly choice of the individual enslaver, but in the U.S. South the bulk of slave patrolling and repression was provided by state and local government (Hadden, 2001), so we take it as a fixed county-sector characteristic.

Finally, when $c_{io} > 1$, the slaveholder coerces more labor from the enslaved than what free workers would choose to supply, highlighting that—in terms of the labor supply but not in terms of enslaved welfare—the coercion parameter is isomorphic to a productivity differential (or subsidy) for enslaved labor, relative to free labor in the same occupation and location. This oversupply of labor drives the utility of the enslaved worker downward, reflecting the cost of coercion.

The payoff to the slaveholder for assigning an enslaved worker ω to (i, o) after optimally choosing their labor supply and imposing the markdown is:

$$W_{io}^{sh} = \Big(w_{io} - w_s\Big) A_{io}\varepsilon_{io}(\omega) l_{io,s} = \frac{1}{1+\phi} \left(w_{io} A_{io} \varepsilon_{io}(\omega)\right)^{1+\phi} \left(\frac{u_{io}}{P_i} c_{io}\right)^{\phi},$$

which then yields the following enslaved occupational share in each location i:

$$\pi_{io,s|i} = \frac{\left(u_{io}^{\frac{\phi}{1+\phi}} c_{io} w_{io} A_{io}\right)^{\eta}}{\sum_{o' \in \mathcal{O}} \left(u_{io'}^{\frac{\phi}{1+\phi}} c_{io',s}^{\frac{\phi}{1+\phi}} w_{io'} A_{io'}\right)^{\eta}}. \tag{12}$$

Comparing equation (12) to the equivalent expression (4) for free workers highlights how enslaved and free workers are differentially allocated across sectors within location, a point we return to in the following subsection.

Aggregating across occupations, the expected profits of a slaveholder who allocates an enslaved worker to location i is:

$$\Pi_{i,sh} = \Gamma\left(\frac{\eta-1-\phi}{\eta}\right) \frac{1}{1+\phi} \left(\sum_{o \in \mathcal{O}} \left(\underbrace{\left(\frac{u_{io}}{P_i}\right)^{-\frac{1}{1+\phi}}}_{\text{Misallocation}} \underbrace{c_{io}}_{\text{Coercion}} \left(\frac{u_{io}}{P_i} w_{io} A_{io}\right)\right)^{\eta}\right)^{\frac{1+\phi}{\eta}}. \tag{13}$$

The highlighted terms in equation (13) show how expected slaveholder profits $\Pi_{i,sh}$ differs from the expected welfare of free workers $\Pi_{i,f}$ given in equation (5). The misallocation term shows that enslaved workers are employed in sectors and locations with lower amenities than free workers, because slaveholders only internalize the disamenities of places of living or content of work of the enslaved inasmuch as they affect the enslaved's participation constraint. Finally, the coercion term captures the additional labor supply that slaveholders elicit from enslaved workers.

Given the expected profits of slaveholders, we can finally calculate the allocation of enslaved labor across Southern locations $i \in \mathcal{N}^S$ as:

$$\pi_{i,s} = \frac{\Pi_{i,sh}^{\theta}}{\sum_{i' \in \mathcal{N}^S} \Pi_{i',sh}^{\theta}}. \tag{14}$$

Comparing equation (14) to its free workers analog (6) highlights the differential sorting across locations for free and enslaved workers, as we will shortly see.

3.4 Explaining the Stylized Facts

We now show how the framework above offers a straightforward explanation of the Stylized Facts presented in Section 2.2. For expositional purposes, we tackle the Stylized Facts a bit out of order.

3.4.1 Explaining Stylized Fact #2

Comparing equation (12) to the equivalent expression (4) for free workers highlights how enslaved and free workers are differentially allocated across sectors within location. Dividing the enslaved occupation share $\pi_{io,s|i}$ from equation (12) by the free occupation share $\pi_{io,f|i}$ from equation (4) yields:

$$\frac{\pi_{io,s|i}}{\pi_{io,f|i}} = \left(u_{io}^{-\frac{1}{1+\phi}} c_{io} \right)^{\eta} / \sum_{o'} \pi_{io',f} \left(u_{io'}^{-\frac{1}{1+\phi}} c_{io'}^{\frac{\phi}{1+\phi}} \right)^{\eta} \tag{15}$$

Equation (15) shows that enslaved workers are allocated relative more to occupations with low amenities—i.e. Stylized Fact #2(b)—and greater coercion—i.e. Stylized Fact #2(c). Conditional on amenities and coercion, however, both free and enslaved labor is equally responsive to the productivity of an occupation, i.e. Stylized Fact #2(a).

3.4.2 Explaining Stylized Fact #1

In a similar spirit, we can compare equation (14) governing the allocation of enslaved workers across locations to its free workers analog in equation (6) to highlight the differential sorting across locations for free and enslaved workers. Taking ratios yields:

$$\frac{\pi_{i,s}}{\pi_{i,f}} = \frac{\left(\sum_{o \in \mathcal{O}} \pi_{io,f|i} \left(\frac{u_{io}}{P_i} \right)^{-\frac{1}{1+\phi}\eta} c_{io} \right)^{\frac{(1+\phi)\theta}{\eta}}}{\sum_{i' \in \mathcal{N}^S} \pi_{i',f} \left(\sum_{o \in \mathcal{O}} \pi_{i'o,f|i'} \left(\frac{u_{i'o}}{P_{i'}} \right)^{-\frac{1}{1+\phi}\eta} c_{i'o}^{\frac{\phi}{1+\phi}\eta} \right)^{\frac{(1+\phi)\theta}{\eta}}}. \tag{16}$$

Equation (16) says that there will be a relatively higher concentration of enslaved workers in locations with lower amenities, i.e. Stylized Fact #1(b), and higher degrees of coercion, i.e. Stylized Fact #1(c). In the model, as in the data, both free and enslaved workers shares are increasing in the productivity of a location, although recall from Stylized Fact #1(a) that there is empirical evidence that enslaved workers were more responsive to differences in cotton suitability. This is consistent with the model if the production of cotton is more susceptible to coercion (e.g. through the gang labor method of production), even conditional on the distance to the North.

3.4.3 Explaining Stylized Fact #3

To explain the third stylized fact, we first need to distinguish between the wage per efficiency unit in the model (and denoted by w_{io}) with the wage per worker observed in the data (which we will denote by $\tilde{w}_{io}$). Similarly, we can define the observed slave price $\tilde{p}_{io,s}$ as the profits earned by the slave-holder per enslaved worker employed in location i and sector o. We can write the ratio of the observed slave price and the wage per worker as follows:

$$\frac{\tilde{p}_{io,s}}{\tilde{w}_{io}} = \frac{1}{1+\phi} c_{io} \left(\frac{\pi_{io,s|i}}{\pi_{io,f|i}} \right)^{-\frac{1+\phi}{\eta}} \left(\frac{\pi_{i,s}}{\pi_{i,f}} \right)^{-\frac{1}{\theta}}. \tag{17}$$

Equation (17) serves two purposes. First, it explains Stylized Fact #3. Both observed slave prices and wages are increasing in the productivity of a location-sector in the same way, so that their ratio is uncorrelated with productivities, i.e. Stylized Fact #3(a). Their ratio is also increasing with the degree of coercion in a location, as the greater potential for coercion increases the output per enslaved worker disproportionately, i.e. Stylized Fact #3(c). Finally, from Stylized Facts #1 and #2, we know that sectors and locations with higher amenities will have relatively more free workers and relatively fewer enslaved workers; through endogenous sorting, this implies that locations with higher amenities have higher slave prices relative to observed wages, since enslaved workers in these locations will have greater unobserved productivities. Or, equivalently, locations with worse amenities (e.g. high malaria) will have lower slave prices relative to observed wages, i.e. Stylized Fact #3(c). The second purpose of equation (17) is that it offers a way of estimating the across-occupation and across-location supply elasticities, a point we will return to in Section 5.1 below.

3.5 Equilibrium

We now close the model with standard general equilibrium conditions. First, demand yields a typical gravity equation for the value of goods being sent from $i \in \mathcal{N}$ to $j \in \mathcal{N}$:

$$X_{ijo} = \tau_{ij}^{1-\sigma_o} \times \left(\frac{p_{jo}}{P_{jo}}\right)^{1-\sigma_o} \times \left(\frac{P_{jo}}{P_j}\right)^{1-\rho} \times E_j,$$

where total expenditure E_j in location $j \in \mathcal{N}$ is equal to total income paid to free labor, enslaved labor, and slave holders, scaled proportionally to account for the aggregate U.S. trade imbalance, i.e.:

$$E_j \xi^{-1} = \sum_{o \in \mathcal{O}} w_{jo} L_{jo,f} + \frac{\phi}{1+\phi} \sum_{o \in \mathcal{O}} w_{jo} L_{jo,s} + \lambda_j \frac{1}{1+\phi} \sum_{i \in \mathcal{N}} \sum_{o \in \mathcal{O}} w_{io} L_{io,s}, \tag{18}$$

where $\xi \equiv \frac{Y_{US} + \sum_{o \in \mathcal{O}} T_o}{Y_{US}}$, Y_{US} is the aggregate U.S. income, and T_o is the difference between total U.S. imports and total U.S. exports in sector o (i.e. the sector trade deficit). Here, we assume that total slaveholder profits are redistributed lump sump to each destination with shares λ_j, which we set equal to the fraction of enslaved workers residing in that location.

We can then formally define an equilibrium: For any geography $\{A_{io}, c_{io}, u_{io}\}_{i \in \mathcal{N}}^{o \in \mathcal{O}}, \{\tau_{ij}\}_{(i,j) \in \mathcal{N} \times \mathcal{N}}$, slaveholder profit shares $\{\lambda_i\}_{i \in \mathcal{N}}$, trade deficits $\{T_o\}_{o \in \mathcal{O}}$, aggregate labor endowments $\bar{L}_f$ and $\bar{L}_s$, and model parameters $\{\sigma, \rho, \theta, \eta, \phi\}$, equilibrium is a set of prices $\{p_{io}, P_{io}, P_i, w_{io}\}_{i \in \mathcal{N}}^{o \in \mathcal{O}}$ and labor allocations $\left\{\pi_{io,s|i}, \pi_{io,f|i}, \pi_{i,s}, \pi_{i,f}\right\}_{i \in \mathcal{N}}^{o \in \mathcal{O}}$ such that:

1. Payments to labor are equal to total sales:

$$p_{io} q_{io} = \sum_{j \in \mathcal{N}} (\tau_{ij})^{1-\sigma_o} \times \left(\frac{p_{io}}{P_{jo}}\right)^{1-\sigma_o} \times \left(\frac{P_{jo}}{P_j}\right)^{1-\rho} \times E_j;$$

2. Expenditure is equal to total purchases:

$$P_{io}^{1-\sigma_o} = \sum_{j \in \mathcal{N}} \tau_{ji}^{1-\sigma_o} p_{jo}^{1-\sigma_o}; \;\; P_i^{1-\rho} = \sum_{o \in \mathcal{O}} P_{io}^{1-\rho};$$

3. Wages are equal to the marginal product:

$$w_{io} = p_{io}; \text{ and}$$

4. Labor allocations satisfy equations (4) and (6) for free labor and equations (12) and (14) for enslaved labor.

4 Calculating the Welfare Gains from Emancipation

We now derive expressions for the welfare gains from emancipation in our model. We employ an equivalent variation welfare metric, where we ask how much more would an individual have to be paid to be indifferent between remaining in the current equilibrium and moving to a counterfactual equilibrium. Equivalent variation allows us to express welfare under different institutional counterfactuals in a comparable money-metric. An important caveat is that we cannot account for any disamenity stemming from enslaved status itself, beyond the excess labor supply, lower consumption, and worse spatial amenities. For example, we cannot measure the "dishonor" experienced by the enslaved (Patterson, 1982), nor the manifold psychic and physical tortures that accompanied slavery apart from those directly related to the labor supplied. We also cannot account for the non-pecuniary benefits or costs whites, even non-slaveholders, may have obtained from the institution of slavery and associated racial domination (Chelwa et al., 2022). We view these estimates as computing a lower bound, narrowly focusing on purely neoclassical labor supply margins.

4.1 The Partial Equilibrium Gains

We begin by considering the partial equilibrium welfare gains from moving from slavery to emancipation, i.e. we hold constant prices and wages. It immediately follows that there are no changes to the welfare of free workers in this partial equilibrium exercise. We proceed by incrementally removing each component of the institution of slavery.

4.1.1 Removing Coercion

We begin by considering a counterfactual where slaveholders are no longer able to coerce enslaved workers to work harder but the institution of slavery otherwise remains unchanged. In this case, enslaved workers can now choose their labor supply, but slaveholders continue to act as monopsonists and decide the location and occupation of the enslaved. It is straightforward to show that the optimal mark-down for slaveholders remains the same, but enslaved workers will choose to reduce their labor supply below the labor supply chosen by free workers to account for this mark-up, resulting in an equilibrium that is as if the coercion parameter was equal to the markdown, i.e. $c_{io} = \phi / (1 + \phi)$.

What is the equivalent variation? The welfare of an individual remaining in slavery in location-sector (i, o) with labor allocation dictated by the slaveholder with coercion c_{io} but earning a scalar multiple λ of the equilibrium remuneration is:

$$W_{io,s} (\lambda, \varepsilon) = \lambda \frac{w_{io,s} u_{io}}{P_i} A_{i,o} \varepsilon_{io,s} (\omega) \, l - \frac{\phi}{1 + \phi} l^{\frac{1+\phi}{\phi}} \tag{19}$$

Substituting in the labor allocation chosen by the slaveholder given in equation (10) and the equilibrium remuneration in equation (11) yields:

$$W_{io,s}\left(\lambda,\varepsilon\right)=\frac{\phi}{1+\phi}\left(\frac{u_{io}}{P_i}w_{io}\left(A_{io}c_{io}\right)\varepsilon_{io}\left(\omega\right)\right)^{1+\phi}\left(c_{io}\right)^{\phi}\left(\lambda-c_{io}\right), \tag{20}$$

so that an enslaved worker is indifferent between slavery with coercion but with greater remuneration and slavery without coercion if:

$$\lambda_1^{EV}=c_{io}+\frac{1}{1+\phi}\left(\frac{\phi/\left(1+\phi\right)}{c_{io}}\right)^{\phi}. \tag{21}$$

Intuitively, the greater the degree of coercion, the greater the welfare benefits of removing that coercion and allowing the enslaved worker to freely choose their own labor supply. The welfare cost of coercion is the difference between the cost of labor faced by slave owners and that borne by the enslaved.[8] The welfare cost of forced labor without compensation is determined by the intensive labor supply elasticity ϕ. A low elasticity of labor supply implies the curvature of the utility function around the optimum is steep, so that large amounts of compensation are required to offset involuntary labor supply, whereas a high elasticity implies only small amounts of compensation are required.

4.1.2 Removing the Slaveholder

Let us proceed by calculating the additional welfare gains from removing the slaveholder. In this counterfactual, enslaved workers will no longer be charged a mark-down on their wages and their labor supply will correspondingly increase to be the same as a free worker. This leads to welfare gains that are equivalent to simply not being charged the mark-down:

$$\lambda_2^{EV}=\frac{1+\phi}{\phi}, \tag{22}$$

i.e. the greater the markdown, the larger the welfare gains for the enslaved from recapturing the proceeds of their own labor.

4.1.3 Freedom of Movement

Finally, let us calculate the additional welfare gains for the enslaved worker from being able to choose their own occupation and location, leveraging the Frechet distribution of productivity heterogeneity in our model. To facilitate this calculation, we develop an intuitive closed-form expression that provides a welfare metric for misallocation in models with Frechet-distributed

[8] This is the dimension of slavery focused on in Hornbeck and Logan (2023) that generates their aggregate inefficiency in partial equilibrium.

productivity, extending the setup in Hsieh et al. (2019), which we summarize in the following proposition:

Proposition 1. *Consider two variations of a discrete choice setting over choices $c \in \mathcal{C}$ with payoffs $x_c y_c \varepsilon_c$, where ε_c is distributed Frechet with shape parameter $\theta > 1$. In the first variation, agents choose $c^* \equiv \arg\max_{c \in \mathcal{C}} x_c y_c \varepsilon_c$. In the second variation, agents are assigned to $c^{**} \equiv \arg\max_{c \in \mathcal{C}} x_c \varepsilon_c$. Then the ratio of expected payoffs between the two variations can be written as:*

$$\frac{\mathbb{E}\left[x_{c^*} y_{c^*} \varepsilon_{c^*}\right]}{\mathbb{E}\left[x_{c^{**}} y_{c^{**}} \varepsilon_{c^{**}}\right]} = \frac{\left(\sum_{c \in \mathcal{C}} \pi_c y_c^{\theta}\right)^{\frac{1}{\theta}}}{\sum_{c \in \mathcal{C}} \pi_c y_c},$$

where $\pi_c \equiv x_c^{\theta} / \sum_{c' \in \mathcal{C}} x_{c'}^{\theta}$ is the probability of being assigned $c \in \mathcal{C}$ in Variation 2.

Proof. See Appendix A.1. □

By the generalized mean inequality, this ratio will be weakly greater than one with equality if and only if $y_c = y$ for all $c \in \mathcal{C}$. This is intuitive: agents will have higher expected payoffs if they get to choose their option based on the entirety of their payoffs than if they are assigned an option based on only a portion of their payoffs. Moreover, it is straightforward to show that gains from being able to choose relative to being assigned an option are larger the greater the θ (i.e. the less the idiosyncratic productivities matter), the greater the variance of y_c (i.e. the greater the heterogeneity of payoffs not accounted for across different choices), and the smaller the covariance between π_c and y_c (i.e. if the assigned options tend to be less attractive).

In our context, we can think of x_c as the wage of an enslaved worker (which both the enslaved and the slaveholder care about) and y_c as the amenity of an enslaved worker (which only the enslaved cares about). By applying Proposition A.1, we can calculate the additional welfare gains from allowing an enslaved worker to choose their location and sector:

$$\left(\lambda_3^{EV}\right)^{1+\phi} = \left(\sum_{i \in \mathcal{N}^S} \pi_{i,s} \left(\sum_{o \in \mathcal{O}} \pi_{io,s|i} \left(\frac{u_{io}}{P_i}\right)^{\frac{\eta}{1+\phi}}\right)^{\frac{1+\phi}{\eta}\theta}\right)^{\frac{1}{\theta}} / \sum_{i \in \mathcal{N}^S} \pi_{i,s} \left(\sum_{o \in \mathcal{O}} \pi_{io,s|i} \left(\frac{u_{io}}{P_i}\right)\right). \qquad (23)$$

All else equal, enslaved workers will have larger welfare gains from being able to choose where they live and what they do if: (a) their labor supply elasticities (i.e. $\frac{\eta}{1+\phi}$ and θ) are larger; (b) if the variation in real amenities $\left\{\frac{u_{io}}{P_i}\right\}$ is larger across occupations and locations; and (c) if the locations and occupations they are assigned to under slavery tend to have lower real amenities.

4.2 A general expression

Equations (21), (22), and (23) offer insight into the size of the welfare gains from sequentially removing each component of slavery, although they do so in a partial equilibrium setting in which we hold prices and wages fixed.

We can also calculate the welfare effects of emancipation incorporating general equilibrium adjustments to emancipation. To do so, we again consider an equivalent variation metric, although we now set it behind the "veil of ignorance", where we calculate the scalar increase in income λ in all sectors and locations that would make the expected utility of enslaved workers under slavery equal to the expected utility in the counterfactual. The equivalent variation approach to welfare allows us to summarize the welfare effects of the complex changes in prices and allocations induced by emancipation in general equilibrium.

Formally, suppose that a counterfactual delivers expected utility $\tilde{U}$ to enslaved workers. The equivalent variation λ^{EV} is then implicitly defined as the solution to the following equation:

$$\tilde{U} = \phi \times p_s \times \sum_{i \in \mathcal{N}^S} \pi_{i,s} \left(\sum_{o \in \mathcal{O}} \pi_{io,s} \left(\left(\frac{u_{io}}{P_i} \right) \left(\lambda^{EV} - c_{io} \right) \right) \right), \tag{24}$$

where p_s is the slaveholder's annual profits per enslaved worker (i.e. the appropriately discounted slave price).

A similar calculation for free workers turns out to more straightforward: the equivalent variation is the ratio of the expected utility under the counterfactual to the expected utility in the baseline to the power of $1/(1+\phi)$ (to account for the endogenous labor supply).

Because allocations of enslaved workers across occupations $\left(\pi_{io,s|i}\right)$ and locations $(\pi_{i,s})$ are readily observed, equations (21), (22), (23), and (24) highlight that it is straightforward to estimate the welfare gains from emancipation given knowledge of model elasticities $\{\eta, \phi, \theta\}$, location fundamentals $\{c_{io}, u_{io}\}$, and the price indices $\{P_i\}$. We now discuss how to estimate and identify these parameters.

5 Quantifying the Welfare and Economic Impacts of Emancipation

We now turn to quantifying the welfare and economic impacts of emancipation. We begin by discussing how we estimate and identify the key model parameters from the data. We then present the impacts of emancipation on the distribution of people and economic activity across sectors and space, followed by presenting the welfare impacts. We conclude by comparing the counterfactual emancipation results of the theory to the observed reallocation of free and formerly enslaved populations across locations and sectors.

5.1 Estimation of model elasticities

We now discuss estimation and identification of the model parameters. There are five model elasticities: the intensive labor supply elasticity ϕ, the across-sector and across-location extensive supply elasticities η and θ, and the across-sector and across-location demand elasticities ρ and σ. We estimate the first three and calibrate the remaining two.

5.1.1 Estimation of the intensive labor supply elasticity ϕ from enslaved military hires

Equation (11) shows that the markdown that enslaved workers earn relative to free workers per efficiency unit is solely a function of the intensive labor supply elasticity ϕ. As a result, if one can observe the remuneration of free and enslaved workers who are both providing the same efficiency units of labor to the same job in the same place at the same time, the observed markdown would allow the estimation of ϕ. This is the strategy we pursue. Slave hiring was commonplace in the antebellum South (Martin, 2009), and provides a useful context to isolate some dimensions of the master-slave relationship. Employers of hired slaves had less ability to use coercion individually, as they would be liable for potential harm, and hired slaves were employed in a variety of occupations, many working side-by-side with free workers (Rockman, 2009). Thus comparisons of payments made by the same employer to owners of hired slaves vs free workers doing the same job are informative about the markdown, and hence the labor supply elasticity ϕ.

Thus, to estimate ϕ, we use the U.S. forts data first digitized by Margo and Villaflor (1987). As we detail in Appendix A.4, slaves were used extensively on U.S. Army forts,[9] in a diverse range of occupations (we observe 64 different occupations). Because the military could not own or recruit slaves directly, enslaved workers were almost always rented. The data report the wages paid to free workers and the payments made to slave owners for enslaved workers working on the fort. Slave owners could be both local slave owners as well as army officers that owned slaves that they rented to the military, but the latter would overwhelmingly be domestic servants (Hamdani, 2022). While the forts data offers only a select sample of locations (there are 38 forts) and occupations (e.g. very few forts hired

[9] In 1842, Congress asks the Secretary of the Army to report on the use of enslaved workers in the military. J.C. Spencer, the Secretary of War responds with "The recruiting regulations authorize only free white male persons to be enlisted in the army; and there are no blacks or colored persons serving as soldiers; but neither regulation nor usage excludes them as mechanics, laborers, or servants, in any branches of service where such force is required" (27th Congress, 2nd day, Doc. No. 282, August 5, 1842).

workers in the agricultural sector), it offers a unique setting where one can observe the payments to free and enslaved workers doing the same thing at the same time and in the same place.

Table 3 reports a regression of the log payments made to a worker in the U.S. forts data on a dummy variable equal to one if that worker is enslaved. One possible concern is that even within a given occupation in a given fort, enslaved and free workers may differ in unobserved ways in their productivities. The model above implies that a sufficient statistic for this sorting is the share of free or enslaved workers employed by the fort that are working in an occupation. Regardless of the set of fixed effects included or if we control for this share of workers, we document a stable, consistent, and statistically significant discount for payments made to enslaved workers relative to free workers. In our preferred specification including year-month and occupation-fort fixed effects and controlling for occupation shares, we estimate that slaveholders are paid 18.1% less for work done by enslaved workers than free workers for doing the same job at the same fort at the same time.

Our interpretation of this differential payment to owners of hired out slaves and free workers is that payments to free workers include money for subsistence, while the payments to enslaved owners are net of the (in-kind) payments to the enslaved. The slave rentals are much more frequently monthly rentals rather than daily, relative to free workers in the same forts, and the enslaved workers were likely living on the forts and eating military rations. Indeed, Appendix Table A.4 shows that once we restrict attention to the sample of contracts where rations are given to both free and enslaved workers, the payment penalty for enslaved workers shrinks to zero once the number of rations per month are included. The lower payments to owners are because the forts deduct the costs of room and board for the payments made to slave owners. This interpretation is the view given by Mark Smith's study of army slavery at Key West, where he writes:

> "In addition to the monthly wages, slaveholders also benefited financially because slave hiring relieved them of much of the cost of support. It appears that slave owners assumed responsibility only for clothing their leased bondsmen. The engineers took care of the rest. The wage of twenty dollars per month that Lt. Wright paid the owners for his first slave laborers represented only part of the slaveholders' compensation. Wright also had to provide food, shelter, and medical treatment to the slaves he leased, and this seems to have been the case at both forts for most of the period, although except sometimes medical services were dropped from the bargain. The major exception to these policies came at Fort Taylor when Maj. William H. Chase was the superintending engineer from late 1854 through 1855. Chase, who had extraordinarily large appropriations during

his tenure, repeatedly attempted to hire more slaves for the Fort Taylor workforce. In his efforts to supplement his labor force, Chase offered slaveholders up to $1.50 per day for their bondsmen, but he insisted that "The masters furnish food, clothes, medical attendance &c." Chase could find no additional slave laborers for these terms." (Smith, 2008, pg. 511)

Put another way, enslaved persons only enjoyed (in kind) payments equal to 18.1% of their labor. How plausible is this number as a markdown? Perhaps the most famous hired enslaved worker was Frederick Douglass (Douglass, 1845(1994), employed as a caulker in the Maryland shipyards, but living with his owner. Douglass also recalls bargaining for his share of the wages earned, with his owner Hugh Auld sometimes denying him all the wage, recalling he was paid "a dollar and fifty cents per day. I contracted for it, worked for it, earned it, collected it; it was paid to me, and it was _rightfully_ my own; and yet, upon every returning Saturday night, this money—my own hard earnings, every cent of it—was demanded of me, and taken from me by Master Hugh." (Douglass, 1845(1994, pg. 85), and "He would, however, when I made him six dollars, sometimes give me six cents, to encourage me" (pg. 88). This would imply that Douglass was getting very close to 0, while Douglass, by his own account, was earning as much as nine dollars a week in 1838. However, these wages were also covering the value of room and board, which Douglass estimates at "two dollars and a half per week" (pg. 89), implying he was retaining 28% of his income, very close to what is implied by our regression.[10]

In Appendix A.4, we discuss other estimates of the markdown and compare them to ours. Many estimates have relied on the comparison between slave hiring rates and free worker wages for the same occupation to infer markdown. But previous researchers have not been able to look at free and enslaved workers doing the same job in the same organization at the same time, the way the army fort data does.

From equation (11), our markdown estimates imply an intensive labor supply elasticity of $\phi = 0.221$ ($\frac{\phi}{1+\phi} = 0.181$). This estimated labor supply elasticity is broadly similar to other estimates from the literature (e.g. Chetty et al. (2011) estimates an intensive (micro) labor supply elasticity of 0.3); for robustness, in what follows we will also assess the sensitivity of our counterfactual results to alternative values.

[10]Other quotes from Douglass' account of this period give upper bounds. For example, when Douglass renegotiates his contract so that he can pay a fixed price to his owner and keep the residual income, Auld accepts 3 dollars a week, with Douglass keeping all the rest of his income, which covered "my regular expenses about six dollars per week" and allowed some savings. These numbers imply Douglass is keeping at least 66% of his income, which would imply a much larger $\phi = 2$, but since he has stronger incentives to work this division of surplus is likely not typical of hired slaves. These fixed-payment contracts were very rare among slave hires (Martin, 2009).

5.1.2 Estimation of the across-sector supply elasticity η and across-location supply elasticity θ

We estimate the across-sector (within location) supply elasticity η and the across location supply elasticity θ simultaneously by comparing the variation in relative slave prices to wages equation with relative free and enslaved labor shares across sectors and locations using equation 17, which we write here in log form:

$$\ln \frac{\tilde{p}_{io,s}}{\tilde{w}_{io}} = -\frac{1+\phi}{\eta} \ln \left(\frac{\pi_{io,s|i}}{\pi_{io,f|i}} \right) - \frac{1}{\theta} \ln \left(\frac{\pi_{i,s}}{\pi_{i,f}} \right) + \phi \ln c_{io} + \ln \frac{1}{1+\phi}. \tag{25}$$

Equation 25 says that, apart from coercion, the only spatial variation in differences between payments to enslaved and free persons employed in the same sector in the same location arise from differences in their unobserved productivities, which are reflected in their respective labor shares. Intuitively, if we observe a large fraction of enslaved people but only a small fraction of free persons engaged in agriculture in a given location, the average free person should have higher unobservable productivity in agriculture than the average enslaved person, which should be reflected in lower observed slave prices relative to free wages.

Column (1) of Table B.1 reports a simple OLS regression of equation 25, where we include the (log) distance to the North as a proxy for coercion. As predicted, the coefficients on both the within-location and across-location shares are negative and the ratio is increasing with the distance to the North. Column (2) also includes county fixed effects, which has the added advantage of only identifying the within-location supply elasticity η using variation across sectors within a location.

However, because the residual includes other (unobserved) components of coercion and these components of coercion will affect the relative shares of free and enslaved persons (see equations 15 and 16), an OLS coefficient will bias the coefficients on both relative shares terms upward toward zero, biasing the estimated elasticities upward. Fortunately, however, our model offers a solution: any proxy for amenities that is uncorrelated with coercion is an appropriate instrument: from equations 15 and 16, the amenities of a location-sector are correlated with relative shares (i.e. they are relevant) and from equation 17, they do not directly affect the ratio of prices to observed wages (i.e. they are excludable).

As a result, we proceed by instrumenting for the relative shares with malarial suitability (and its interaction with dummy variables for each of the sectors), controlling for our proxy for coercion. Column (3) shows that this set of instruments, unfortunately, is not strong enough to offer sufficient variation to estimate both the within-location supply elasticity η and across-location supply elasticity θ simultaneously, so we instead proceed in two steps. First, we estimate the within-location supply elasticity η by including county fixed effects and instrumenting for sector shares with malarial suitability interacted with sector dummy variables. County fixed-effects will absorb all other sources of county-level coercion, like the local variation in slave patrols documented in Hadden (2001), increasing the plausibility of our conditional exogeneity assumption. Column (4) shows that the inclusion of county fixed effects improves the power of the first stage (albeit still with a first-stage F-statistic of only 6), resulting in an estimated within-location supply elasticity of $\eta = 2.453$. Next, we take the value of η as given and estimate the across-location supply elasticity θ using malarial suitability of a county as an instrument. Column (5) reports the results: we have a strong first stage, yielding an across-location supply elasticity of $\theta = 3.258$. These supply elasticities are similar in magnitude to other estimated elasticities in the literature (albeit in different settings); although given remaining concerns about a weak instrument, in what follows, we will also assess the sensitivity of our counterfactual results to alternative values.[11]

5.1.3 Calibration of the across-sector demand elasticity ρ and the across-location demand elasticities σ_o.

We calibrate the demand elasticities to values from the literature. We set the across-sector demand elasticity to $\rho = 0.89$, following the estimate in Herrendorf et al. (2013) for homothetic CES demand. For within-sector, across-location demand elasticities, we need three separate values for agriculture, manufacturing, and services. For agriculture, we set $\sigma_{ag} = 9.22$ following Donaldson and Hornbeck (2016). This is our preferred estimate given our shared setting (the United States in the 19th century), but it is also very close to the estimate from Caliendo and Parro (2015) of 9.11. For manufacturing, we set $\sigma_{mfg} = 4.05$ following Hornbeck and Rotemberg (2024),[12] which also shares our setting and is similar to the median manufacturing elasticity found in Caliendo and Parro (2015) of 4.965. Finally, for services, we set $\sigma_{serv} = 5.98$ following Gervais and Jensen (2019), which is also similar to estimates from Blank et al. (2022) as well as Ahmad and Schreiber (2024).

[11]For example, Monte et al. (2018) estimate an across-location labor supply elasticity of 4.4 in contemporary U.S., Tombe and Zhu (2019) estimate an across-location labor supply elasticity of 2.5 in contemporary China, and Morten and Oliveira (2024) estimate an across-location labor supply elasticity of 3.4 in 20th century Brazil, and Burstein et al. (2019) estimate a across-sector labor supply elasticity of 1.8 in the 20th century U.S.

[12]The Hornbeck and Rotemberg (2024) estimate is from a model that combines trade in manufacturing and agriculture. However, the focus of the paper and model is on manufacturing - for instance, the input price wedges for agriculture are assumed to be the same as those estimated for manufacturing, and the production function elasticities are at the county level for manufacturing but at the national level for agriculture.

5.2 Estimation of geographic variables

Given model elasticities, it remains to estimate the U.S. geography. We calibrate bilateral trade costs τ_{ij} and then "invert" the model to recover the location-sector specific productivities A_{io}, amenities u_{io}, and coercion parameters c_{io}.

5.2.1 Calibration of Trade Costs and International Trade

We calibrate the bilateral trade costs τ_{ij} between all U.S. counties to the values given by Donaldson and Hornbeck (2016) for the year 1860. For international trade, the only additional data required is trade costs and aggregate trade levels between the U.S. and ROW in each traded sector. Given observed trade costs, we maintain balanced trade with transfers equivalent to the observed trade imbalance. For trade costs between U.S. counties and the ROW, we assume international trade is shipped through New York City to Liverpool, where the additional cost of international trade is calculated using the pound sterling cost of shipping cotton to Liverpool reported by the New York Chamber of Commerce (Chamber of Commerce, 1861), converting to 1860 dollars following Officer (2025).[13] Lastly, we convert the calculated cost to a bilateral trade cost between U.S. counties and ROW using the same procedure as Donaldson and Hornbeck (2016). Aggregate trade levels in 1860 for agriculture and manufacturing are sourced from the New York Times (1862), while services trade is calculated from shares and statistics in Officer (2021).

5.2.2 Estimation of Unobserved Location-Sector Characteristics

We follow the standard procedure in the quantitative spatial literature to "invert" the observed labor shares and wages to recover the unobserved location-sector characteristics (see e.g. Allen and Arkolakis (2014)). One difficulty that arises in this approach is that we do not directly observe the division of output between free and enslaved persons. To overcome this difficulty, we use the fact that in equilibrium the expected profits to the slaveholder from the enslaved will be equalized across sectors and locations.[14]

What is the expected (annual) profits to the slaveholder of an enslaved person? In what follows, we it to be $276 per year, which corresponds to the midpoint between the estimate calculated from discounting enslaved profits using the gross return in Lindert and Williamson (2012) ($192) and the estimate calculated based on measures of enslaved subsistence con-

[13] In 1860, New York City was the largest port in the U.S. and third largest in the world behind Liverpool and London. Roughly two-thirds of all U.S. imports ($234 million of $362 million) and one-third of all U.S. exports ($121 million of $373 million) transited via New York City (Chamber of Commerce, 1861).

[14] While in principle it would be possible to use our proxy for slave prices to estimate the output of enslaved persons, because this proxy also includes other slaveholder assets, it would overstate enslaved output.

sumption ($360). A value of $276 per year in turn implies an average remuneration of enslaved persons of $61 ($\phi \times 276$) per year. We discuss the sources and motivation for the calculation of these two numbers, as well as additional evidence in Appendix A.4.

The following Proposition shows that given model elasticities, trade costs, and international trade, there exists a unique (to-scale within sector) set of productivities, amenities, and coercion parameters such that the model equilibrium given these location-sector characteristics is exactly equal to the observed data on labor allocations, wages, and slave price for locations within the U.S., $\mathcal{N}^{US}$:[15]

Proposition 2. *Given model elasticities $\{\eta, \theta, \rho, \sigma, \phi\}$, trade costs $\{\tau_{ij}\}_{i,j \in \mathcal{N}}$, slaveholder profit shares $\{\lambda_i\}_{i \in \mathcal{N}}$, slave price p_s, and international imports and exports $\left\{M_o^{ROW}, X_o^{ROW}\right\}_{o \in O}$, there exists a geography $\{A_{io}, c_{io}, u_{io}\}_{i \in \mathcal{N}^{US}}^{o \in \mathcal{O}}$ such that the model equilibrium is equal to the observed (per person) wages $\{\tilde{w}_{io}\}_{i \in \mathcal{N}^{US}}^{o \in \mathcal{O}}$ and labor allocations $\left\{\pi_{io,s|i}, \pi_{io,f|i}, \pi_{i,s}, \pi_{i,f}\right\}_{i \in \mathcal{N}^{US}}^{o \in \mathcal{O}}$. The geography is unique (up-to-scale) within sector.*

Proof. See Appendix A.2. □

Intuitively, the wages and free workers' choices of occupations allow us to identify the relative amenities: if a free worker works in a location-occupation with low wages, the amenity value of that location-occupation must be relatively high. Conversely, since enslaved workers are allocated to maximize profits for slaveholders, their labor allocation (again conditional on adjusted wages) identifies the relative coercion parameters. Given amenities and coercion parameters, productivities can then be recovered using market clearing conditions. In Appendix A.2, we also offer an iterative algorithm that in practice efficiently inverts the model.

Appendix Figure B.4 depicts the resulting spatial distribution of estimated productivities, amenities, and coercion for the agricultural sector across the U.S. South. The so-called "Cotton Belt" along the Mississippi and through central Alabama is estimated to have high productivities, low amenities, and high degrees of coercion. Counties in West Virginia and Kentucky, in contrast, tended to have lower agricultural productivity, but higher amenities and lower degrees of coercion. Appendix Figure B.5 compares the model estimated spatial distribution in agricultural productivities, amenities, and coercion to the geographic proxies of cotton suitability, malaria suitability, and distance to North we used in the Stylized Facts

[15]The inversion is unique to-scale within sector because of the possibility that across-sector demand is complementary, i.e. we allow $\rho \leq 1$. When $\sigma_o > \rho > 1$ for all $o \in \mathcal{O}$, the inversion is unique (to-scale) across sectors as well. See Allen et al. (2024) Appendix A.5 for more discussion.

presented in Section 2.2. Reassuringly, the estimated location fundamentals are strongly correlated with their corresponding geographic proxy in the expected direction, even conditional on state fixed effects and the other two geographic proxies.

5.3 Aggregate Impacts of Emancipation

Given the estimated model elasticities and geography, we calculate a series of counterfactuals that incrementally dismantle the institution of slavery. As in Section 4, we first remove coercion, allowing enslaved persons to choose their own intensive labor supply. We then remove slaveholders, allowing enslaved persons to receive the entirety of the proceeds from their own labor. Finally, we remove the mis-allocation, allowing enslaved persons to choose both their sector and location. For this last step, we consider two variants: in the first, enslaved persons must remain in the U.S. South; in the second, they may reside anywhere in the United States. In this latter version, enslaved persons and free persons behave identically. All counterfactuals include all general equilibrium impacts on prices, wages, and allocations across all U.S. counties.

We begin by reporting the aggregate impacts of emancipation. We report the welfare impacts in equivalent variation, as discussed in Section 4.2. Economic impacts are measured in dollars per person per year. Table 5 presents the results.

The first row presents our slavery baseline where the model is calibrated to exactly match the observed data. The second row presents what would occur if there were no coercion. Recall from equation (21) in Section 4.1.1 that this welfare gain arises from enslaved workers being able to reduce their labor supply. This leads to a welfare gain equivalent to a 361% increase in enslaved remuneration from the baseline scenario, i.e. an increase from \$61 to \$281 a year. The magnitude implies that the average enslaved person is coerced into offering approximately twice as much labor than they would have otherwise, which accords well with historical evidence on how Black labor supply adjusted after slavery ended.[16] This decline in slave labor causes a reduction in agricultural output of 5.3% and a decline in overall GDP of 0.9%.[17]

[16] It is important to emphasize that we estimate that enslaved persons are coerced into offering twice as much labor as they would have chosen *given their remuneration under slavery.* If we instead compare slavery to the labor supply chosen without slave-holders imposing a mark-down, we find enslaved persons are coerced into providing 37% more labor than they would have chosen. In comparison, Ransom and Sutch (1977) estimates that prime age working men in agriculture reduce their hours by 12% after emancipation, although Goldin (1973) notes that this figure underestimates the decline in labor supply for the family as a whole.

[17] The smaller decline in aggregate GDP is because we estimate coercion parameters less than the mark-down in the non-agricultural sectors in many locations. Intuitively, coercion is difficult in non-agricultural sectors like manufacturing and services (as evinced by the low share of enslaved workers in these sectors despite high observed wages), so that the enslaved supply less labor in that sector than they would if they

The third row presents what would occur if there were no coercion and enslaved persons were able to retain all the fruits of their labor. Recall from equation (22) in Section 4.1.2 that this welfare gain arises from transferring all slaveholders' profits to the enslaved persons. The gains from receiving the value of all of one's labors (or equivalently, removing the markdown) is large, equal to a 731% increase in wages in the baseline case, or an additional 81% increase over and above removing coercion on its own. Overall output increases by 6.5% relative to baseline, as enslaved persons choose to increase their labor supply once their wages are no longer marked down.

The fourth row presents what would occur if enslaved persons were free but confined to remain in the U.S. South. Recall from equation (23) in Section 4.1.3 that this welfare gain arises from enslaved persons being able to reallocate away from low-amenity / high-coercion location-sectors toward high-amenity location-sectors. The overall gains relative to the baseline case are equivalent to a 889% increase in wages, or an additional 19% increase over and above removing coercion and slave-holders. This welfare gain is substantial because, as noted in Stylized Fact 1(b) and 2(b), enslaved persons were allocated to low amenity location-sectors; indeed, we find a negative correlation of -0.54 between (log) enslaved labor shares and (log) amenities across all Southern location-sectors in 1860. But because enslaved persons now get to choose their location and occupation to maximize welfare rather than being forced to maximize profits, aggregate GDP falls by 2.9%.

Finally, the fifth row presents what would occur if enslaved persons were free and could choose to reside anywhere in the U.S. In this case, all persons in the model act identically. All told, the gains are equivalent to an 1192% increase in baseline wages, a further 55% increase over removing coercion and monopsony on their own. In dollar terms, these welfare gains are equal to an increase from \$61 to \$788 in annual remuneration—well above the per capita GDP at the time. As noted in the Section 4, these welfare costs are lower bounds on the true costs of slavery, as they abstract from any direct disutility of being enslaved that is invariant to labor supply. Because the U.S. North is estimated to be more attractive in both its amenities and productivities than the U.S. South, the welfare gains from being able to move anywhere in the U.S. are substantially larger than the gains from just reallocating within the U.S. South. Moreover, the ability of the formerly enslaved to move to the more productive North enables emancipation to increase U.S. per capita GDP by 9.1% relative to the baseline. On the other hand, free person welfare declines by 0.7%, as increased competition from the formerly enslaved drives down the wages in more attractive locations

could freely choose. The difficulty of coercing enslaved workers in manufacturing is confirmed in a number of case studies of slave manufacturing (Dew, 1995), as well as monographs like Bateman and Weiss (2002) and Starobin (1968). James H. Hammond, one of the leading slaveowners in South Carolina, wrote "Whenever a slave is made a mechanic he is more than half-freed" (Andrews, 2019, Chapter 2).

and sectors.

How do these aggregate welfare effects compare to the estimates of others? Seagrave (1971) examines the wage rate of gang-laborers post emancipation to estimate that the gang labor system requires paying workers approximately 150% more than enslaved persons were compensated. Building on this estimate, Fogel and Engerman (1974) calculate the pecuniary and non-pecuniary incidence of the gang-labor system on the enslaved, and argue that slaves got roughly 5 dollars of additional compensation but bore 75 dollars of non-pecuniary costs, which corresponds to an equivalent variation welfare gains of removing the gang labor system of 115%. These estimates correspond to roughly one-third of our estimated equivalent variation welfare gains from removing all forms of coercion, suggesting that gang labor was an important (but not comprehensive) component of coercion. Hornbeck and Logan (2023) focus on the uncompensated externality and the aggregate welfare growth, and estimate increases in welfare relative to Southern GDP of between 11% and 358%. In comparison, our estimated welfare gains for enslaved persons from emancipation is equal to an increase of 241% in Southern GDP, well within their range.

5.4 Impacts of Emancipation across Sectors and Locations

The aggregate impacts, however, mask substantial heterogeneity in the impacts of emancipation across sectors and locations. For brevity, we will focus on the counterfactual of complete emancipation. Figure 3 depicts the change in allocation for both enslaved persons (panel a) and free persons (panel b). As is evident, emancipation would result in a massive change in the spatial distribution of labor allocation. More than two-thirds—69%—of formerly enslaved persons move to the North, but even of those who remain in the South, at least 22% change their location, moving out of high-productivity, high-coercion, low-amenity locations like those in the Cotton Belt toward high-amenity, lower-productivity locations like those in Kentucky and West Virginia. This, in turn, would raise equilibrium wages in the areas they are departing, inducing free persons to move in. While substantial, the free person response is an order of magnitude smaller, requiring only 2.4% of the free population to move.

Figure 4 shows that the sectoral impacts of emancipation were also large. The share of enslaved persons engaged in agriculture falls nearly everywhere from an average of 83% to 39%. While the overall increase in free labor in agriculture is negligible, there are especially notable increases in the share of free persons engaged in agriculture in locations with high agricultural productivity like in the Cotton Belt where enslaved persons have fled.

What are the economic impacts of these substantial changes in labor allocations? Figure 5 depicts the changes in the value output in each sector in all U.S. counties. The large scale exit of enslaved persons from high-productivity, low-amenity locations in the South combined with the large scale move of enslaved persons into manufacturing and services results in declines in agricultural output in these locations and corresponding increases in the output in services and manufacturing. All sectors expand in the U.S. North: Northern agricultural output increases by 24%, manufacturing increases by 29%, and services increase by 28%. The South experiences similar growth in manufacturing (19%) and services (8.8%) but substantial declines in agriculture (-29%). All told, total U.S. agricultural output falls by 5.4%, whereas the services and manufacturing sectors expand by 21%, and 27%, respectively. Hence, the counterfactual results suggest that slavery played an important role in slowing structural transformation in the U.S.

Appendix Figures B.6, B.7, and B.8 show how the quantitative impacts of emancipation vary with alternative values of the supply elasticities ϕ, θ, and η. As is evident, the magnitude of the economic impacts are of similar magnitudes, the welfare impacts on free persons remain modest, and the welfare impacts for enslaved persons remain large for all reasonable parameter values.

5.5 Comparing Counterfactual Emancipation to Actual Emancipation

The previous section highlighted the substantial reallocation of both free and enslaved populations across both sectors and locations after emancipation. Did this reallocation actually occur after the U.S. Civil War? To answer this question, we compare the predicted changes in population from complete emancipation to the actual population changes across locations and sectors for Black and White populations using the 1870 complete count Census.[18]

For both Black and White workers, we compare the (log) observed change in populations and sectoral labor shares with the (log) observed changes across all Southern counties. Figure 6 presents the results. As is evident, the predicted changes in both (across-location) changes in population shares and (within-location) changes in sectoral shares are positively and strongly correlated with the observed changes between 1860 and 1870, with one exception: a strong positive correlation for changes in Black population shares only exists after controlling for the initial (1860) Black county population. This provides suggestive evidence that the formerly enslaved's actual post-Civil War experience including substantially more migration frictions across locations than the costless reallocation assumed by the model.

[18] In particular, we compare the ratio of the Black population in 1870 to the enslaved population in 1860 and the White population in 1870 to the free population (both White and Black) in 1860. Given the relatively small number of free Black workers in the U.S. South in 1860 (55,000 of 1.6 million free workers), here we refer to the latter group as "White" workers.

6 Conclusion

We view our model as a first attempt to quantify how the institution of slavery shaped the antebellum economy in the United States. We have built a rich model of the allocation of free and enslaved workers across many locations and sectors based on the premise that, unlike free workers, enslaved workers do not get to choose how much they work, what sector they are working in, or where to live and work. Using the observed allocations of free and enslaved workers across sectors and space, together with new data on wages and slave prices, we estimate the key parameters of the model. We then use the model to simulate emancipation as restoring a competitive labor market for the enslaved, accounting for the general equilibrium response, and quantitatively recover the welfare gains to emancipation and the impacts on the spatial economy across a variety of emancipation scenarios.

The main takeaways are two-fold. First—and perhaps unsurprisingly—the welfare of the enslaved was enormously reduced by slavery, with emancipation generated an equivalent variation welfare gain of 1,192%. These welfare losses arise from three sources, all of which are quantitatively important: enslaved persons are coerced into providing much more labor than they would have otherwise chosen (361%), a substantial fraction of the proceeds of enslaved persons' labor is captured by slaveowners (81%), and enslaved persons are allocated to locations and sectors that they otherwise would not have chosen (55%). We re-emphasize that these welfare costs of slavery are undoubtedly lower bounds, as they abstract from any direct disutility from being enslaved that does not depend on labor supply choices.

Second, we find that slavery had large impacts on the spatial and sectoral composition of the aggregate U.S. economy: emancipation led to large expansions of the services (21%) and manufacturing (27%), and a substantial movement of agricultural production into the U.S. North (where agricultural output increased by 24%) and away from the U.S. South (where agricultural output fell by 29%). These findings suggest that the institution of slavery not only slowed structural transformation and inhibited economic growth in the U.S., but also led to spatially inefficient patterns of production.

To highlight the role that slavery played in shaping the antebellum economy, our exercise is built on two assumptions: (1) (but for the institution of slavery), the economy would be efficient; and (2) (but for the institution of slavery), all workers would behave identically. While we think these assumptions offer a reasonable quantitative benchmark for evaluating the institution of slavery, they also necessarily omit a number of key dimensions of both American slavery and the larger American economy. For example, the first assumption abstracts from economic externalities like increasing returns to scale in manufacturing or urban agglomerations (Bateman and Weiss, 2002) and labor market frictions such as monopsony power due to heterogeneous worker preferences (see e.g. Berger et al. (2022); Méndez and Van Patten (2022)), whereas the second assumption abstracts from human capital accumulation (Sacerdote, 2005). Other margins that our analysis abstracts from include intermediate input market and production network linkages (Bailey, 1990), aggregate demand externalities on northern manufacturing(Rockman, 2024), effects on innovation (Connell, 2024), international capital flows from slaveholdings (Heblich et al., 2022), inequality in landholdings (Jaynes, 1995; Miller, 2020), political economy considerations (Masera and Rosenberg, 2021), and credit markets (González et al., 2017). We leave exploration of these important economic forces for future work.

Finally, our results suggest that the observed allocation of workers in 1870 reflects more than emancipation itself. Our model predicts that enslaved workers would have been more mobile across locations than we see in the data. As discussed in the introduction, actual emancipation came alongside an extremely destructive war, a military occupation, and political attempts to restore something close to the slave system. Perhaps these forces, or others we have omitted from the analysis, can rationalize the persistence of slavery and its effects well into the present. Again, we think exploring these empirical facts through the lens of models like the one we have constructed could be a fruitful direction for future research.

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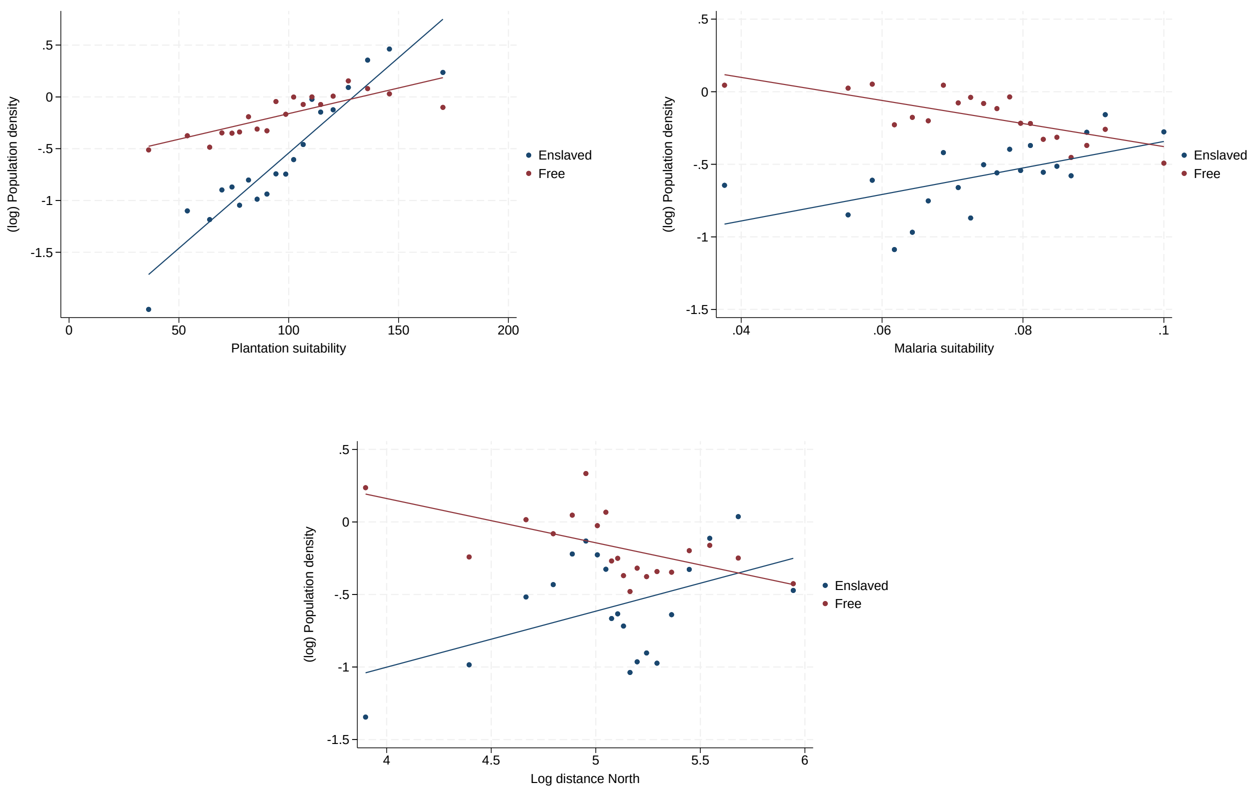
Figure 1: Free and Enslaved Sorting across Locations

(a) Cotton suitability

(b) Malaria suitability



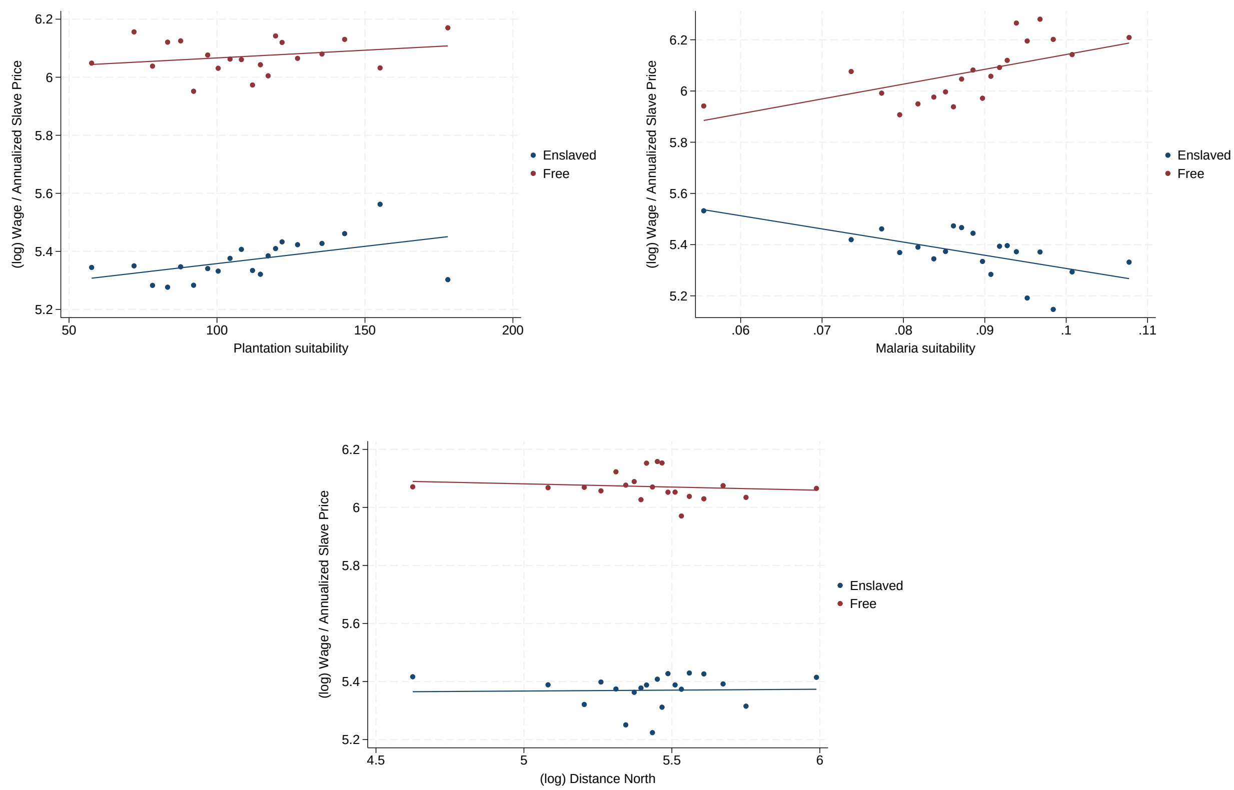
(c) Distance to North

Notes: These figures are binned scatterplots showing how the density of free and enslaved workers varies across counties by geographic characteristics. An observation is a county. Cotton suitability is the predicted cotton yield given agro-climatic conditions in absence of irrigation and fertilizer. Malaria suitability is the malaria ecology index developed by Kiszewski et al. (2004). Log distance north is the Vincenty centroid distance from each county to the U.S.
North. All plots control for state fixed-effects and the other two geographic variables.

Figure 2: Free and Enslaved Payments across Locations

(a) Cotton suitability

(b) Malaria suitability

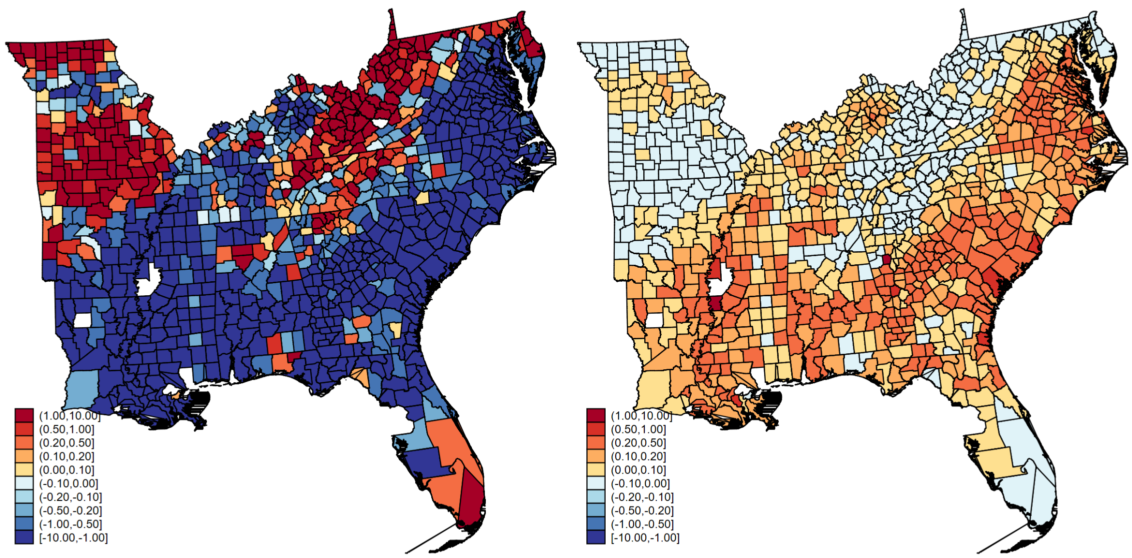


(c) Log distance to North

Notes: These figures are binned scatter plots showing how free worker wages and enslaved prices vary across counties by geographic characteristics. An observation is a county-sector. Observations are weighted by the total number of enslaved persons in a county-sector. Cotton suitability is the predicted cotton yield given agro-climatic conditions in absence of irrigation and fertilizer. Malaria suitability is the malaria ecology index developed by Kiszewski et al. (2004). Log distance north is the Vincenty centroid distance from each county to the U.S. North. All plots control for state-sector fixed-effects and the other two geographic variables.

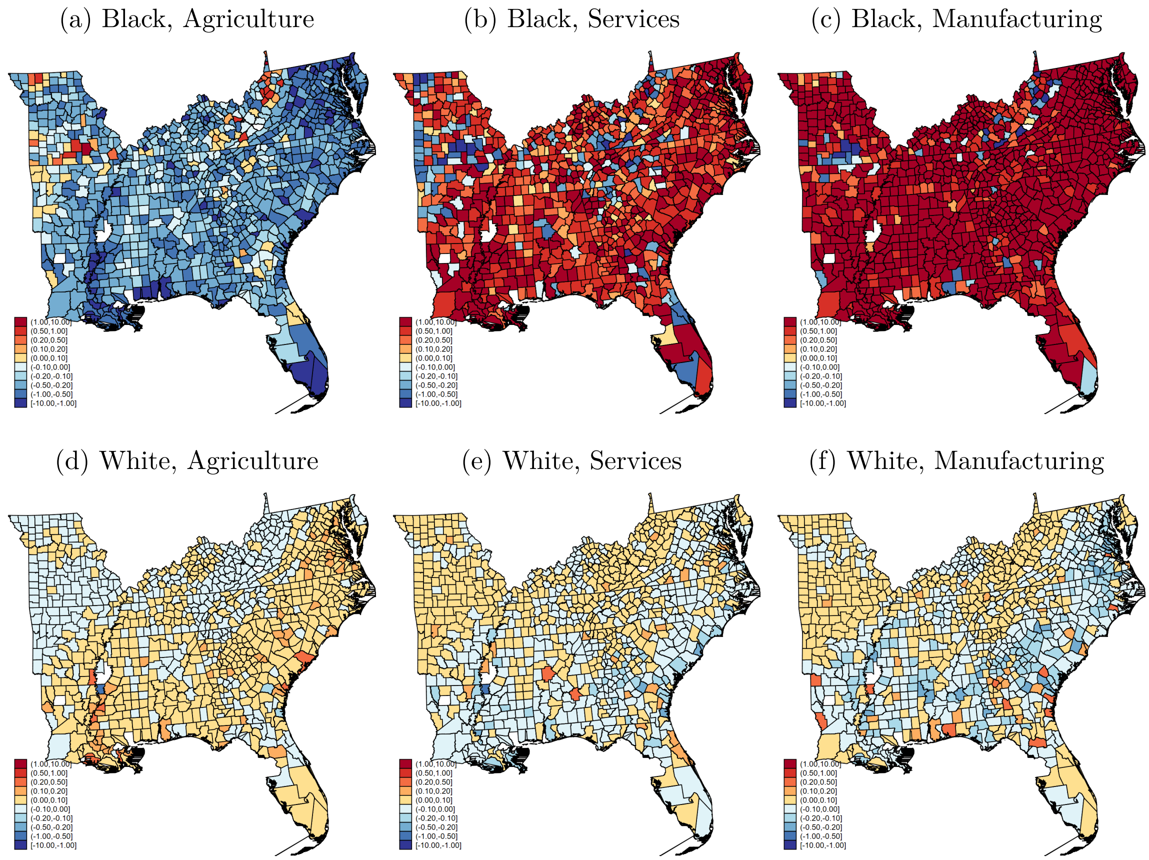
Figure 3: The impact of emancipation on the distribution of Black and White labor across space

(a) Change in Black population (b) Change in White population



Notes: This figure depicts the counterfactual change in the distribution of enslaved and free labor across counties in the U.S. South as a result of a complete emancipation. Values reported are the log of the population ratios.

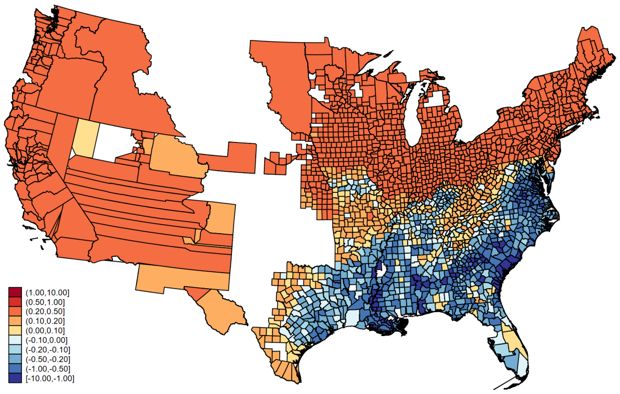
Figure 4: The impact of emancipation on the distribution of Black and White labor across sectors



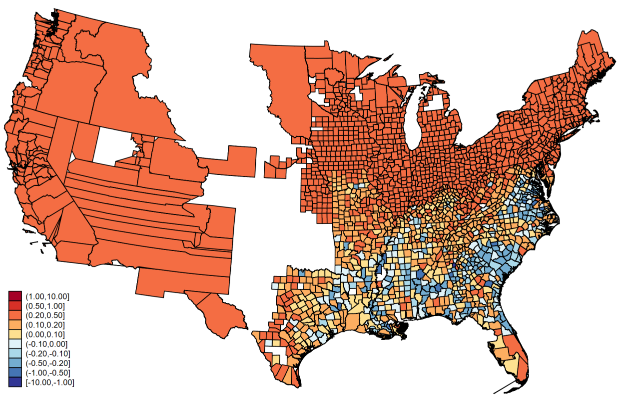
Notes: This figure depicts the counterfactual change in the fraction of enslaved and free labor employed in each sector across counties in the U.S. South as a result of complete emancipation. Values reported are the log ratio.

Figure 5: The impact of emancipation on economic output

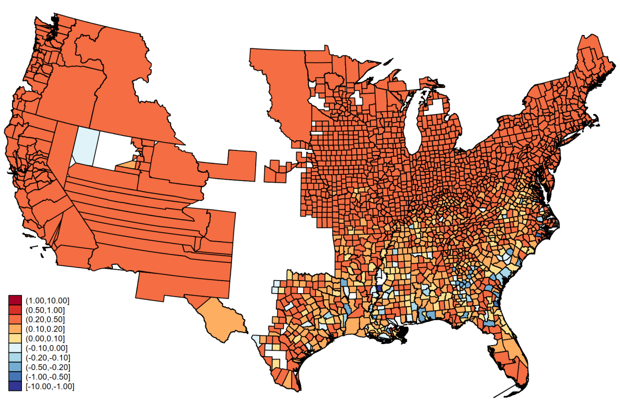
(a) Agriculture



(b) Services



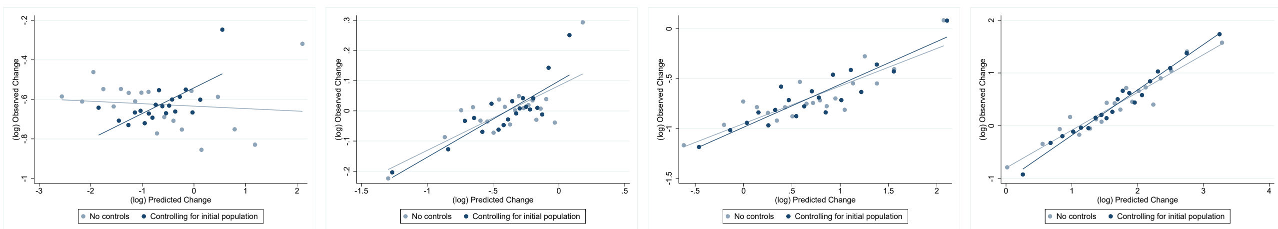
(c) Manufacturing



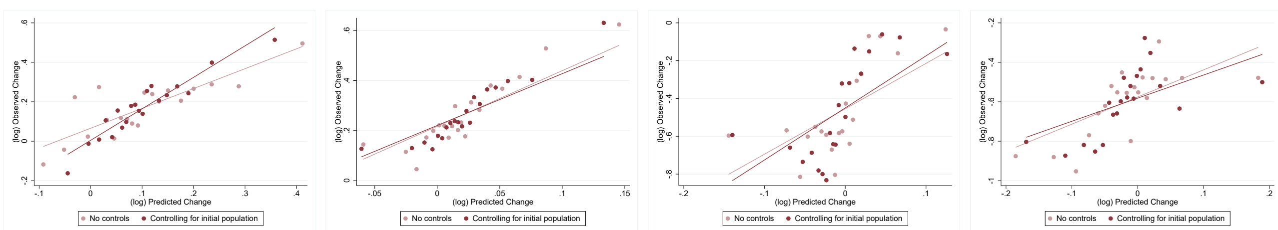
Notes: This figure depicts the counterfactual change in the value of agricultural and manufacturing output across all U.S. counties as a result of a complete emancipation. Values reported are the log ratio.

Figure 6: How well does the model predict changes in labor allocations after the U.S. Civil War?

(a) Black, Total (b) Black, Agriculture (c) Black, Services (d) Black, Manufacturing



(e) White, Total (f) White, Agriculture (g) White, Services (h) White, Manufacturing



Notes: This figure presents binned scatter plots comparing the model predicted change in allocations of formerly enslaved black population (panels (a)-(d)) and free white population (panels (e)-(h)) from a complete emancipation relative to the actual changes observed between 1860 and 1870 for all Southern counties. Panels (a) and (e) report the change in the total population in each county; the remaining panels report the change in the share of the population employed in each sector. All bin-scatters include state fixed effects; each panel also shows bin-scatters that control for the initial (log) 1860 enslaved or free population. Values reported are log ratios.

Table 1: Enslaved and free persons sort differenctly

	Across locations		Across sectors	
	(1)	(2)	(3)	(4)
Plantation suitability	0.005***		-0.000	
	(0.001)		(0.000)	
Cotton * Enslaved	0.013***	0.013***	0.001***	0.001***
	(0.001)	(0.001)	(0.000)	(0.000)
Malaria suitability	-8.014***		-3.607***	
	(1.793)		(0.945)	
Malaria * Enslaved	17.147***	17.085***	1.403	0.088
	(2.920)	(2.914)	(1.065)	(0.419)
Log distance to North	-0.315***		0.090**	
	(0.049)		(0.038)	
Log distance to North * Enslaved	0.701***	0.691***	-0.076**	-0.006
	(0.091)	(0.091)	(0.036)	(0.018)
State-Type FE	Yes	Yes	Yes	Yes
County FE	No	Yes	No	Yes
R-squared	0.482	0.858	0.041	0.153
Number of counties	973	970	990	990
Number of observations	1943	1940	3441367	3441367

Notes: Ordinary least squares. In columns 1 and 2, the dependent variable is the number of free or enslaved workers aged 15-50 per hectare and a unit of observation is a county in the U.S. South x type of person (free or enslaved). In columns 3 and 4, the dependent variable is a dummy variable equal to one if a worker aged 15-50 is engaged in agriculture and each observation is an individual worker residing in the U.S. South. Cotton suitability is the predicted cotton yield given agro-climatic conditions in absence of irrigation and fertilizer. Malaria suitability is the malaria ecology index developed by Kiszewski et al. (2004). Log distance north is the Vincenty centroid distance from each county to the U.S. North. Standard errors clustered at the county level reported in parentheses. Stars indicate statistical significance: * p<.10 ** p<.05 *** p<.01.

Table 2: Free wages and slave prices correlate with geography

	Free wages (1)	Slave prices (2)	Slave prices / free wages (3)
Cotton suitability	0.001***	0.001*	-0.001
	(0.000)	(0.001)	(0.001)
Malaria suitability	3.843***	-5.148***	-8.800***
	(0.487)	(0.839)	(1.036)
Log Distance North	-0.048***	0.006	-0.016
	(0.014)	(0.030)	(0.030)
State-Sector FE	Yes	Yes	Yes
R-squared	0.422	0.303	0.430
Number of counties	964	955	964
Number of observations	2685	2555	2685

Notes: Ordinary least squares. Each observation is a county-sector. In column 1, the dependent variable is the (log) free wage; in column 2 the dependent variable is the (log) slave price; and in column 3 the dependent variable is the (log) ratio of the slave price to the free wage. Cotton suitability is the predicted cotton yield given agro-climatic conditions in absence of irrigation and fertilizer. Malaria suitability is the malaria ecology index developed by Kiszewski et al. (2004). Log distance north is the Vincenty centroid distance from each county to the U.S. North. Observations in column 1 are weighted by the number of free workers. Observatiosn in columns 2 and 3 are weighted by the number of enslaved workers. Standard errors clustered at the county level reported in parentheses. Stars indicate statistical significance: * p<.10 ** p<.05 *** p<.01.

Table 3: Estimating the enslaved mark-down using U.S. Forts Data

	(1)	(2)	(3)	(4)	(5)
Enslaved	-0.249***	-0.241***	-0.229***	-0.194***	-0.181***
	(0.040)	(0.044)	(0.048)	(0.049)	(0.053)
Log share of workers			-0.025***		-0.020*
in fort in occupation			(0.008)		(0.011)
Implied labor	0.331***	0.318***	0.297***	0.240***	0.221***
supply elasticity (ϕ)	(0.072)	(0.076)	(0.080)	(0.075)	(0.079)
State FE	Yes	Yes	Yes	Yes	Yes
Year X Month FE	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes
Fort FE	No	Yes	Yes	Yes	Yes
Occupation X Fort FE	No	No	No	Yes	Yes
R-squared	0.685	0.713	0.713	0.808	0.808
Number of forts	40	37	37	37	37
Number of workers	14909	14906	14906	14871	14871

Notes: Ordinary least squares. The dependent variable is the (log) wage. Each observation is a worker contract; observations weighted by number of workers on a contract. Standard errors clustered at the fort reported in parentheses. Stars indicate statistical significance: * p<.10 ** p<.05 *** p<.01.

Table 4: Estimating elasticities using local slave price to wage ratios

	OLS		IV		
	(1)	(2)	(3)	(4)	(5)
Log ratio of enslaved to free within location occupation shares	-0.164***	-0.081***	0.511	-0.498**	
	(0.032)	(0.021)	(0.376)	(0.229)	
Log ratio of enslaved to free across location shares	-0.195***		-0.455***		-0.307***
	(0.015)		(0.066)		(0.036)
Log distance to North	0.078***		0.293***		0.181***
	(0.029)		(0.076)		(0.044)
Implied across location elasticity (θ)	5.126***		2.196***		3.258***
	(0.392)		(0.319)		(0.381)
Implied within location elasticity (η)	7.461***	15.120***	-2.390	2.453**	
	(1.471)	(3.873)	(1.760)	(1.126)	
Occupation FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
County FE	No	Yes	No	Yes	No
R-squared	0.454	0.843			
1st-stage SW F-stat: Within location shares			3.344	5.994	
1st-stage SW F-stat: Across location shares			4.182		65.376
Observations	2560	2430	2560	2430	2560

Notes: The dependent variable is the (log) ratio of slave price to wages. Each observation is an occupation-county in the U.S. South in the year 1860. Columns 1 and 2 are ordinary least squares. In column 3, the within- and across-location relative shares are instrumented with the Malaria suitability of a county interacted with each occupation, where malaria suitability is the malaria ecology index developed by Kiszewski et al. (2004). In column 4, the within-location relative shares are instrumented with the malaria suitability interacted with each location. In column 5, we fix the implied η at its estimated value from column 5 and only estimate θ by intrumenting the across-location shares with malaria suitability. Log of distance to north calculated using Vincenty distance between county centroids. Implied within location elasticity η calculated assuming labor supply elasticity $\phi = 0.221$. Observations are weighted by the number of free and enslaved workers. Standard errors clustered at the county level are the reported in parentheses. Stars indicate statistical significance: * p<.10 ** p<.05 *** p<.01.

Table 5: Welfare and economic impacts of emancipation

	Welfare impacts			Economic impacts			
	(1) Enslaved persons	(2) Free persons	(3) Slaveholders	(4) Agric.	(5) Manuf.	(6) Services	(7) Total GDP
Slavery	1.000	1.000	1.000	$143.98	$60.74	$86.84	$291.55
No coercion	4.607	1.002	0.976	$136.39	$62.97	$89.51	$288.88
No slaveholders	8.316	1.004	0.000	$151.27	$65.20	$93.97	$310.44
Emancipation (South only)	9.891	1.002	0.000	$132.12	$70.82	$98.47	$301.40
Emancipation	12.923	0.993	0.000	$136.24	$76.85	$105.04	$318.12

Notes: This table reports the aggregate welfare and economic impacts of removing the institution of slavery. Welfare is equivalent variation; economic impacts are measured in dollars per capita per year. No coercion means that enslaved people can choose their own labor supply, No slaveholders means that enslaved people also receive the proceeds of their labor, emancipation (South only) means that enslaved people can also choose their occupation and location but must remain in the U.S. south, and emancipation means they can choose occupations and locations in the U.S. North as well, i.e. they act as free persons.