Slavery and the British Industrial Revolution*

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Abstract

We provide theory and evidence on the contribution of slavery wealth to Britain's economic development prior to the abolition of slavery in 1833. We combine data on individual slaveholders from compensation records, an exogenous source of variation in slavery wealth from weather-induced shocks to mortality of the enslaved during the middle passage, and a quantitative spatial model. Exogenous increases in slavery wealth reduce the agricultural employment share, increase the manufacturing employment share, raise the number of cotton mills, and increase property values. Quantifying our model, we find that slavery wealth raises aggregate income by the equivalent of around a decade of economic growth, and increases local income in places with the greatest involvement in slavery by more than 40 percent.

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1 Introduction

Before the abolition of the slave trade, Europeans forcibly transported millions of enslaved Africans to their colonies. The survivors of transatlantic voyages were forced to labor on sugar, tobacco, cotton, and coffee plantations across the Caribbean, North America, and South America. Europeans amassed significant wealth from the slave trade itself, plantation production, and the extensive triangular trade network connecting Europe, Africa, and the Americas. While recent scholarly attention has predominantly focused on the detrimental impact of slavery on Africa (Nunn 2008; Nunn and Wantchekon 2011), we examine a complementary but equally important question: To what extent did slavery and the wealth it created contribute to Europe's growth and economic development?

We analyse this question for the case of Britain, using novel data on slaveholding and economic activity, exogenous variation in slavery wealth, and a quantitative spatial model. Our data on individual slaveholders were collected under the 1833 British Abolition of Slavery Act. We combine these data on slaveholding with detailed information on economic activity within Britain, including information on the period before Britain's entry into transatlantic slavery in the 1560s. We use exogenous variation in slavery wealth from the mortality of the enslaved during the middle passage. In the age of sail, weather conditions were the primary determinant of middle-passage duration. As sailing times increased, water ran out and infectious diseases spread, sharply increasing middle-passage mortality. This higher mortality directly reduced the wealth of slave traders, and reduced the likelihood of continued involvement in slave trading and slave holding, which lowered the stock of slavery wealth. By the time slaveholding was abolished, Britain was a rapidly industrializing country, having broken free from Malthusian constraints. Using only data up to the 1830s, we show that exogenous increases in slavery wealth in the preceding period are strongly correlated with a lower agricultural employment share, a higher manufacturing employment share, more cotton mills, and higher property values at the time of abolition.

To quantify the aggregate consequences of slavery wealth for Britain's economic development, we develop a quantitative spatial model. As in the conventional specific-factors model, agriculture is land intensive, and manufacturing is capital intensive. Wealth accumulated from slavery is in part invested domestically, which expands the domestic capital stock, and leads to a reallocation of employment away from agriculture towards manufacturing. Domestic capital investments decline with distance, as observed in our data. Hence, capital accumulation and structural transformation mainly occur where slavery wealth is held, thereby promoting local economic development. Within the model, the share of slavery wealth in total wealth in each location is a sufficient statistic for its impact on both aggregate and local economic development. To assess the quantitative implications of our model, we calculate a counterfactual, asking how much poorer Britain in 1833 would have been without its involvement in slavery prior to this date. We find that slavery wealth raises national income by around a decade of growth, and increases local income in locations with the greatest involvement in slavery by more than 40 percent. It also has important distributional consequences, raising returns for capitalists and lowering those of landholders.

We focus on Britain for several reasons: In addition to being the first country to experience an industrial revolution, it was a market-based economy with strong protection of property rights. Detailed data are available on the geography of economic activity. Crucially, compensation records collected under the 1833 Abolition of Slavery Act and the 1837 Slavery Compensation Act provide new, granular information on slaveholding at the individual level. Investment in slave plantations preceded the start of the British Industrial Revolution, which therefore may have benefited from the influx of capital. Importantly, because slavery investment occurred *overseas*, it did not create the headwinds of extractive domestic institutions, distorted labor markets, and the cultural consequences of being a slave-owning society seen elsewhere, including the U.S. South. Nevertheless, the mechanism linking wealth and local economic development in our model applies more generally. Hence we expect it to operate in other contexts in which exogenous increases in wealth stimulate domestic capital accumulation, and expand capital-intensive economic activities.

The idea that slavery and the trade in enslaved human beings jump-started the Industrial Revolution is hotly debated in the economic history literature.[1] One influential line of research argues that Britain accumulated vast wealth from the triangular trade and used this wealth to finance its Industrial Revolution, which is typically referred to as the Williams hypothesis following Williams (1944). There is ample anecdotal evidence that wealth from slaveholding and slave trading was indeed invested in Britain's rapidly expanding industrial and trading sector: For example, the compensation records contain many examples of slaveholders with investments in industrial activities. Of the 15 founders of *Clarke, Acramans, Maze and Co.* (builders of the Great Western Cotton Works in Bristol), eight appear in the slave compensation records, and one is the son of a slaveholder. Sir George Philips, owner of a cotton factory and textile warehouses, filed substantial compensation claims. Nevertheless, another prominent strand of work argues that the profits from the slave trade were no higher than in other lines of business, and profits from the slave trade were small relative to the size of the British economy, such that slavery played a relatively minor role in Britain's industrial development.

[1]For evidence on the impact of slavery on African economic development, see Nunn and Wantchekon (2011) and Nunn (2008). Other related research on the political economy of development includes Acemoglu and Robinson (2012), Papaioannou and Michalopoulos (2014), Dal Bó et al. (2022) and Mayshar et al. (2022).

We make a number of contributions to this debate. First, much of the existing discussion about the Williams hypothesis has focused on the aggregate level of the economy. Since many factors change over time at the economy-wide level, this creates challenges for identification and measurement. In contrast, we exploit geographical variation in slavery participation across locations within Britain, which enables us to control for these other aggregate time-varying factors. We combine novel direct data on slaveholder wealth with detailed information on population, employment structure and property values across locations within Britain over time. Our findings also shed light on the puzzling concentration of manufacturing firms in the area surrounding Liverpool (the leading slave-trading port) and nearby Manchester (Crafts and Wolf 2014). Our results have rich implications for how slavery wealth reshaped the geography of economic development within Britain.

Second, we use exogenous variation in slavery wealth from the mortality of the enslaved during the middle passage. We provide evidence that weather shocks led to longer sailing times. In turn, greater middle-passage duration lead to higher mortality among the enslaved, which reduced the likelihood of continued involvement in the slave trade. We trace the connection between locations and slave traders using the ancestral homes of the latter. Consistent with the close connection between slave trading and slave holding, locations with more successful slave-trading ancestors (with lower accumulated mortality among the enslaved) have higher slaveholding by the time of abolition. To address the concern that having successful slave-trading ancestors could be correlated with other characteristics of locations, we always control for the share of ancestors directly (in the spirit of a shift-share analysis), and we control for a range of observed characteristics. In our balance checks, there are no statistically significant differences between locations with many successful slave-trading ancestors and other locations before Britain's entry into transatlantic slavery. Thereafter, however, significant differences emerge.

We find statistically significant and substantial effects of exogenous variation in slavery wealth on local economic development. In our first-stage regression, we find that a one standard deviation increase in local exposure to successful slave-trading leads to a 0.37 standard deviation increase in slaveholder wealth in 1833. In our second-stage regression, a one standard deviation increase in slaveholder wealth translates into a 0.84 standard deviation increase in property values, a 0.75 standard deviation decrease in agricultural employment, a 0.90 standard deviation increase in manufacturing employment, and a 0.62 and 0.83 standard deviation increase in the average number of cotton mills in 1788 and 1838, respectively.

Third, we develop a quantitative spatial model to evaluate the aggregate and distributional consequences of slaveholding. The model formalizes the idea that slavery wealth accelerates domestic capital accumulation, which leads to a expansion of the capital-intensive manufacturing sector. As long as these domestic investments are decreasing in distance, as is the case empirically, this accumulation of wealth promotes local economic development.

At the aggregate level, we find an increase in national income of 3.5 percent, which corresponds to the equivalent of around a decade of growth of contemporary income per capita. This is in line with the historical estimates in Pebrer (1833) of the relative value of all capital and land in the West Indies and the United Kingdom. Capitalists were the largest beneficiaries with an increase in their aggregate income of 11 percent, both because of the direct income from slavery capital invested in colonial plantations, and because of the induced increase in steady-state domestic manufacturing capital. Landowners experience small aggregate income losses of just under 1 percent, because of the reallocation of labor away from agriculture. Expected worker welfare rises by 3 percent, because of the substantial wage increases in locations with slavery wealth, and the migration of workers to these locations.

At the disaggregated level, we find that access to slavery investments played an important role in shaping the geography of the Industrial Revolution, consistent with our causal estimates using variation in middle-passage mortality. The locations with the greatest levels of participation in slavery investment experience increases in total income of more than 40 percent, with population increasing by 6.5 percent, capitalists' income rising by more than 100 percent, and landlords' income declining by just over 7 percent.

The remainder of the paper is structured as follows. Section 2 reviews the related literature. Section 3 discusses the historical background. Section 4 introduces our data. Section 5 provides motivating evidence on patterns of slaveholding and economic activity within Britain over time. Section 6 develops our theoretical model. Section 7 reports our main causal estimates and our quantitative analysis of the model. Section 8 summarizes our conclusions.

2 Related Literature

There is a large literature examining the links between slavery and Britain's Industrial Revolution. The idea that riches derived from slavery accelerated economic development is almost as old as capitalism itself – and so are the counterarguments. Adam Smith considered slavery and the colonial system economically inefficient. On the other hand, in 1788, when the British parliament debated the possible abolition of slavery, merchants involved in the trade argued that "the effects of this trade to Great Britain are beneficial to an infinite Extent ... [and] ... were this [trade to be] abolished, it would [cause] very great Detriment to our Manufacturers...." (Eltis and Engerman 2000). Karl Marx (1867), in "Das Kapital," famously opined that "the veiled slavery of the wage-workers in Europe needed, for its pedestal, slavery pure and simple in the new world..." In 1944, Eric Williams (1944) argued

> "Britain was accumulating great wealth from the triangular trade. ...that trade inevitably [increased] ... the productive power of the country... the investment of profits from the triangular trade in British industry ... supplied ... the huge outlay for the construction of vast plants to meet the needs of the new productive process..."

Williams' hypothesis stimulated a large body of academic research on links between the triangular trade and industrial development in Britain. Historians of the 'world system of capitalism' in the vein of Immanuel Wallerstein and Gunder Frank have argued that economic development in the European 'core' cannot be separated from exploitation and political suppression in the periphery (Frank 1967, Wallerstein 2004), emphasizing the importance of capital accumulation.

The Williams hypothesis is part of a broader debate about the contribution of slavery to economic development in enslaving countries, including the United States. On the one hand, Fogel (1989) argues that the rise of slavery in America was driven by economic factors, and that slavery persisted for as long as it did because it was economically profitable. On the other hand, Wright (2006) argues that although slave-based wealth was a crucial factor in the growth of banks and railroads in the South, it hindered the development of labor-saving technologies in agriculture.[2] A key difference of our setting with the United States is that there, slavery occurred domestically, directly affecting capital accumulation, the local labor market, and domestic institutions. In contrast, British involvement in slavery was through the slave trade and overseas plantations, allowing us to focus on the impact of slavery wealth on economic development through these channels.

Acemoglu et al. (2005) emphasize that, in North—Western Europe, growing Atlantic trade led to better institutions by strengthening the hand of merchants. This Atlantic trade included the trafficking of enslaved Africans and trade in the products produced on slave plantations. One line of research on the Williams hypothesis emphasizes the profits derived from this trade. Price and Whatley (2020) examine the financial impact of the South Sea Company's temporary monopoly on the trade of enslaved Africans to Spanish America (the Asiento de Negros). Using data on slave-trading voyages from British and European ports over time, Derenoncourt (2019) estimates the contribution of the slave trade to city population growth. But the profitability of the slave trade itself has been disputed. For example, Eltis and Engerman (2000) examine the aggregate effects of the slave trade and conclude "African slavery ... did not ... cause the British Industrial Revolution ... ." Similarly, Findlay (1990), argues "slavery was an integral part

[2]More recently, Francis (2021) emphasizes the role played by the tariff revenue derived by the Federal Government from the imports that were made possible by the export of the cotton produced by slave plantations, while Bleakley and Rhode (2021) find lower land values South of the border between free and slave states.

of a complex ... system of trade in goods and factors within which the Industrial Revolution ... emerged... [but there is] no causal arrow from slavery to British industrialization."

A second vein of work stresses that the slave trade was only one aspect of the slave economy. Wealth was also accumulated through slave holding, the trade in the products of slave plantations, and the wider triangular trade to which it gave rise, as emphasized in Darity (1990) and Berg and Hudson (2023). Indeed, Solow (1985, 1993) argues that the profits from slave-holding were an order of magnitude greater than direct profits from the slave trade itself.[3] Other historians have cast doubt on this idea. Thomas and Bean (1974) calculates that Britain did not profit from slave plantations producing colonial produce, while Ragatz (1928) argues that planters in the West Indies barely covered their cost and that profitability declined from the 1750s onwards. But these claims have been disputed by Drescher (2010).

There is a tendency in this debate to coalesce towards one of the two extremes, where slavery was either the primary cause or largely irrelevant for Britain's Industrial Revolution.[4] Distinguishing between these two extremes and more moderate positions is challenging at the aggregate level. We therefore exploit micro-geographic variation in slaveholding across locations within Britain, which allows us to abstract from other aggregate shocks. We exploit a new source of exogenous variation in slavery wealth from middle-passage mortality among the enslaved. Our quantitative spatial model allows us to derive a nuanced quantitative estimate of how much slavery wealth affected aggregate economic development and the geography of economic activity within Britain.

Our research is also related to the wider literature on structural transformation and economic development, including Uy et al. (2012), Herrendorf et al. (2012), Bustos et al. (2016), Gollin et al. (2016), and Caprettini and Voth (2020). We contribute to research on the geography of the British Industrial Revolution (Crafts and Wolf 2014), and to work on the role of financial development in economic growth, including Gerschenkron (1962), Guiso et al. (2004), Moll (2014), Itskhoki and Moll (2019), and Heblich and Trew (2019).

Although our focus is on the role of slavery wealth in stimulating domestic capital accumulation in Britain, the mechanism in our model finds empirical support in other contexts. Focusing on slavery wealth, González et al. (2017) provide empirical evidence that this slavery wealth was an important source of collateral used to finance U.S. entrepreneurship. Using another source of quasi-experimental variation in wealth from the adoption of genetically engineered soy in Brazil, Bustos et al. (2020) finds that the resulting capital accumulation led to

[3] According to conventional estimates, profits from slave trading amounted to around 0.5 percent of GDP. In contrast, Solow (1993) estimates that profits from slaveholding were around 5 percent of GDP, or roughly 80 percent of total domestic investment.

[4] For a discussion of the wide range of proposed determinants of the Industrial Revolution, see for example Deane (1967) and Caprettini et al. (2022).

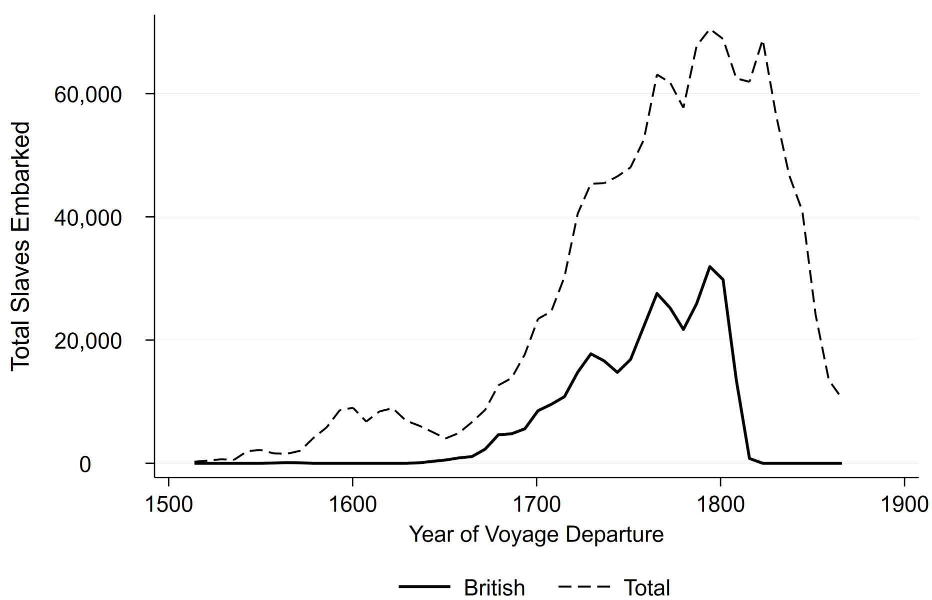
structural transformation towards industry and services.

3 Historical Background

Britain's involvement in the slave trade dates back to the 1560s and expanded substantially after 1640. In 1660, the Royal African Company was granted a monopoly over English trade with the West Coast of Africa, including the slave trade. However, following the Glorious Revolution of 1688 and the accession of William III, this monopoly was broken up; subsequent slave voyages were financed and organized by private ship owners, acting alone or in partnership.

By the 1700s, the 'triangular trade' from Europe-Africa-Americas was the mainstay of the British West Coast ports of Bristol and Liverpool. This trade involved the export of manufacturing goods, including textiles, from Britain to the West Coast of Africa; the transportation of enslaved persons from the West Coast of Africa to the Americas; and the export of plantation products such as sugar, tobacco, coffee and cotton from the Americas to Britain.

Figure 1: Slave Trade - Annual Total of Enslaved Persons Shipped, British vs ROW



Note: Annual total number of enslaved persons transported across the Atlantic ocean using ships from British ports and ships from all nations.

Figure 1 shows the annual number of enslaved persons transported across the Atlantic by ships from British ports (solid line) and ships from all nations (dashed line). From 1701-1807, British ships are estimated to have carried over 2.5 million enslaved persons, more than one third of the over 6 million total transported during this period.[5] The British slave trade was

[5]The total number of enslaved persons embarked, including years after 1807, was 10.6 million (Eltis 1984).

concentrated in three British ports: Liverpool (49 percent); London (29 percent); and Bristol (21 percent); with all other ports accounting for only 1 percent of trade.

The wealth accumulated from the slave trade and slaveholding was far from evenly distributed within Britain. James Penny, who was heavily involved in the slave trade, predicted instant ruin from its abolition for the British towns most exposed to it: "[s]hould this trade be abolished, it would not only affect the Commercial Interest . . . of the County of Lancaster, and more particularly the Town of Liverpool, whose fall, . . . would be as rapid as its Rise has been astounding." (Eltis and Engerman 2000).

Over time, reports of barbaric conditions on slave ships led to a campaign for the abolition of the slave trade.[6] In response to this growing agitation, the Abolition of the Slave Trade Act was passed in 1807, which prohibited the slave trade (but not slavery) in the British Empire. Some abolitionists hoped that slavery would be unsustainable without the slave trade, but further legislation was delayed by the Revolutionary Wars. Eventually, the Slavery Abolition Act of 1833 was passed, making the ownership of enslaved persons illegal within the British Empire (Taylor 2020).

Slaveholders were required under the 1833 Act to register claims for the number of enslaved persons held, which were systematically collected and processed by a Slave Compensation Committee. Separate schedules were drawn up for each colony that specified a compensation rate per slave that depended on age and occupation.[7] Compensation was paid under the subsequent Slavery Compensation Act of December 1837, after a commission had assessed all claims. Overall, the British government spent £20 million to compensate slaveholders, equivalent to 40 percent of government revenue or 5 percent of GDP (Barro 1987). Additionally, formerly-enslaved persons were forced to work without remuneration for up to six years under an "apprenticeship" system.

We use the data from the records of the compensation committee as a census of wealth from slaveholding in Britain at the time of abolition in the mid-1830s. We focus on the causal impact of this accumulated wealth from slaveholding on Britain's economic development up the 1830s. We do not examine the impact of the compensation payments themselves on economic development after 1838, the earliest date at which compensation was paid out (and often much later), in order to abstract from issues of Ricardian equivalence from the future tax implications of the financial payments made to slaveholders.

[6] Black African writers played an important role in making these barbaric conditions more widely known, including Equiano (1789). For further discussion of the abolitionist campaigns, see Taylor (2020).

[7] See Figure S.2.3 in Online Supplement S.2.3.1 for an example of such a compensation schedule.

4 Data

We construct a new spatially-disaggregated dataset on slaveholding and economic activity in England and Wales.[8] We combine seven main data sources: (i) individual-level data on slaveholding based on compensation claims paid under the 1833 Abolition of Slavery Act and 1837 Slavery Compensation Act; (ii) individual slave-trading voyages from British ports; (iii) population and employment structure; (iv) property valuations; (v) location of cotton mills; (vi) family linkages; (vii) ship logbooks.[9]

Slaveholding. We use data from the *Legacies of British Slavery Database* to measure the geographical distribution of slavery wealth within Britain at the time of the abolition of slavery in 1833. Starting with the records of the Slave Compensation Committee, this database was constructed over more than a decade by the *Centre for the Study of the Legacies of British Slavery* at University College London. The data include detailed information on compensation claims, the identity of the awardees, the legitimacy of their claims, and the ownership records of awardees. Data include information on 25,000 individuals who were awarded compensation for 425,000 enslaved persons.

In Online Supplement S.2.3.1, we provide an example of the entry from this database for the Second Earl of Harewood. We observe name, date of birth and death, biographical information including family history, address, the name and location of each colonial plantation, and the compensation awarded and number of enslaved persons for each plantation.

We find a tight and approximately log linear relationship across slaveholders between the value of slavery compensation paid and the number of enslaved persons claimed.[10] We use the number of enslaved persons claimed for compensation purposes as our baseline measure of slaveholding in our regressions. We construct a measure of the wealth derived from slaveholding using the compensation payments, which we use in our quantitative analysis of the model. We use information on domestic investments made by slaveholders from the compensation records to estimate the relationship between these investments and distance from each slaveholder' address. We find a large, negative and statistically significant coefficient on distance, consistent with our assumption in the model that investments are geographically concentrated.

[8] We focus on England and Wales because the population census is reported separately for these two countries; our historical property valuation data is unavailable for Scotland; and the Act of Union with Scotland occurs later in 1707 after the start of slave trading from the British Isles.

[9] See Online Supplement S.2.3 for further details about the data sources and definitions.

[10] See Figure S.2.4 in Online Supplement S.2.3.1 for a binscatter of this relationship.

Slave voyages. We use the slave voyages dataset constructed by Herbert Klein and collaborators.[11] This database contains information on 36,000 slave voyages, with a total of over 10 million enslaved persons shipped across the Atlantic from 1526 onward. Of these, 10,785 voyages were conducted by British owners, involving the transportation of 2.9 million enslaved persons from 1562 to the Abolition of the Slave Trade in 1807. For each voyage, we know the names of (up to) eight owners; the port of origin; the ports visited on the African coast; and the final destination. For a subset of voyages, we also observe the duration of the voyage, and the number of enslaved embarked and disembarked. From this, we construct a voyage mortality rate, which we use for our IV-strategy.

Population and Employment Structure. We use data on parish population from 1801-1831 from the population census (see Wrigley 2011). We supplement these population census data with information from the *History Database of the Global Environment* (Hyde) for years before 1801 (see Klein Goldewijk et al. 2017). Data on employment structure by parish in 1831 come from Southall et al. (2004). We distinguish employment in agriculture, as well as in manufacturing.

Cotton Mills. We construct two sets of data on the location of cotton mills within England and Wales. First, we digitized data on the number of cotton mills in each parish for the year 1838, as reported in House of Commons (1839). This parliamentary report summarizes the results of factory inspections under the Factory Act and contains the most comprehensive data on industrial establishments in Britain before the start of the Census of Production during the 20th century. Second, we digitized data on the location of 212 British cotton mills that were erected in the early decades of the Industrial Revolution from 1768-88 from Colquhoun, as revised and extended by Chapman (1981).

Property Valuations. We use a number of different sources of data on property valuations for each parish. For the year 1086, we construct the value of land, buildings and equipment for each parish from the Domesday Book, using the digitized data for each manor in PASE (2010). For the year 1334, we use the value of personal property (excluding land and buildings) for each parish from the Lay subsidies, as compiled by Glasscock (1974) and Campbell and Bartley (2006). For the year 1798, we digitized the data on the land tax quotas for each parish, as reported in House of Commons (1844). These land tax quotas were originally specified in 1690, and were subject to gradual amendment over time (Ginter 1992). In 1798, these land tax quotas were made unalterable by law; they remained unchanged until abolished in 1963. For the years 1815 and 1843, we digitized rateable values for each parish, which correspond to the

[11] Available online at www.slavevoyages.org.

market value of the annual flow of rent for the use of land and buildings. With a few minor exceptions, these rateable values include all categories of land and property, and were used to raise revenue for local public goods.

Family Linkages. We link the location of slaveholders in 1833 to that of slave traders' ancestors. Many individuals involved in the slave trade either returned to their ancestral home areas, or continued to have family there (who would inherit, or benefit from their relative's expertise). From the Slave Voyages database (see above), we identify individuals involved in the slave trade. We then link slave traders to locations using genealogical information. For each slave trader, we find the largest family tree containing this person from `Ancestry.com`. and extract the universe of the slave trader's parents, grandparents, and great-grandparents (as far as these are available). These we locate geographically based on birth address (or death address if birth address is unavailable).

CLIWOC weather data To isolate the effect of weather on voyage outcomes, we use CLIWOC weather data (García-Herrera 2007). The database contains 0.3 million observations on weather conditions from merchant log books for the period 1750-1850. We focus on ships in the Atlantic at the same time as slave ships (same week).

Data Structure. To overcome changes in the boundaries of administrative units such as parishes over time, we construct a hexagonal spatial grid over England and Wales, consisting of 849 cells ("regions").[12] Each grid cell covers an area of 200 square kilometers and the distance from the centroid to the vertex measures around 9 km. Since the dominant mode of commuting during our sample period was walking, 9 km is a reasonable maximum distance over which it would be possible to walk to work. A further advantage of this grid cell structure is that it is straightforward to examine the robustness of our results to alternative sizes of grid cells, as discussed below. We assign our data to grid cells either based on exact geolocated addresses (e.g., for slaveholder addresses) or the latitude and longitude coordinates of the centroids of parishes (e.g., for our population census data). With around 10,000 parishes in England Wales, each parish is small relative to the area of our 849 grid cells.

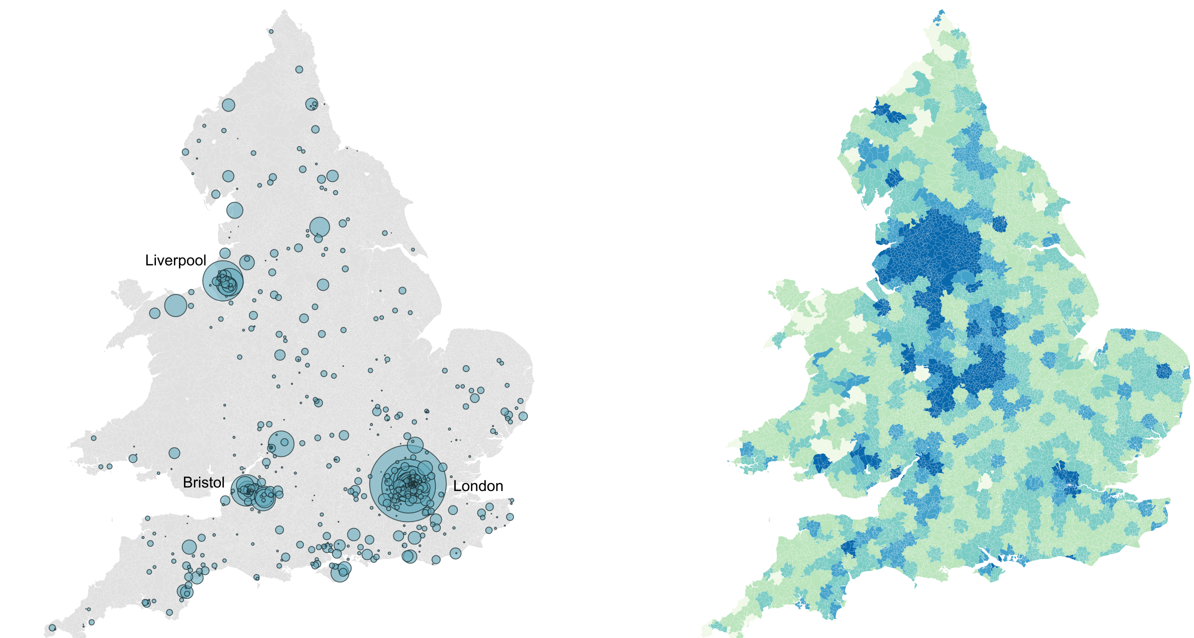
5 Motivating Evidence

We begin by providing some motivating evidence on patterns of slaveholding and economic activity in England and Wales. In Figure 2a, we show the spatial distribution of slaveholder compensation in 1833 in England and Wales. To provide as fine a level of spatial resolution

[12] We choose hexagons (rather than squares or triangles) because of their advantages for partitions of geographical space, as discussed for example in Carr and Pickle (2010).

as possible, we display slavery wealth in this figure at the parish level. The size of the blue circles is proportional to the amount of slavery compensation awarded in current price 1833 pounds sterling. There is a close relationship between slaveholding and slave trading. The areas with the largest concentrations of slaveholding surround the three ports that were most heavily involved in the slave trade: Liverpool in the North-West, Bristol in the South-West, and London in the South-East. But slaveholding extends throughout much of England and Wales, particularly in coastal regions, and in the main population centers.

Figure 2: Slaveholding and Structural Transformation in the 1830s



(a) Slaveholder Compensation in 1833

(b) Manufacturing Employment Share in 1831

Note: *Left panel*: Slaveholder compensation in each parish in 1833 pounds sterling; size of blue circles proportional to the total value of slaveholder compensation in each region. The largest three slave trading ports by enslaved persons embarked are labelled. *Right panel*: Manufacturing employment share in each region in the 1831 census; darker blue colors correspond to higher values; lighter green colors correspond to lower values.

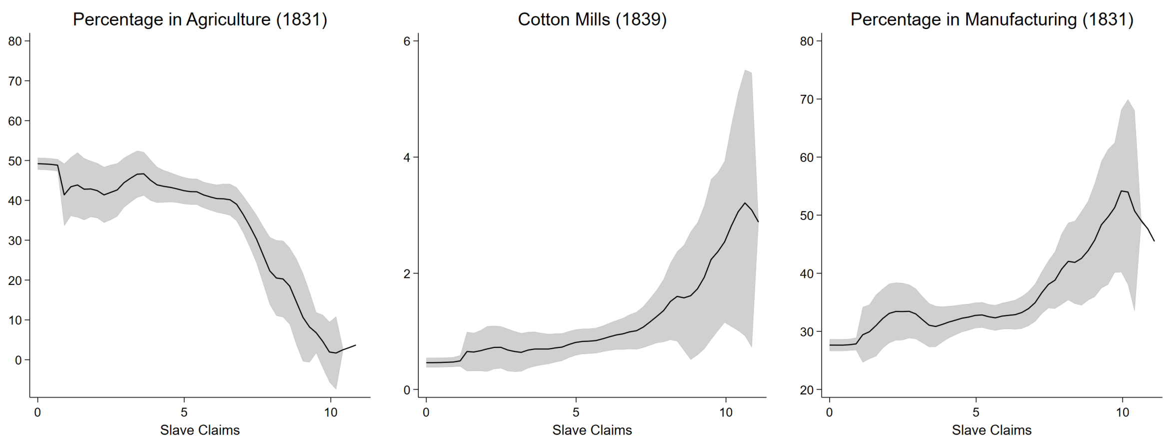
In Figure 2b, we show the manufacturing employment share in each of our hexagonal regions in 1831. By that time, the manufacturing employment share for England and Wales as a whole was approximately 42%, and we see the emergence of industrial agglomerations in the North. However, agriculture still employs approximately 27% of the population. There is substantial heterogeneity in agricultural specialization across regions, with agriculture still accounting for more than 60% percent of employment in some counties.[13] Comparing the

[13]See Figure A.1 in Online Appendix A.1 for a corresponding map of agricultural employment shares. Along similar lines, Crafts (1985) reports a share of male employment in industry later, in 1840, of 47.3%.

two figures, manufacturing employment shares and slaveholder compensation are positively correlated.

In Figure 3, we provide further evidence on this correlation between structural change and slaveholding using three different indicators: the agricultural employment share in 1831 (left panel), the number of cotton mills in 1838 (middle panel),[14] and the industry employment share in 1831 (right panel). We show the fitted values and 95 percent confidence intervals from local polynomial regressions of all three measures on the number of enslaved persons claimed in 1833. Areas with greater slaveholding have lower agricultural employment shares, more cotton mills, and higher manufacturing employment shares.

Figure 3: Structural Transformation and Slaveholding in the 1830s



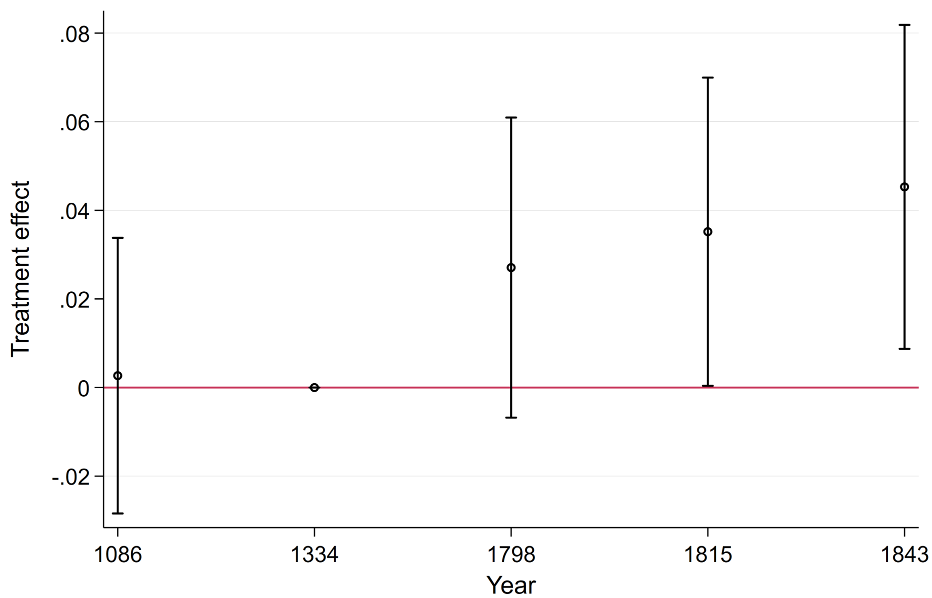
Note: In all three panels, the horizontal axis shows total number of enslaved in each hexagon in 1833; vertical axes show agricultural employment share in 1831 (left panel), number of cotton mills in 1839 (middle panel), and manufacturing employment share in 1831 (right panel); dark line shows fitted values from local polynomial regression; gray shading shows 95 percent confidence intervals. Slave claims and the number of cotton mills are inverse hyperbolic sine transformed.

A natural concern about this cross-sectional correlation is that regions that were already wealthy before Britain's involvement in slavery could have subsequently invested more in slave holding. We now show that we find no evidence of statistically significant differences in property values between areas with high and low values of our instrument before Britain's entry into the slave trade. Figure 4 illustrates this using an event-study specification. The figure shows the estimated coefficients from a panel regression of property values on slavery compensation payments interacted with year indicators. The excluded category is the last

[14]Strictly speaking, the location of mills in 1838 is measured after the abolition of slaveholding. However, it seems highly unlikely that the disbursal of funds, rather than prior developments, are reflected in industry location – the 1830 census shows the strength of industrial development. Crucially, compensation was only paid after December 1837, when the Slavery Compensation Act was passed – less than 12 months before the location of textile mills was recorded.

year for which we have property values before Britain's entry into the slave trade (1334). We include location fixed effects, year dummies, and controls for latitude and longitude (linear and squared) and population in 1000 interacted with year dummies. We find no evidence of pre-trends before Britain's entry into the slave trade. In contrast, we find a substantial and statistically significant increase in property values in locations with greater slavery wealth after Britain's entry into the slave trade. We regard these findings as suggestive, because we only have data on slavery wealth in 1833, and our property values data are missing for some locations in years before 1798. We provide further evidence in support of a causal interpretation of the relationship between slavery wealth and local economic development in our instrumental variables estimation in Section 7 below.

Figure 4: Property Valuations by Year and Number of Enslaved Persons Claimed in 1833



Note: The figure shows the estimated coefficients β_τ from the panel regressions $RV_{it} = \sum_{\tau \setminus \{1334\}} \beta_\tau \mathbf{I}(\tau = t) \times S_i + \mu_i + f(i,t) + \epsilon_{it}$ for $\tau = \{1086, 1334, 1798, 1815, 1843\}$. RV_{it} are property values in hexagon region i at time t; $\mathbf{I}(\tau = t)$ is an indicator function for a specific year $t \in \tau$; S_i are 1833 slave compensation payments in region i; μ_i are region fixed effects; $f(t,i)$ are flexible time trends for interactions between year indicators and (i) geographic locations (latitude, latitude squared, longitude, longitude squared) and (ii) population in the year 1000 (IHS-transformed); and ϵ_{it} is an iid error term. Standard errors are clustered at the level of hexagon region i. Rateable values and slavery compensation payments are inverse hyperbolic sine (IHS) transformed. The error bars show 95%-confidence intervals.

6 Theoretical Model

To understand the mechanisms linking slavery wealth and economic development, we develop a simple theoretical model of economic development and structural transformation.[15] We consider a conventional specific-factors model, in which agriculture is land-intensive and manufacturing is capital-intensive. We extend this framework to incorporate population mobility across locations within Britain and investment in colonial slave plantations.

We compare the actual world in which Britain has access to these colonial slavery investments to a counterfactual world in which it does not. We show that access to these colonial slavery investments expands the set of investment opportunities, and raises the rate of return to capital accumulation. This increase in the rate of return to capital accumulation leads to a higher steady-state *domestic* capital stock in the actual world with investments in colonial slave plantations than in the counterfactual world without. This domestic capital accumulation causes an expansion of the capital-intensive manufacturing sector, and a contraction of the land-intensive agricultural sector.

We allow the financial frictions to investing in colonial slave plantations to vary geographically within Britain, with distance from slave ports and family connections to the slave trade. To match our empirical findings that domestic investments satisfy a gravity equation, we also assume domestic financial frictions such that investments are concentrated locally. Under these assumptions, the higher steady-state domestic capital stock in locations with better access to colonial slavery investments leads to an expansion in the local manufacturing sector, a contraction in the local agricultural sector, and an increase in local population density.

Although we focus on colonial investments in slave plantations, because we observe them in our data, our mechanism applies more generally to other colonial investments. This mechanism is nevertheless especially powerful for colonial investments in slave plantations for two main reasons. First, labor costs for these investments were determined by the price of slaves rather than the wage of free workers, implying lower labor costs and higher profitability (otherwise free workers would have been used by revealed preference). Second, these investments were especially collateralizable, because enslaved people were treated as property.

6.1 Model Setup

We consider a set of small open economies: many domestic locations indexed by $i, n \in \{1, \ldots, N\}$ and a colonial plantation $\mathbb{N}$. Time is discrete and indexed by t.

The world economy includes four types of agents: workers, capitalists, landlords and en-

[15] For a more detailed exposition of the model and the derivation of all theoretical results in this section of the paper, see Online Supplement S.2.1.

slaved persons. Workers, capitalists and landlords are located in the domestic economy. Enslaved persons work in the colonial plantation. There are three sectors of economic activity: agriculture and manufacturing (produced in the domestic economy) and plantation products (produced in the colony). Agriculture is produced with labor and land. Manufacturing is produced with labor and capital. Workers are mobile between the two domestic sectors. But land and capital are specific factors that only can be used in agriculture and manufacturing respectively. Enslaved persons and capital produce plantation goods.[16]

Workers are endowed with one unit of labor that is supplied inelastically. They are geographically mobile across locations within the domestic economy, but geographically immobile between the domestic economy and the colonial slave plantation. Landlords in each domestic location are geographically immobile and own local land (m_n).

Capitalists are geographically immobile and own local capital (k_{nt}). Each period, they allocate capital to either local manufacturing or to plantation production. They also make a dynamic consumption-investment decision. They can either invest their assets (a_{nt}) in capital (k_{nt}) or a consumption bond that pays a constant rate of return ρ. Investments in capital are subject to collateral constraints, such that capitalists can only invest a multiple of their current assets: $k_{nt} \leq \lambda_n a_{nt}$. If they invest in capital, they observe idiosyncratic draws for the productivity of each unit of capital if invested in each location. These idiosyncratic productivity draws give rise to a downward-sloping Keynesian marginal efficiency of capital schedule for each location, and imply that investments are imperfect substitutes across locations, as in the recent research on asset demand systems.

Capitalists face financial frictions, such that $\phi_{nit} \geq 1$ units of capital must be invested from location n in order for one unit to be available for production in location i. We allow domestic locations n to differ in their financial frictions of investing in the colonial slave plantation ($i = \mathbb{N}$), consistent with the observed variation in slaveholding across domestic locations in the data. We also assume that domestic locations n face financial frictions investing in other domestic locations $i \neq n$, consistent with the observed decline in domestic investments with distance in the data. In our baseline specification, we assume for simplicity that these financial frictions to other domestic locations are prohibitive, such that all domestic investments occur locally. In Online Supplement S.2.2, we develop an extension, in which capitalists can invest in any domestic location subject to financial frictions that increase with distance.

[16]For simplicity, we abstract from land use in plantation products and capital use in agriculture, although both can be introduced. What matters is that plantation products and domestic manufacturing both use capital, and domestic manufacturing is more capital-intensive than domestic agriculture.

6.2 Preferences and Endowments

The indirect utility function for a worker ϑ in location n at time t ($u_{nt}(\vartheta)$) depends on the wage (w_{nt}^L), the consumption goods price index (p_{nt}), amenities that are common across workers (B_{nt}), and an idiosyncratic amenity draw ($b_{nt}(\vartheta)$) that captures all the idiosyncratic reasons why an individual worker can choose to live in a particular location:

$$u_{nt}(\vartheta) = \ln B_{nt} + \ln w_{nt}^L - \ln p_{nt} + \kappa \ln b_{nt}(\vartheta), \tag{1}$$

where the parameter κ regulates the heterogeneity in idiosyncratic amenities. The consumption goods price index (p_{nt}) depends on the price of agriculture (p_{nt}^A), the price of manufacturing (p_{nt}^M) and the price of plantation products (p_{nt}^S):

$$p_{nt} = \left[\left(p_{nt}^A/\beta_t^A\right)^{1-\sigma} + \left(p_{nt}^M/\beta_t^M\right)^{1-\sigma} + \left(p_{nt}^S/\beta_t^S\right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{2}$$

where (β_t^A, β_t^M, β_t^S) are taste parameters that control the relative weight of the three goods in utility; we assume inelastic demand between the three sectors ($0 < \sigma < 1$), as in the macroeconomics literature on structural transformation.

Each location is connected to world markets through iceberg trade costs that can differ across sectors ($\tau_{it}^A \geq 1$, $\tau_{it}^M \geq 1$, $\tau_{it}^S \geq 1$) and faces exogenous prices for each good on world markets (p_t^{AW}, p_t^{MW}, p_t^{SW}).[17] Therefore, no-arbitrage implies that the local prices of the three goods (p_{nt}^A, p_{nt}^M, p_{nt}^S), and hence the local consumption price index (p_{nt}), are pinned down by these iceberg trade costs and exogenous world market prices.

6.3 Technology

Each good is produced under conditions of perfect competition using constant returns to scale Cobb-Douglas technologies. Cost minimization and zero profits imply that price equals unit costs if a good is produced:

$$p_{it}^A = \frac{1}{z_{it}^A} \left(q_{it}\right)^{\alpha^A} \left(w_{it}^L\right)^{1-\alpha^A}, \qquad i \in \{1, \ldots, N\}. \tag{3}$$

$$p_{it}^M = \frac{1}{z_{it}^M} \left(r_{it}\right)^{\alpha^M} \left(w_{it}^L\right)^{1-\alpha^M}, \qquad i \in \{1, \ldots, N\}. \tag{4}$$

$$p_{\mathbb{N}t}^S = \frac{1}{z_{\mathbb{N}t}^S} \left(r_{\mathbb{N}t}\right)^{\alpha^S} \left(w_{\mathbb{N}t}^S\right)^{1-\alpha^S}, \tag{5}$$

where z_{it}^j denotes productivity for sector $j \in \{A, M, S\}$; q_{it} is the domestic agricultural land rent; r_{it} is the domestic rental rate per effective unit of capital; $r_{\mathbb{N}t}$ is the exogenous rental rate

[17] While our baseline specification assumes for simplicity that locations are small open economies that face exogenous world market prices, we can also allow for an endogenous terms of trade.

per effective unit of capital in the colonial slave plantation; $w_{\mathbb{N}t}^{S}$ is the exogenous shadow cost of enslaved labor; and $0 < \alpha^{A}, \alpha^{M}, \alpha^{S} < 1$.

The equilibrium wage (w_{it}^{L}) is determined by the equality of labor's value marginal product in agriculture and manufacturing for each domestic location where both these goods are produced. Given prices (p_i^A, p_i^M), productivity (z_i^A, z_i^M), land supply (m_i), capital allocated to domestic manufacturing (k_{it}^{M}) and total employment (ℓ_{it}) for a given location i, the model behaves as in the conventional specific-factors model. In contrast to this conventional framework, both the capital allocated to domestic manufacturing k_{it}^{M}) and total employment (ℓ_{it}) are endogenous, and the capital stock (k_{it}) is determined by consumption-saving decisions.

6.4 Labor Market Clearing

After observing her idiosyncratic amenity draws ($b_n(\vartheta)$), each worker chooses her preferred domestic location. We make the conventional assumption that idiosyncratic amenities are drawn from an extreme value distribution: $F\left(b\right) = \exp\left(-\exp\left(-b-\overline{\gamma}\right)\right)$, where $\overline{\gamma}$ is the Euler-Mascheroni constant. Using this assumption, the share of workers who choose to live in location n depends on relative amenity-adjusted real wages, and takes the logit form:

$$\mu_{nt} = \frac{\ell_{nt}}{\bar{\ell}_t} = \frac{\left(B_{nt} w_{nt}^{L} / p_{nt}\right)^{1/\kappa}}{\sum_{k=1}^{N} \left(B_{kt} w_{kt}^{L} / p_{kt}\right)^{1/\kappa}}, \tag{6}$$

where $\bar{\ell}_t$ is total domestic employment, such that labor market clearing implies $\sum_{i \in N} \ell_{it} = \bar{\ell}_t$. Worker expected utility taking into account the idiosyncratic productivity draws is:

$$\mathbb{U}_t = \kappa \log \left[\sum_{k=1}^{N} \left(B_{kt} w_{kt}^{L} / p_{kt}\right)^{1/\kappa} \right]. \tag{7}$$

Intuitively, expected utility increases in amenities (B_{nt}) and wages (w_{nt}^{L}) in each location, and decreases in the consumption price index (p_{nt}) in each location.

6.5 Capital Allocation Within Periods

At the beginning of period t, the capitalists in location n inherit an existing stock of capital k_{nt}, and decide where to allocate this existing capital, and how much to consume and invest. Once these decisions have been made, production and consumption occur. At the end of period t, new capital is created from the investment decisions made at the beginning of the period, and the depreciation of existing capital occurs. In the remainder of this subsection, we characterize capital allocation decisions at the beginning of period t. In the next subsection, we characterize optimal consumption-investment decisions.

Given our assumptions on financial frictions, capital can be allocated either locally (k_{nnt}) or to the colonial slave plantation ($k_{n\mathbb{N}t}$). The productivity of capital in each of these uses is subject to idiosyncratic productivity draws (ϵ_{nnt}, $\epsilon_{n\mathbb{N}t}$) for effective units of capital, as in Kleinman et al. (2023). These idiosyncratic productivity draws correspond to Keynesian marginal efficiency of capital shocks, and give rise to imperfect substitutability of investments across locations.[18] The return to a capitalist from location n of investing a unit of capital in destination i ($v_{nit}(\epsilon_{nit})$) depends on the rental rate per effective unit (r_{it}), the number of effective units (ϵ_{nit}) and financial frictions (ϕ_{nit}): $v_{nit}(\epsilon_{nit}) = \epsilon_{nit} r_{it}/\phi_{nit}$. We assume that these idiosyncratic productivity shocks (ϵ_{nit}) are drawn independently from a Fréchet distribution: $F(\epsilon) = e^{-\epsilon^{-\theta}}$. The shape parameter $\theta > 1$ controls the dispersion of these shocks. We normalize the scale parameter to one, because it enters the model isomorphically to financial frictions (ϕ_{nit}).

Using the properties of this Fréchet distribution, the shares of capital allocated to each location depend on relative rental rates (r_{it}) and financial frictions (ϕ_{nit}):

$$\xi_{nit} = \frac{k_{nit}}{k_{nt}} = \frac{(r_{it}/\phi_{nit})^{\theta}}{\sum_{m \in \{n,\mathbb{N}\}} (r_{mt}/\phi_{nmt})^{\theta}}, \qquad i \in \{n, \mathbb{N}\}. \tag{8}$$

Both local domestic manufacturing and the colonial slave plantation face an upward-sloping supply function for capital, such that each must offer a higher rental rate (r_{it}) in order to attract a larger share of capital (ξ_{nit}). If some domestic locations n have better information about slavery investments, for example through ancestral links to the slave trade, this is reflected in lower financial frictions for colonial slavery investments (lower $\phi_{n\mathbb{N}t}$), and hence a higher share of capital invested in the colonial slave plantation $\mathbb{N}$ (higher $\xi_{n\mathbb{N}t}$).

Capital market clearing implies that the capital employed in local manufacturing (k^M_{nt}) equals the capital allocated locally (k_{nnt}). Similarly, the capital employed in the colonial slave plantation ($k^S_{\mathbb{N}t}$) equals the capital allocated there from all domestic locations $n \in N$:

$$k^M_{nt} = k_{nnt} = \xi_{nnt} k_{nt}, \qquad\qquad k^S_{\mathbb{N}t} = \sum_{n=1}^{N} k_{n\mathbb{N}t} = \sum_{n=1}^{N} \xi_{n\mathbb{N}t} k_{nt}, \tag{9}$$

where $\xi_{nnt} + \xi_{n\mathbb{N}t} = 1$. As an investment location i attracts a larger share of capital from an ownership location n (ξ_{nit}), it receives units of capital with lower realizations for idiosyncratic productivity, and hence moves further down its marginal efficiency of capital schedule, reducing the average productivity of capital. Therefore, we can write the capital market clearing condition (9) in productivity-adjusted terms as:

$$\widetilde{k}^M_{nt} = \gamma \xi_{nnt}^{-\frac{1}{\theta}} k_{nnt} = \gamma \xi_{nnt}^{\frac{\theta-1}{\theta}} k_{nt},$$

[18] This imperfect substitutability is consistent with slavery investments being concentrated in cane sugar, tobacco, cotton and coffee, none of which could be efficiently produced domestically at the time. It is also in line with the theoretical and empirical literature on asset demand systems following Koijen and Yogo (2019).

$$\widetilde{k}^S_{\mathbb{N}t} = \sum_{n \in \mathbb{N}} \gamma \xi_{n\mathbb{N}t}^{-\frac{1}{\theta}} k_{n\mathbb{N}t} = \sum_{n \in \mathbb{N}} \gamma \xi_{n\mathbb{N}t}^{\frac{\theta-1}{\theta}} k_{nt},$$

where we use the tilde above the capital stock to denote the productivity-adjustment; $\gamma \xi_{nit}^{-\frac{1}{\theta}}$ is the average productivity of capital; $\gamma \equiv \Gamma\left(\frac{\theta-1}{\theta}\right)$; and $\Gamma(\cdot)$ denotes the Gamma function.

Again using the properties of the Fréchet distribution, the expected return to capital taking into account the idiosyncratic productivity draws is equalized across locations:

$$v_{nt} = v_{nnt} = v_{n\mathbb{N}t} = \gamma \left[\sum_{m \in \{n, \mathbb{N}\}} \left(r_{mt} / \phi_{nmt} \right)^{\theta} \right]^{\frac{1}{\theta}}. \tag{10}$$

Intuitively, if location i offers a higher rental rate net of financial frictions (r_{it}/ϕ_{nit}), it attracts investments with lower idiosyncratic realizations for productivity, which reduces capital productivity through a composition effect. With a Fréchet distribution for capital productivity, this composition effect exactly offsets the impact of the offers a higher rental rate net of financial frictions (r_{it}/ϕ_{nit}), such that the expected return to capital is equalized across locations. Therefore, the rental rate for capital can differ between local manufacturing and the colonial plantation ($r_{nt} \neq r_{\mathbb{N}t}$), but the expected return to capital taking into account the idiosyncratic productivity draws is equalized ($v_{nnt} = v_{n\mathbb{N}t} = v_{nt}$). Total capitalist income is linear in the existing capital stock: $V_{nt} = v_{nt} k_{nt}$.

The expected return to investment (v_{nt}) in equation (10) is decreasing in financial frictions to the colonial slave plantation ($\phi_{n\mathbb{N}t}$). Therefore, locations with better access to the colonial slave plantation have higher rates of return to capital accumulation, which we show below implies a higher steady-state capital stock. Intuitively, access to colonial slavery investments expands the set of investment opportunities, which raises the rate of return to capital accumulation, because investments are imperfect substitutes across locations.

6.6 Capital Allocation Across Periods

Capitalists choose consumption and saving to maximize intertemporal utility subject to their budget constraint:

$$\max_{\{c_{nt}, a_{nt+1}\}} \left\{ U^k_{nt} = \sum_{t=0}^{\infty} \beta^t \ln c^k_{nt} \right\}, \tag{11}$$
$$\text{subject to } p_{nt} c^k_{nt} + p_{nt} \left(a_{nt+1} - a_{nt} \right) = R_{nt} a_{nt},$$

where R_{nt} is the gross return to assets: $R_{nt} = \max\{v_{nt} - \delta p_{nt}, \rho\}$.

Given the linearity of capitalists' income in the existing stock of assets, equilibrium investments are characterized by a corner solution. If the expected return to capital net of depreciation ($v_{nt} - \delta p_{nt}$) exceeds the return from the consumption bond (ρ), capitalists invest all their assets in capital up to the collateral constraint (λ_n): $k_{nt} = \lambda_n a_{nt} \cdot 1_{\{(v_{nt} - \delta p_{nt}) > \rho\}}$. We assume that collateral constraints do not bind in steady-state. Therefore, the expected return to capital equals the return from the consumption bond in steady-state: $v^*_{nt} - \delta p_{nt} = \rho$.

Given our assumption of logarithmic utility, capitalists' optimal consumption-saving decisions are characterized by a constant saving rate, as in Moll (2014):

$$a_{nt+1} = \beta \left(R_{nt}/p_{nt} + 1 \right) a_{nt}. \tag{12}$$

Therefore, although the saving rate is here endogenous, capital accumulation takes a similar form as in the conventional Solow-Swan model. There exists a steady-state capital-labor ratio in each location. If the initial capital stock in a location differs from this steady-state value, consumption smoothing implies that capitalists gradually accumulate or decumulate capital along the transition path towards this steady-state.

6.7 Slavery Investments and Industrialization

Given time-invariant values of the exogenous variables, we show in Proposition S.2.1 in Online Supplement S.2.1.11 that there exists a unique steady-state equilibrium. We now use the model to characterize the aggregate impact and distributional consequences of greater access to slavery investments. We undertake a comparative static in which we reduce financial frictions to the colonial slave plantation ($\phi_{n\mathbb{N}}$) from prohibitive values for all locations (such that $\xi_{nn} = 1$ for all n) to finite values for some locations n (such that $\xi_{nn} < 1$ for some n, as observed in our data). We hold constant world prices (p^{AW}, p^{MW}, p^{SW}) and other exogenous fundamentals. Therefore, this comparative static captures the pure impact of greater access to slavery investments through capital accumulation. We show that the domestic investment share (ξ_{nn}) is a sufficient statistic for the impact of financial frictions to the colonial slave plantation ($\phi_{n\mathbb{N}}$) on steady-state economic activity, as summarized in the following proposition.

Proposition 1. ***(Slavery Investments and Industrialization)*** *Other things equal, in steady-state equilibrium, locations with better access to slavery investments (lower $\phi_{n\mathbb{N}}$ and hence lower ξ^*_{nn}) have (i) lower agricultural employment (ℓ^{A*}_n); (ii) higher manufacturing employment (ℓ^{M*}_n); (iii) higher total population (ℓ^*_n); (iv) a lower rental rate for capital (r^*_n); (v) higher wages (w^{L*}_n) and worker real income (w^{L*}_n/p_n); (vi) lower price of agricultural land (q^*_n); (vii) higher productivity-adjusted and unadjusted stocks of capital ($\widetilde{k}^*_n$, k^*_n); (viii) higher productivity-adjusted and unadjusted stocks of capital in domestic manufacturing ($\widetilde{k}^{M*}_n$, k^{M*}_n); (ix) higher capitalist real income ($v^*_n k^*_n/p_n$); (x) lower landlord real income ($q^*_n m_n/p_n$).*

Proof. See Online Supplement S.2.1.12. □

This proposition reflects the net effect of counteracting forces. On the one hand, for a given stock of capital (k_n), lower financial frictions to the colonial slave plantation ($\phi_{n\mathbb{N}}$) reduce the capital allocated to local manufacturing (lower k_{nn}) through a conventional substitution effect. On the other hand, lower financial frictions to the colonial slave plantation ($\phi_{n\mathbb{N}}$) expand the set of investment opportunities and raise the rate of return to capital accumulation, which increases the steady-state capital stock (k_n^*). The proposition establishes that the second effect dominates the first, such that the fall in financial frictions to the colonial slave plantation ($\phi_{n\mathbb{N}}$) increases the steady-state capital allocated to local manufacturing (higher k_{nn}^*). In the new steady-state, the expected return to capital is again determined by no-arbitrage with the unchanged rate of return on the consumption bond ($v_n^* = \rho + \delta p_n$), but the expansion in the set of investment opportunities, and the resulting capital accumulation, leads to a fall in the steady-state local rental rate (r_n^*).

The remaining parts of the proposition follow from the specific-factors structure of production and population mobility. Given constant prices and zero-profits in manufacturing, a lower steady-state rental rate (r_n^*) raises the steady-state wage (w_n^*). Given constant prices and zero-profits in agriculture, a higher steady-state wage (w_n^*) reduces the steady-state price of land (q_n^*). Additionally, higher wages imply higher worker real income (w_n^*/p_n) for constant goods prices, which increases steady-state population (ℓ_n^*). A higher steady-state allocation of capital to local manufacturing (k_{nn}^*) raises labor's value marginal product in manufacturing, which together with the increase in steady-state population (ℓ_n^*) implies higher manufacturing employment (ℓ_n^{M*}). Finally, given constant prices and a fixed supply of land, the higher steady-state wage (w_n^*) implies lower agricultural employment (ℓ_n^{A*}).

Therefore, we find that improved access to slavery investments both changes the structure of economic activity within locations (stimulating industrialization and structural transformation away from agriculture) and also changes the spatial distribution of economic activity across locations (raising population density in locations with better access to slavery investments and reducing population density elsewhere). Since the reduction in financial frictions to the colonial slave plantation expands the set of investment opportunities, aggregate real income across all locations and factors of production (capitalists, workers and landowners) increases. But there are distributional consequences across the different factors of production. Given an unchanged supply of land (m_n) and constant goods prices (p_n), a fall in the price of agricultural land (q_n^*) in locations with better access to slavery investments reduces the real income of landowners ($q_n^* m_n/p_n$). Additionally, given an unchanged steady-state expected return to capital ($v_n^* = \rho + \delta p_n$) and constant goods prices (p_n), the increase in the capital stock (k_n) in these locations raises the real income of capitalists ($v_n^* k_n^*/p_n$).

Finally, we have focused here on the impact of access to investments in colonial slave plantations on steady-state levels of economic activity, in order to highlight how improved access to these investments increases the rate of return to capital accumulation. But this potentially underestimates the full impact of access to slavery investments in stimulating Britain's Industrial Revolution, because collateral constraints do not bind in steady-state. Along the transition path where collateral constraints do bind, access to slavery wealth can also accelerate convergence to steady-state by alleviating these collateral constraints (higher λ_n), since investments in colonial slave plantations were particularly collateralizable.

7 Main Empirical Results

We now report our main empirical results on the causal relationship between slavery wealth and economic development. In Section 7.1, we introduce our identification strategy, explain the construction of our instrument, and provide evidence in support of our causal argument. In Section 7.2, we report our main instrumental variables estimation results for a range of measures of economic development. In Section 7.3, we carry out a number of robustness checks. Finally, in Section 7.4, we quantify our theoretical model using the observed data to evaluate the aggregate and distributional consequences of Britain's involvement in slavery.

7.1 Identification Strategy

We are interested in the relationship between economic development (Y_i) and slaveholding wealth (S_i) in location i within Britain. Section 5 shows a positive cross-sectional relationship between slavery wealth and economic development. To establish causality, we use an instrumental variable (IV) strategy. Our identification strategy is based on the close relationship between slave trading and slaveholding. This appears prominently in historical discussions of slaveholding (see, for example, Hall et al. 2014), and is reflected in the clustering of slaveholders around the major slave trading ports in Figure 2a.[19] Our main instrument combines plausibly exogenous variation in slave trader wealth, driven by middle-passage mortality, with local exposure weights reflecting the geographical distribution of slave traders' ancestors.

To participate in the slave trade, traders often moved away from their ancestral family home. Investors in slave voyages, however, were recruited from the network of family and friends back home. To capture these ties, we infer the familial locations of the slave traders observed in the slave voyages database. We use genealogical information from family trees

[19] As discussed further below, a famous example of a family that transitioned from slave trading to slave holding is the Lascelles family. Three sons of the Member of Parliament Daniel Lascelles were slave traders (George, Henry and Edward). Their descendant Henry Lascelles, 2nd Earl of Harewood received £26,307 for 1,277 slaves, which corresponds to around £19m (inflation adjusted) or £128m (adjusted to to the same share of GDP) today.

and assign slave traders to their familial locations based on the locations of their ancestors.[20]

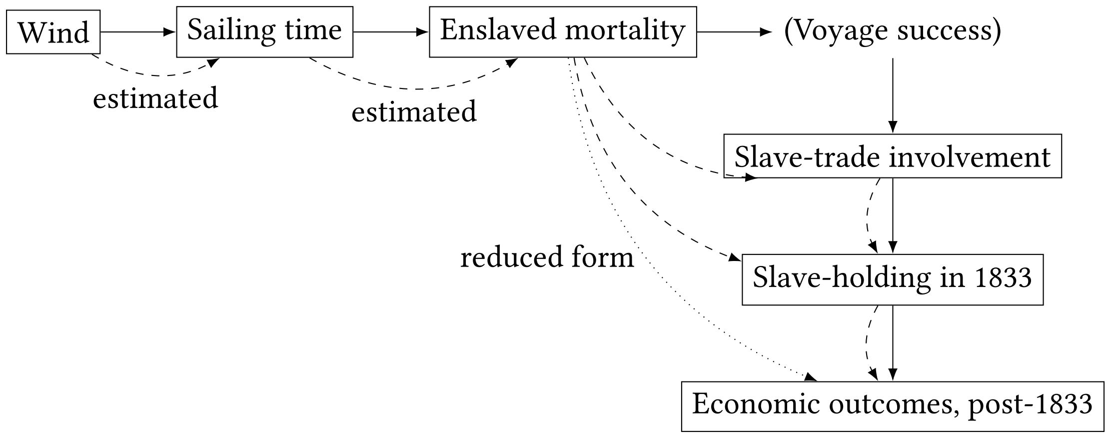
We begin by discussing the role of middle-passage mortality as an exogenous source of wealth shocks. We next provide empirical evidence in support of the steps in our causal argument. We then construct a measure of average voyage success for each slave trader, which captures these wealth shocks from middle-passage mortality. Finally, we assign slave traders to their familial locations using the addresses of their ancestors. Although we use middle-passage mortality as our baseline measure of wealth shocks, this measure is not available for all voyages in the slave voyages dataset. Therefore, as a check on the representativeness of these voyages, we also report robustness checks using other measures of voyage success.

Middle-Passage Mortality. The key ideas underlying our identification strategy are outlined in Figure 5. First, starting from the top-left, wind conditions were the primary determinant of voyage duration across the Atlantic in the age of sail. Second, moving towards the right, voyage duration was a key determinant of slave mortality during the middle-passage under the crowded, insanitary and inhumane conditions on slave ships. As sailing times across the Atlantic increased, water ran out and infectious diseases began to spread, leading to sharp increases in middle-passage mortality. Third, moving further to the right, higher middle-passage mortality reduced the profitability of slave-trading voyages. Fourth, moving downwards, this reduction in voyage profitability from adverse wind conditions discouraged (or made impossible) future participation of slave traders in subsequent slave voyages, given the substantial upfront costs involved. Fifth, moving further downwards, less involvement in the slave trade reduced the likelihood of traders making the transition to slaveholding as plantation owners, and the wealth they could use to do so. In sum, since bad weather shocks both directly lowered slave trader wealth, and induced exit from the slave trade, they reduced slaveholding wealth in 1833 at the time of abolition.

Causal Mechanism. We now provide evidence in support of the steps in this causal chain. For sailing ships, wind speed and direction were the main determinants of ship speed and voyage duration, as discussed in Rodger (1996) and Pascali (2017). Ship log books of slave-trading voyages from West Africa to the West Indies could last between 25 and 60 days, as discussed in Haines et al. (2001) and Cohn and Jensen (1982). When voyages took longer than expected, and drinking water ran out, the horrendous conditions aboard for enslaved persons led to sharp increases in mortality, as documented in Kiple and Higgins (1989).

[20] As a robustness check, we also use the geographical concentration of surnames in Britain to probabilistically assign slave traders to their familial locations, based on the locations of people sharing that surname in the population census, as discussed in Online Appendix A.1.4.

Figure 5: Identification Strategy



Note: Solid arrows are causal relationships; dashed arrows are estimated relationships; variables in parentheses are unobserved; dotted arrows are reduced-form relationships. In robustness checks, we also consider estimations that employ sailing time instead of enslaved mortality.

Wind and Sailing Time. To establish a relationship between weather conditions and sailing time, we infer historical weather conditions.[21] For this purpose, we use the CLIWOC database of ship logs containing weather and wind conditions in a given week. We assign these observations from ship logs to grid cells for one degree of latitude and longitude. To interpolate wind patterns between these observed grid cells, we exploit the regularity of atmospheric pressure fields over the North Atlantic that evolve around a low-pressure area near Iceland and a high-pressure area around the Azores, as reflected in weather maps. We use a standard set of weekly weather maps for the North Atlantic for the period 1979–2010. Historical wind observations are then matched to the modern weather map with the best fit in the same week. Here we define best fit as the weather map that minimizes the difference between all historical observations and the wind conditions implied by the weather map.

To determine predicted trip length, we simulate middle-passage voyage length using a cost surface informed by these wind patterns and a polar diagram as in Pascali (2017), reflecting a ship's ability to sail close to the wind. To account for changing weather conditions, we update the weather map every week and recalculate the least cost path from a ship's current location. We repeat this procedure until the ship has reached its final destination.

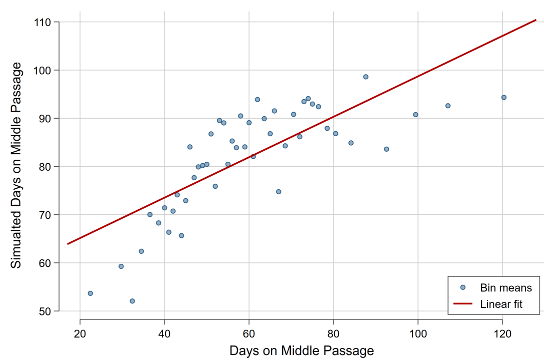
To assess the validity of this procedure, we simulate trip lengths for all slave voyages where we observe the middle passage length and compare our predictions to the actual sailing time. As illustrated in Figure 6a, our predictions closely match actual sailing times, confirming that wind patterns are the main driver of voyage length. Estimated with no constant, we obtain an R^2 of 0.87 and the coefficient on weather-predicted length is 0.74, suggesting that predicted

[21] Online Appendix A.1.2 provides a detailed description of this procedure.

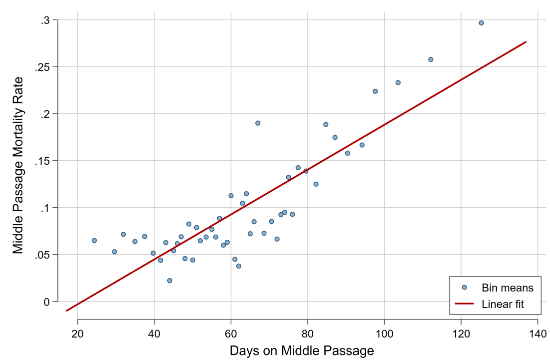
sailing times are slightly faster than actual ones.

Sailing Time and Mortality. Next, we use data from the Slave Voyages database to corroborate the relationship between sailing time and enslaved mortality. Figure 6b presents a binscatter plot of the relationship between middle-passage mortality and the duration in days of the voyage from West Africa to the Americas. Consistent with the historical literature emphasizing voyage duration as the main determinant of middle-passage mortality, we see a strong and positive relationship between sailing time and mortality. Ten extra voyage days increase the mortality rate by 2.3 percentage points. For a ship carrying 350 enslaved persons, this corresponds to 8 additional deaths. Figure 7a further highlights the variation in middle-passage mortality across all slave voyages from British ports. We find large differences in middle-passage mortality. While many voyages experienced mortality rates of 5-10 percent, some saw rates of 20 percent or more. From Figure 6b, these differences in mortality are heavily influenced by sailing time.

Figure 6: Middle-passage Length and Mortality for Slave Voyages



(a) Weather and Voyage Duration

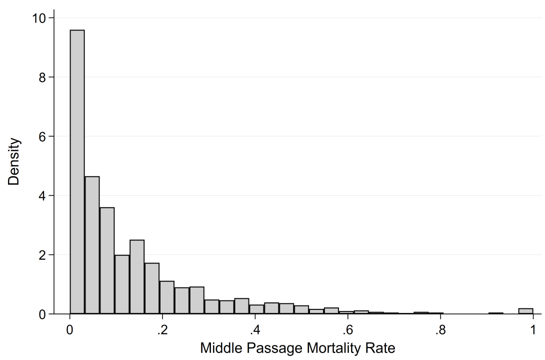


(b) Voyage duration and mortality

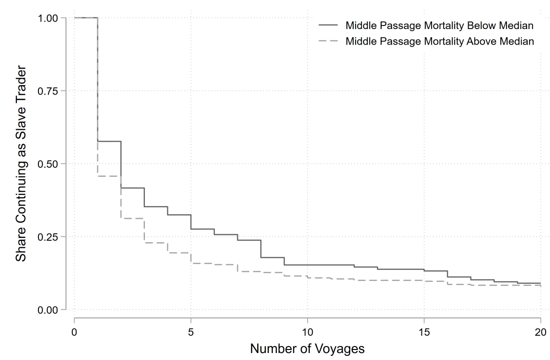
Note: *Left panel:* The figure shows a binscatter (50 equally sized bins) of the duration of slave-trading voyages from British ports predicted from weather data (horizontal axis) and the actually documented duration of the same slave-trading voyage (vertical axis) *Right panel:* The figure shows a binscatter (50 equally sized bins) of the duration of slave-trading voyages from British ports (horizontal axis) and mortality rates among the enslaved (vertical axis); blue dots correspond to ventiles and the red dashed line shows the linear fit.

Financing slave-trading voyages required considerable upfront capital investments in ship and crew and for the purchase of slaves in West Africa. The main source of revenue was the sale of the enslaved in the Americas. Therefore, high mortality rates on slave-trading voyages could result in substantial losses for the slave traders involved. Specifically, we expect voyage duration and middle-passage mortality to be key in enabling continued involvement in the slave trade. To demonstrate this link, Figure 7b displays mean continuation probabilities for slave traders across slave voyages n. We compute these mean continuation probabilities from voyage n to $n+1$ separately for slave traders that experienced above and below-median middle-passage mortality during voyage n.[22] Consistent with the idea that adverse wind conditions and low voyage profits reduced the likelihood of individuals continuing in the slave trade, we find lower continuation probabilities for slave traders who experience above-median middle-passage mortality. For example, after 5 voyages, we find that over one third of the owners who experienced below-median mortality of enslaved stayed involved, whereas less than 20 percent of those exposed to above-median mortality continued to participate.[23]

Figure 7: Middle-passage Mortality and Continued Involvement in the Slave Trade



(a) Histogram of middle-passage mortality



(b) Continued involvement and mortality

Note: *Left panel:* The figure shows a histogram of the mortality rates among the enslaved (measured as (enslaved embarked - enslaved disembarked)/enslaved embarked) across slave-trading voyages from British ports. *Right panel:* Horizontal axes is number of slave voyages n; Vertical axis is continuation probability from slave voyage n to slave voyage $n+1$; mean probabilities of continued involvement shown separately for middle-passage voyages with above and below median mortality among the enslaved during voyage n.

This pattern of results is consistent with selection on profitability in the slave trade. Those who were lucky with wind conditions and made substantial voyage profits accumulated further wealth and continued to participate in the slave trade. Those who were unlucky with weather conditions and experienced substantial voyage losses dropped out of the slave trade.

Voyage Success. We construct a measure of average voyage success for each slave trader based on middle-passage mortality. We observe a decline in middle-passage mortality over time in the slave voyages data, in part because of improvements in ship technology. To abstract from this secular decline and focus on variation across voyages within the same time

[22] In Table A.1 in Online Appendix A.1.3, we provide further evidence that voyage failure, as recorded by the Slave Voyage Database, became more common the longer the middle passage lasted.

[23] In Figure A.4 in Online Appendix A.1.3, we provide further evidence on this relationship between middle-passage mortality and continuation probabilities in the slave trade.

period, we remove decadal fixed effects from all British ships' middle-passage mortality. In addition, we remove route fixed effects to account for route-specific variation in voyage length. Beside this baseline specification, we consider a variety of robustness checks where we remove captain fixed effects or use the weather-based voyage length calculations to predict mortality.

Our voyage success measure for slave-trading voyage j and ship owner or "voyager" v is the inverse of the residual mortality rate among the enslaved: $1/mortality_{vj}$, where mortality equals the number of enslaved embarked, minus the number of enslaved disembarked, divided by the number of enslaved embarked. This voyage success measure has a lower bound of one for voyages where all of the enslaved die, and approaches infinity as the number of deaths among the enslaved approaches zero.[24]

The slave voyages data report up to eight ship owners or "voyagers" for each slave voyage, such that a given voyager can appear multiple times for different slave voyages. We compute the average *voyage success* for voyager v as the average across all of their slave voyages j:

$$VS_v = \frac{1}{n_v} \sum_{j=1}^{n_v} \frac{1}{mortality_{vj}}, \tag{13}$$

where n_v is the number of slave voyages for which voyager v is observed.

The set of voyage success measures VS_v, $v = 1, ..., V$, based on our different measures of residual mortality, or residual mortality predicted by weather conditions, constitute our plausibly exogenous *shock*. Next, we explain how we derive regional exposure weights from local ancestor shares $s_{ia(v)}$ that define each region i's exposure to voyager v's success. The notation $a(v)$ indicates an ancestor-voyager match.

Family Trees In our baseline specification, we measure the ancestral home of slave traders using the addresses of their forebears from family trees on Ancestry.com. Often, families hailing from a particular place would see one of theirs work and live in a major trading port for a few years – but the majority of the family network, including many individuals who followed the business advice of a relative and invested in the slave economy, remained near the ancestral home. For example, the Lascelles family initially lived in Stank Hall, Yorkshire; three of the family's male descendants became slave traders, participating in 14 voyages between 1699 and 1736. By 1787, the Lascelles owned 27,000 acres in Barbados, Jamaica, Grenada, and Tobago. All the male lines save one eventually died out. Only Henry, second Earl of Harewood (1767-1841), received slavery compensation under the terms of the Slave Compensation Act, as shown in the family tree in Figure A.2 in Online Appendix A.1.1.

[24]For the small number of voyages with zero mortality among the enslaved, we use $0 + \epsilon = 0.005$ to avoid this voyage success measure becoming undefined for voyages with no deaths.

Using the family trees reported on *Ancestry.com*, we identify 5,005 ancestors of 825 voyagers, where we observe birth and death locations. Online Supplement S.2.3 provides further details. This allows us to calculate location i's share of ancestors a who we could match to a slave voyager v, i.e. $s_{ia(v)}$, where the notation $a(v)$ makes explicit that ancestor a is matched with voyager v. Combining the voyage mortality information with our local exposure measure, we compute our voyage success instrument (VSI_i) as an exposure-weighted average of the voyage successes across all slave-trading ancestors in that location:

$$VSI_i = \sum_{a=1}^{A_i} s_{ia(v)} VS_{a(v)}, \tag{14}$$

In our first-stage regression, we predict slaveholding in 1833 using this instrument. We do not require *direct* family connections to exist between slaveholders in 1833 in a given location and the ancestors of slave traders in that same location. Ancestor presence of slave traders could create indirect connections, leading to more slaveholding: For example, slave traders could pass information about opportunities to friends, business associates, and other social contacts in their place of origin. Since our instrument combines plausibly exogenous variation in voyage success with potentially endogenous variation in ancestor shares, we control in all our specifications for the local ancestor share (A_i/A).

In Table 1, we compare location characteristics between three groups of locations: those without ancestors involved in the slave trade, those with successful ancestors in the slave trade (above-median voyage success instrument), and those with unsuccessful ancestors in the slave trade (below-median voyage success instrument).

Before Britain's entry into the transatlantic slave trade, we find no significant differences in property values (as measured in 1086 and 1334) for regions that were home to the ancestors of slave traders. Similarly, we do not see any population differences in 1500. Locations with ancestors of slave traders do not have significantly different latitudes, longitudes or probabilities to be located on a coal field; they are a bit further away from the coast; and they are located slightly closer to Liverpool and a bit further away from London. The absence of major differences between Columns (2)-(3) and Column (1) suggests that our instrument is likely as good as randomly assigned across locations. Nevertheless, we will still control in all specifications for the local ancestor share, and we will explore different specifications of the middle-passage mortality calculations, including using middle-passage mortality predicted by weather conditions.

Table 1: Location Characteristics by Slave-Trading Ancestor Status

Variable	(1) None Mean/SE	(2) Unsucessful Mean/SE	(3) Successful Mean/SE	T-test Difference (1)-(2)	(1)-(3)	(2)-(3)
Domesday Wealth (1086)	4.78	4.73	4.96	0.05	-0.18	-0.23
	(0.04)	(0.15)	(0.11)			
Wealth Subsidy (1334)	4.11	3.99	4.19	0.12	-0.08	-0.21
	(0.04)	(0.13)	(0.16)			
Population (1500)	10.77	11.10	11.12	-0.33	-0.35	-0.02
	(0.03)	(0.06)	(0.07)			
Longitude	-1.87	-1.93	-1.47	0.07	-0.39	-0.46
	(0.07)	(0.11)	(0.13)			
Latitude	52.45	52.70	52.50	-0.25	-0.05	0.20
	(0.05)	(0.12)	(0.11)			
Coal field indicator	0.04	0.11	0.07	-0.07	-0.02	0.04
	(0.01)	(0.03)	(0.03)			
Dist Coast	29.26	37.56	41.58	-8.30	-12.32	-4.03**
	(1.07)	(2.92)	(3.08)			
Dist. to Liverpool	215.40	153.72	177.08	61.68***	38.33***	-23.35
	(3.35)	(9.81)	(10.29)			
Dist. to London	224.67	208.45	177.91	16.21***	46.76***	30.55
	(4.29)	(10.73)	(10.15)			
N	667	92	92			

Note: The value displayed for t-tests are the differences in the means across the groups. Standard errors are robust. Column (1) reports results for the set of regions without any identified ancestors of slave voyagers. Columns (2) and (3) split regions with ancestors into those with above and below-median voyage success. Wealth and count variables are inverse hyperbolic sine transformed. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

7.2 Instrumental Variables Estimation

We now use our instrumental variable to estimate the causal impact of slaveholding wealth on economic development. First, we report our baseline estimation results for economic development in Britain at the time of abolition in 1833, comparing OLS and IV results. Second, we report a specification check on this baseline estimation using never-takers: regions where ancestors of slave traders lived, but where no slaveholders dwelled in 1833.

Baseline Estimation We consider the following two-stage least squares (2SLS) specification for the relationship between economic development (Y_i) and slaveholding wealth (S_i) in location i within Britain, in which we instrument slaveholding wealth using our voyage success instrument (VSI_i) discussed above:

$$Y_i = C_2 + \beta \widehat{S}_i + \delta X_i' + \epsilon_i \tag{15}$$

$$S_i = C_1 + \alpha VSI_i + \gamma X_i' + \rho_i \tag{16}$$

where C_1 and C_2 are regression constants; X' is a vector of control variables for other determinants of economic activity, including the population in 1500 before Britain's entry into the slave trade, latitude, longitude, distance to the coast and the nearest coal field, and the local ancestor share; finally ϵ_i and ρ_i are stochastic errors.[25]

Table 2, Panel A reports the OLS estimates. In line with Figure 3, we find a positive estimated coefficient for property taxes in 1815 (Column (2)) and a negative coefficient for the agricultural employment share (Column (3)). We find a higher share of employment in manufacturing (Column (4)) and a larger number of cotton mills in both 1788 and 1839 (Columns (5) and (6)) in locations with greater slave holding.

Panel B reports the corresponding IV-estimates. In our baseline specification, we use residual middle-passage mortality after controlling for decade and route fixed effects. Column (1) shows the first-stage. The first-stage F-statistics are strong and Anderson-Rubin p-values are below 0.01, indicating that we are using a relevant instrument. We also report tF-adjusted 95%-confidence intervals suggested by Lee et al. (2022). They confirm that our instrument is strong. Quantitatively, we find that a one standard deviation increase in voyage success causes a 0.37 standard deviation increase in slaveholder wealth in 1833.

Columns (2)-(6) report the second-stage estimates. We find that an increase in slaveholder wealth predicted by our instrument results in higher property taxes in 1815 (Column (2)) and a lower agricultural employment shares (Column (3)). We find a higher manufacturing employment share (Column (4)) and a larger number of cotton mills in both the late-18th and early-19th centuries in locations with exogenously higher slaveholder wealth.

We standardize all variables to facilitate the interpretation of the inverse hyperbolic sine transformed measures. Therefore, our estimates imply that a one standard deviation increase in compensation payments translates into a 0.84 standard deviation increase in rateable values, a 0.75 standard deviation decrease in agricultural employment, a 0.90 standard deviation increase in manufacturing employment and a 0.62/0.83 standard deviation increase in the number of cotton mills in 1788 and 1839, respectively.[26]

[25] In line with the argument in Borusyak et al. (2021), we control for the local ancestor share, A_i/A, so as to focus on plausibly exogenous variation in voyage success across regions – meaning that we identify off the variation in voyage outcomes driven by mortality shocks. Since we do not observe voyage success measures for all matched voyagers, these shares do not add up to one in every region.

[26] We also derive elasticities following the approach in Bellemare and Wichman (2020) and report them at the bottom of the table. Doubling slave claims implies an 17 percent increase in rateable values, 12 percentage points

Our IV coefficients are larger than the corresponding OLS estimates. Compliers in our instrumental variable estimation are more likely to be small places without an abundance of entrepreneurs and capital, where the influx of overseas wealth may have made a larger difference. In this sense, the difference between the LATE identified by the IV and the OLS coefficients underlines the importance of slavery wealth for the geography of economic development prior to 1833.

Panels (C) and (D) repeat the OLS-IV comparison using *predicted* slave mortality, calculated using simulated voyage duration based on weather conditions, and adjusted for decade and route fixed effects. Because we use the simulated voyage length drawing on weather logs and optimal paths, we can exploit information on a larger number of traders – 389 instead of 169. It is reassuring that we find large and significant effects that are largely unchanged compared to the baseline specification. The only difference is the now insignificant result for mills in the early days of industrialization in 1788. The simulated values have the advantage of being based on weather-shocks only.[27]

In Table A.7 in Online Appendix A.1.4, we demonstrate that results are largely unchanged when we use a log-transformation instead of the inverse hyperbolic sine. Our baseline specification controls for 1500 population, which implies that our results capture changes in economic activity since then – reflecting the economic gains following Britain's entry into slave holding. We also adjust for decade and route fixed effects in constructing our baseline measure of mortality among the enslaved. But our results are not dependent on the inclusion of these controls. In Online Appendix A.1.4, we show additional results without control variables. We also report estimates in which we adjust mortality among the enslaved for captain fixed effects to control for unobserved variation in captain ability.

Our baseline specification uses robust standard errors, because our 849 regions are relatively large, which helps to alleviate potential concerns about spatially correlated errors. In Online Appendix A.1.4, we report results using Heteroskedasticity Autocorrelation Consistent (HAC) standard errors following Conley (1999). Again, we find a similar pattern of results.

In combination, these empirical results provide strong support for the mechanism in our model: Exogenous increases in access to slavery wealth induce a reallocation of economic activity away from the land-intensive agricultural sector, and towards the manufacturing sector. This is reflected in employment, and in the location of one key new industry, textile manufacturing, as well as in property values.

less agricultural employment, 17 percentage points more manufacturing employment, and 70 (62) percent more mills in the region in 1788 (1839).

[27] The higher number of slave traders reflects the larger number of ships for which we can infer crossing times, based on their departure times in Africa.

Table 2: Instrumental Variables Estimates

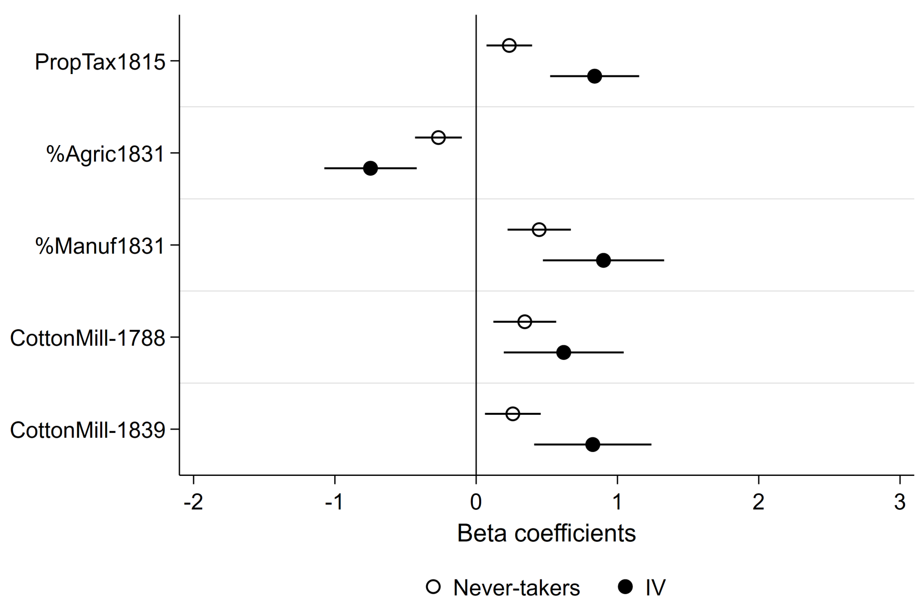
	(1) First Stage	(2) PropTax1815	(3) %Agric1831	(4) %Manuf1831	(5) CottonMill-1788	(6) CottonMill-1839
Panel A: OLS – Base						
Slave Claims		0.179^{***}	-0.241^{***}	0.190^{***}	0.0745^{**}	0.192^{***}
		(0.033)	(0.033)	(0.033)	(0.035)	(0.035)
Panel B: IV – Base						
VSI	0.370^{***}					
	(0.072)					
Slave Claims		0.839^{***}	-0.748^{***}	0.901^{***}	0.620^{***}	0.825^{***}
		(0.161)	(0.167)	(0.219)	(0.216)	(0.211)
Observations	849	849	849	849	849	849
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Elasticity	0.51	0.17	-0.12	0.17	0.70	0.62
N Voyagers	169	169	169	169	169	169
KPW F-stat		26.74	26.74	26.74	26.74	26.74
AR p-value		0.00	0.00	0.00	0.00	0.00
tF adjusted CI		[0.45,1.22]	[-1.15,-0.35]	[0.38,1.43]	[0.10,1.14]	[0.32,1.33]
Panel C: OLS – Simulated						
Slave Claims		0.171^{***}	-0.227^{***}	0.171^{***}	0.0536	0.171^{***}
		(0.033)	(0.033)	(0.033)	(0.036)	(0.036)
Panel D: IV – Simulated						
VSI	0.365^{***}					
	(0.096)					
Slave Claims		1.131^{***}	-0.877^{***}	0.905^{***}	0.370	0.910^{***}
		(0.270)	(0.238)	(0.288)	(0.230)	(0.275)
Observations	849	849	849	849	849	849
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Elasticity	0.60	0.23	-0.18	0.25	0.42	0.69
N Voyagers	389	389	389	389	389	389
KPW F-stat		14.54	14.54	14.54	14.54	14.54
AR p-value		0.00	0.00	0.00	0.11	0.00
tF adjusted CI		[0.35,1.91]	[-1.56,-0.19]	[0.07,1.74]	[-0.29,1.03]	[0.12,1.70]

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Standardized coefficients with robust standard errors in parenthesis. Slave claims and the outcomes in columns 1, 5 and 6 are IHS-transformed. The Voyage Success Instrument (VSI) allocates slave-traders to their ancestral locations using family trees. Panels A and B use observed mortality after adjusting for decade and route fixed effects. Panels C and D use predicted mortality, calculated using simulated voyage duration based on weather conditions, and again adjusting for decade and route fixed effects. Controls are population in 1500, latitude, longitude, distance to the coast, and the local ancestor share A_i/A.

Never-takers Following Bound and Jaeger (2000), Angrist and Krueger (1994), and D'Haultfœuille et al. (2022), we now report a specification check of our IV estimates. We examine never-taker regions, where ancestors of slave traders lived, but where we find no slaveholder wealth in 1833. We hypothesize that ancestral links to the slave trade primarily affect economic development through slaveholder wealth – and not a latent variable influencing both slavery involvement and subsequent development, like a proclivity for risk-taking. If this is correct, we should *not* find statistically significant links between economic development and ancestral links to the slave trade, once we focus on the subsample of locations with no slaveholder wealth in 1833.

In Figure 8, we plot the estimated coefficients from an IV-regression of our main outcomes on ancestral links to the slave trade, for both our baseline specification including all locations, and the never-takers subsample that excludes any location with positive slaveholder wealth in 1833. Consistent with the mechanism in our model, we find much larger standardized coefficients for our baseline specification than for the never-taker specification.[28]

Figure 8: Beta Coefficients for our IV Specification and Never-takers



Note: Beta coefficients with 95% confidence intervals from our baseline IV estimation and reduced-form OLS regressions for nevertaker regions with no slaveholding in 1833.

[28]Table A.13 in Online Appendix A.1.4 reports the estimated coefficients for the never-taker analysis.

7.3 Robustness Tests

This section summarizes a number of additional robustness tests, as discussed in further detail in Online Appendix A.1.4.

We first assess the presence of spatial auto-correlation (SAC), using Moran's I. SAC becomes insignificantly different from zero at around 500km for the majority of our regressions, and for all within 750km. To ensure that the presence of SAC below these distances is not unduly biasing our standard errors, we calculate Conley Spatial HAC standard errors (Conley 1999) which correct for cluster correlation in spatial settings. Even at a bandwidth distance of 750 km, our main results remain statistically significant at conventional levels.

Second, we choose a different procedure to assign parish-level observations to hexagons. Our preferred approach assigns parishes to a hexagon if their centroid falls inside. The benefit of not employing area weights to map values into polygons is that we do not mechanically introduce spatial auto-correlation. On the downside, we may assign large rural parishes to a neighboring hexagon even though the majority of its area does not lie within it. To rule out that our results depend on this specific procedural choice, we map parish information to hexagons and rerun our analysis using area weights. Results remain unchanged.

In a similar vain, we experiment with hexagons of different size. Our preferred hexagons span an area of around 9km from the center to vertex, which represents a plausible commuting distance at a time when walking was the dominant mode of transport. In Table A.12, we present specifications where we consider parishes, the smallest political unit; registration districts; and grid of squares with side length 0.2°, or roughly 20km. We find a similar quantitative and qualitative pattern of results across each of these alternative choices of spatial units.

Third, we report a robustness test, in which we use the duration of slave voyages directly, instead of slave mortality. Slave mortality was mainly driven by weather shocks, but it may also reflect poor judgement of the captain or inadequate care of slaves by the crew. Voyage length is arguably closer to a truly exogenous variable (especially when we derive it from our weather-based model). Table A.3 shows the results. Again, we find strong, highly significant results in our baseline specification, for both directly observed and weather-induced (simulated) voyage duration. Magnitudes are similar throughout.

Fourth, we assess whether our results are driven by the three major slave ports, i.e. Bristol, Liverpool and London. Specifically, we exclude any region located within 30km of these slave ports and find that the magnitude and significance of the coefficients remain largely unchanged. Overall, we conclude that our findings are not driven by the major slave ports alone.

Fifth, our baseline specification assigns slave traders to locations using genealogical information from family trees. In Online Appendix A.1.4, we report a robustness check in which we instead assign them to regions probabilistically based on surname, exploiting the geographic concentration of surnames in England and Wales. Again we find a similar pattern of results as in our baseline specification.

Finally, we present the results from a permutation exercise where we randomly assign the voyage success measure to local ancestor shares. We repeat this procedure 1,000 times and compare the resulting distribution of first-stage F-statistics and first-stage instrument coefficients to our baseline specification. It is reassuring to see that the actual values are at the fringe of the placebo distribution. This rules out that spurious correlation is driving our result and underlines the relevance of our instrument.

7.4 Quantitative Analysis of the Model

Guided by this evidence of a causal impact of slavery wealth on economic development, we now use our theoretical model to quantify its aggregate economic implications.

We calibrate the model's parameters using central values from the existing literature and our historical time period. We set the share of land in agricultural costs as $\alpha^A = 0.31$, based on the share of land and buildings in farm income in Feinstein (1972). We set the share of capital in manufacturing costs as $\alpha^M = 0.36$, which ensures that the model matches both the 20% share of agriculture in national income in 1851 in Deane and Cole (1967), and the 65% share of labor in national income in 1850 in Crafts (2022). We assume a migration elasticity of $1/\kappa = 2$, as a central value in the range of estimates in Bryan and Morten (2019) and Galle et al. (2020). We assume an elasticity of substitution between domestic and slavery investments of $\theta = 4$ based on the estimates in Koijen and Yogo (2020).[29]

Our quantification uses three key sources of data: domestic employment by sector, domestic rateable values, and slavery wealth.[30] Rateable values measure the market value of domestic land and buildings and correspond to rental flow values. In contrast, slavery compensation was rationalized as a one-off payment for the net present value of enslaved labor. To convert this net present value to a flow value, we assume a rate of return of 10 percent, reflecting the high rates of slave mortality and the risk of slave rebellion. Additionally, slave compensation was set at 40 percent of market values, in part because of implicit compensation through the "apprenticeship" system. Therefore, we multiply the flow compensation values by 2.5 to obtain flow market values. Finally, the total value of slavery plantations was typically 3 times the value of the enslaved, according to the accounting studies in Sheridan (1965), Ward (1978), and Rosenthal (2018). Therefore, we multiply the flow market values of enslaved

[29]See Online Appendix A.2 for further details on the parameter calibration. In Online Appendix A.3, we demonstrate the robustness of our results to the assumption of alternative parameter values.

[30]See Online Supplement S.2.1.13-S.2.1.14 for further details on the quantification of the model.

people by 3 to obtain the flow market value of slave plantations. For the aggregate economy as a whole, the resulting flow income from these slavery plantations equals 3.63 percent of the flow income from all capital and land (including slavery capital, domestic capital and land), which is in line with the estimates in Pebrer (1833).[31]

In the model, the share of slavery investments in total investments in each location is a sufficient statistic for the impact of access to slavery investments on the spatial distribution of economic activity. We use the model to undertake a counterfactual in which we assume that Britain had no involvement in slavery investments. We start at the observed equilibrium in the data in 1833 (with slavery investments) and evaluate the impact of a prohibitive increase in financial frictions with the colonial slave planation ($\phi_{n\mathbb{N}} \rightarrow \infty$ for all n). We hold goods prices constant to focus purely on the impact of access to slavery investments through capital accumulation. We assume that the observed equilibrium in the data in 1833 is close to what would be the steady-state in the absence of any further technological progress or changes in other location characteristics. We solve for the steady-state without slavery investments, and report changes from the counterfactual equilibrium (with no slavery investments) to the observed equilibrium (with slavery investments). Therefore, our results capture the impact of access to slavery investments on Britain's economic development.[32]

Our counterfactual yields predictions for changes in economic activity in each location and hence for the aggregate economy as a whole. In the first column of Table 3, we report the implied percentage changes in the aggregate values of total income, capitalist income, landlord income and worker welfare from access to slavery investments. We find an increase in the aggregate income of all factors of production (including capital, labor and land) of 3.54 percent. Capitalists benefit most with an increase in their aggregate income of 11 percent, both because of the direct income from slavery capital invested in colonial plantations, and because of the induced increase in steady-state domestic manufacturing capital. Landowners experience small aggregate income losses of just under 1 percent, because of the reallocation of labor away from agriculture. Expected worker welfare rises by 3 percent, because of the substantial wage increases in locations with slavery wealth, and the migration of workers to these locations.[33]

These results are plausible: Our calculated increase in aggregate income of 3.54 percent is close to the value of slavery plantations as a share of the value of all capital and land in both

[31]According to Pebrer (1833), the value of all capital and land in the West Indies was 3.44 percent of the value of all capital and land in both the United Kingdom and the West Indies in 1833.

[32]This approach is conservative, in the sense that if the full steady-state impact of British involvement in slavery had not been achieved by the 1830s, it will understate this full steady-state impact.

[33]In Section A.3 we investigate the results of the calibration exercise for alternative parameter values. We obtain welfare gains of 2 to 6 percent, and aggregate income changes of 1-4 percent.

our data and Pebrer (1833). An aggregate increase of this magnitude is sizeable relative to conventional estimates of the welfare gains from international trade (an upper bound of 9 percent for 19th-century Japan in Bernhofen and Brown 2005), particularly since this counterfactual focuses on the mechanism of capital accumulation, holding goods price constant. During the period 1800-30, British GDP per capita was growing at 0.3% per annum according to Crafts (2022). Therefore, our estimates imply that slavery investments increased aggregate income by the equivalent of more than a decade of growth.

Table 3: Aggregate and Distributional Consequences of Access to Slavery Investments

Variable	Aggregate	<p50	≥p50<p75	≥p75
Population Share 1833	100	68.27	8.68	23.04
Population Change	—	-1.97	-0.33	6.47
Aggregate Income Change	3.54	-1.58	4.88	40.68
Capitalist Income Change	11.11	-2.55	15.52	104.14
Landlord Income Change	-0.87	-0.08	-1.96	-7.18
Worker Welfare Change	3.06	3.06	3.06	3.06

Note: The first column (aggregate) reports values for the aggregate economy; <p50 column reports aggregate values for locations with slavery investment shares ($\xi_{n\mathbb{N}}$) less than the median across those locations with positive shares; ≥p50<p75 column reports aggregate values for locations with slavery investment shares ($\xi_{n\mathbb{N}}$) from the 50-75th percentiles across locations with positive shares; ≥p75 column reports aggregate values for locations with slavery investment shares ($\xi_{n\mathbb{N}}$) above the 75th percentile across locations with positive shares. We calculate slavery investment shares as the share of the flow income from slavery capital in the flow income from all capital and land; changes are from the counterfactual equilibrium with prohibitive colonial financial frictions ($\phi_{n\mathbb{N}t} \rightarrow \infty$) to the observed equilibrium in 1833; population change is the percent change in population; aggregate income change is the percent change in the aggregate income of all factors of production; capital income change is the percent change in capitalist income from slavery and domestic investments; landlord income change is the percent change in landlord income; worker welfare is the expected utility of the domestic workers, as defined in equation (7).

In the second to fourth columns of Table 3, we show that these aggregate changes for the economy as a whole imply substantial distributional consequences in some locations. We divide locations into three groups: those with slavery investment shares ($\xi^*_{n\mathbb{N}}$) less than the median across locations with positive values for slavery investment (68 percent of the 1833 population); locations with slavery investment shares from the 50-75th percentiles of these positive values (just under 9 percent of the 1833 population); and locations with slavery investment shares above the 75th percentile of these positive values (23 percent of the 1833 population).[34]

For locations with the lowest slavery investments, we see a decline in aggregate income of -1.58 percent, a fall of population of 1.97 percent, a drop in capitalist income of 2.55 percent, and little change in landlord income, as economic activity reallocates towards locations with

[34]The median slavery investment share ($\xi^*_{n\mathbb{N}}$) for locations with positive slavery investment is 3.55 percent.

greater involvement in slavery. In contrast, for locations with the highest slavery investments, we find an increase in aggregate income of more than 40 percent, a rise in population of 6.47 percent, a growth in capitalist income of more than 100 percent, and a decline in landlord income of 7.18 percent. Since labor is mobile across locations, workers in all three groups of locations experience the same increase in welfare of 3.06 percent.[35]

Therefore, we find sizeable aggregate effects of access to slavery investments on both total income and the distribution of income across factors of production at the aggregate level. Additionally, our results highlight the uneven geographic impact of slavery investments within Britain, consistent with our causal estimates using quasi-experimental variation above. Locations with better access to slavery investments saw more growth, a larger move out of agriculture, and redistribution of income away from landlords and towards capitalists.

8 Conclusion

Slavery's contribution to the British Industrial Revolution has remained controversial. One influential line of research has argued that slavery wealth played a key role in financing Britain's industrialization. Another prominent vein of work has cast doubt on this hypothesis, arguing that the profits from the slave trade in particular were too small relative to those from other economic activities.

We provide new theory and evidence using administrative data on slaveholder wealth collected under the auspices of the British Abolition of Slavery Act in 1833 and the Slavery Compensation Act of 1837. We exploit micro-geographic variation in this slavery wealth across locations within Britain to examine how much poorer and less productive Britain would have been at the height of the Industrial Revolution, had it not been involved in the slave trade and slave holding in the preceding centuries (while deliberately abstracting from the subsequent effect of the compensation payments themselves).

To this end, we develop a new instrument for slavery wealth, based on the close connection between slave holding and slave trading, and use the mortality of the enslaved during the middle passage. High mortality directly reduced slave trader wealth, and lowered participation in the slave trade, thereby reducing slave holder wealth in the areas from which traders and their ancestors had originally had hailed, at the time of abolition in 1833. These results also hold if we use weather information from merchant ship logbooks to predict likely sailing times of slave ships, thereby isolating the effect of weather shocks alone.

Exogenous increases in slavery wealth lead to higher manufacturing employment, lower

[35] As subsection A.3 shows, welfare gains for workers might have been as high as 6 percent, and total increases in income above the 75th percentile of slavery investment (relative to other capital), as high as 67 percent.

agricultural employment, and more cotton mills at the time of abolition in 1833. In a specification check using never-taker locations that have no slaveholding wealth in 1833, we find little relationship between levels of economic activity and our instrument, consistent with our mechanism operating through slaveholder wealth.

To quantify the aggregate implications of these findings, we develop a quantitative model of the spatial distribution of economic activity within Britain. In our theoretical framework, access to slavery investments expands the set of investment opportunities and raises the rate of return to investment, which stimulates domestic capital accumulation. To the extent that these domestic investments decline with distance, this capital accumulation leads to an expansion in the local capital-intensive manufacturing industry, a contraction in the local land-intensive agricultural industry, and an increase in local population density.

We use the model to calculate a counterfactual in which we assume that Britain had no involvement in slavery. Comparing actual levels of economic activity in 1833 to those in this counterfactual, we find that slavery wealth raises national income by around 3.5 percent, which corresponds to a decade of growth in income per capita at the time. For the locations within Britain with the greatest involvement in slavery, total income increases by more than 40 percent. The model also suggests that slavery had important implications for the distribution of income: in the most exposed locations, capital owners' income rises by more than 100 percent, and the income of landowners falls by around 7 percent. Workers, on average, benefit from the industrial development induced and accelerated by slave wealth.

Our results do not suggest that slavery was essential for Britain's industrialization; nor do they demonstrate that its effects were largely irrelevant. Instead, our quantitative results mark a middle ground, with slavery significantly accelerating growth and structural change at the height of the Indusrial Revolution. The largest impact, according to our model, is on the geography of economic activity and the distribution of income, with towns and cities that are exposed to slave wealth growing faster. As a result, slavery wealth shifted the locus of economic activity to the North and West of the country, and it boosted the income of capitalists and workers at the expense of landowners.

We focus on Britain as our empirical setting because of the availability of direct data on slavery wealth. Here, slavery wealth may have had a larger effect on economic development than elsewhere because of favorable institutions and pre-existing technology which may have raised the return to capital. Nevertheless, we expect the mechanism in our model to apply more generally, whenever expansions in the set of investment opportunities stimulate capital accumulation and facilitate the rise of capital-intensive activities.

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