Slavery and the British Industrial Revolution*

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Abstract

We provide theory and evidence on the contribution of wealth from slavery to Britain's industrial revolution. We use granular data on the location of slaveholders within Britain and develop a novel instrument for slavery wealth. Prior to the big surge in slave trading in the 18th century, areas with high vs low slave wealth in 1833 were indistinguishable in terms of wealth. However, by the 1830s, slave holding is highly correlated with economic development – slave-holding areas are less agricultural, closer to cotton mills, and have higher property wealth. We rationalize these findings using a spatial general equilibrium model, in which slavery wealth alleviates collateral constraints, stimulates local investment, and hence expands production in capital-intensive sectors. To demonstrate causality, we use arguably exogenous variation in slave mortality on the passage from Africa to the Indies, driven by weather shocks. We show that weather-induced mortality conditioned success in the slave trade; ancestors' success in the slave trade is strongly predictive of slave holding in 1833. These findings strongly suggest that slavery may have contributed importantly to economic development during the British Industrial Revolution.

Keywords: slavery, industrial revolution, trade, finance

JEL: J15, F60, N63

++ Preliminary and incomplete - please do not share ++

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1 Introduction

Europeans enslaved millions on the African continent during their colonization of the Americas, consigning survivors of transatlantic slaving voyages to forced labor on sugar, tobacco, cotton and coffee plantations in the Caribbean and North and South America. In the process, Europeans accumulated wealth, either from the slave trade itself, or from plantation production, and the wider triangular trade from Europe-Africa-Americas that it facilitated. To what extent did this wealth contribute to the growth and economic development of modern Europe?

We provide new theory and evidence on the contribution of slavery to Britain's industrial revolution. We use granular data on the location of slaveholders within Britain from compensation payments made under the 1833 Abolition of Slavery Act. We combine these slaveholder compensation data with rich, spatially-disaggregated information on economic activity in Britain before and after its first participation in transatlantic slavery in the 1560s. To identify causal effects, we develop an instrument for slavery wealth using data on their slave-trading ancestors: Longer voyages increase the mortality of the enslaved during the middle passage, and the fewer the survivors, the lower slavery wealth in 1833. We show that areas with exogenously more slavery wealth grow faster, experience more structural change, and develop more mills and factories. We rationalize these findings using a spatial general equilibrium model, in which slavery wealth alleviates collateral constraints, stimulates local investment, and hence expands production in capital-intensive sectors.

A growing literature has documented slavery's adverse economic effects on African economic development: African countries exposed to the slave trade are still markedly poorer today, with lower levels of interpersonal trust (Nunn and Wantchekon 2011, Nunn 2008). While statues commemorating slave traders and slaveholders continue to adorn European cities, and endowed hospitals and libraries perpetuate their names, slavery's economic consequences in today's developed countries are not well understood. The idea that slavery and the trade in enslaved human beings jump—started the Industrial Revolution is not new: Eric Williams (1944) famously argued that Britain accumulated vast wealth from the triangular trade – and that it re-invested this wealth in the leading sectors of the Industrial Revolution. Indeed, no country had greater involvement in the transatlantic slave trade than Britain, and it also industrialized first. At the same time, quantitative economic historians have questioned the idea that the slave trade boosted economic development in Europe, and in industrializing Britain in particular. Profits from the slave trade were no higher than in other lines of business, the argument goes;

absolute levels of profit from the slave trade were small relative to the size of the British economy (Engerman 1972, Eltis and Engerman 2000).

In this paper, we make a number of contributions. First, we emphasize *slave holding* in addition to *slave trading*. The purchase and sale of human beings was only one part of the slave economy. Much of the wealth accumulated from slavery was derived from colonial sugar, tobacco, cotton and coffee plantations, which, as we argue later on, participation in the slave trade facilitated. Indeed, Solow (1993) argues that the profits from slave holding were an order of magnitude greater than direct profits from the slave trade itself.[1] To measure this wealth from slaveholding, we use a distinctive feature of our empirical setting: Britain, through the Abolition of Slavery Act in 1833, provided compensation payments to existing slaveholders. These compensation payments were substantial, equal to £20 million in current prices, around 40 percent of the government's budget, and 5 percent of gross domestic product (GDP), with the resulting debt not paid off until 2015. We use individual-level data on these compensation payments to more than 25,000 slaveholders, as compiled by historians over more than a decade in the *Legacies of British Slavery* database (Draper 2013, Hall et al. 2014). This allows us to directly measure slavery wealth for each slaveholder in terms of the total number of slaves and their assessed value.

Second, much of the existing debate about the Williams hypothesis has occurred at the level of the economy as a whole. Since many factors change over time at the aggregate 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 construct rich, spatially-disaggregated data on economic activity for periods both before and after British entry into transatlantic slavery. This allows us to check for differences in pre-trends between locations that subsequently have high or low slavery wealth.

Third, a key challenge in the existing debate about the Williams hypothesis is that slavery wealth is endogenous. To address this concern, we first use rich, geographically disaggregated data on local wealth prior to the rise of the slave economy, using property values in Britain dating back to 1086. We also develop a new instrumental variables estimation strategy based on the fact that many slave traders eventually became slaveholders, investing their riches in vast plantations in the West Indies. In the age of sail, the idiosyncracies of wind and weather heavily influenced the duration of transatlantic voy-

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

ages. Crowded and inhumane conditions on slave voyages led to high rates of mortality during the middle passage, and a primary determinant of mortality for the enslaved was voyage duration (Cohn and Jensen 1982, Eltis 1984). As voyage times increased because of unfavorable winds, water began to run out, and infectious diseases began to spread, leading to sharp increases in mortality among the enslaved. These high rates of mortality reduced the profits from slave trading and made it less likely that traders retained enough wealth to finance subsequent voyages. These inclement weather shocks both directly reduced wealth, and induced exit from the slave trade, leading to reduced slave-holder wealth in 1833 at the time of abolition. We therefore instrument 1833 slavery wealth using the average middle-passage mortality of slave-trading ancestors.

Fourth, we develop a quantitative spatial general equilibrium model that highlights a new mechanism through which slavery wealth affects economic development. Slavery investments differed from other investments in at least two important ways. First, the profitability of slavery investments depends on the shadow cost of enslaved labor rather than the wage of free workers. Second, slavery investments could easily be collateralized because enslaved people were treated as property, which could be mortgaged and used as security.[2] For both reasons, the wealth accumulated through slavery alleviated collateral constraints, thereby stimulating capital accumulation. In the presence of financial frictions, this capital accumulation occurs disproportionately locally, which in turn induces economic growth and structural transformation towards capital-intensive sectors such as manufacturing.

We begin by providing descriptive evidence on patterns of slaveholding in England and Wales. Slave holding is geographically concentrated around the three main slave trading ports of Liverpool, Bristol and London, but extends throughout England and Wales. We find strong correlations between measures of industrialization and slave holding at the time of abolition in 1833. Areas with greater slave holding have lower employment shares in agriculture, higher employment shares in industry, and are closer to mills and factories.

We use the persistent geography of slave holding to examine the timing of the emergence of these cross-sectional patterns of economic activity. We find no evidence of a relationship between property valuations from the Domesday Book (1086) and Lay Subsidies (1344) and subsequent slave holding, before Britain's entry into the slave trade in the 1560s. In contrast, we show that property values from Land Tax quotas (as reported

[2] Of the twelve rules governing slavery in the West Indies in (Stephen 1824), rule X states "The slave may be mortgaged, demised, and settled for any particular Estate or estates, in possession, remainder, or reversion." The Legacies of British Slavery Database contains many examples of slaves used as collateral.

in 1798 based on amended 1690 quotas) and rateable values (from 1815-1896) are strongly related to slave holding, after Britain's entry into the slave trade.

Using our instrument for slavery wealth from middle passage mortality and ancestral success in the slave trade, we find that exogenous increases in slave holding are associated with greater proximity to cotton mills and factories, greater wealth, a lower share of employment in agriculture, and a higher share of manufacturing employment in general.

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 descriptive evidence on patterns of slave holding and the evolution of economic activity within Britain over time. Section 6 develops the theroretical model that guides our empirical analysis. Section 7 reports our main instrumental variables estimation results and provides evidence on the model's key mechanism of local financing. Section 8 summarises our conclusions.

2 Related Literature

There is a large literature examining links between slavery and economic development. 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, and driven by psychological motives. 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 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... Capital comes dripping from head to foot, from every pore, with blood and dirt." In 1944, Eric Williams (1944) investigated the idea in his book *Capitalism and Slavery*. His hypothesis is best summarized when he says that

> "Britain was accumulating great wealth from the triangular trade. The increase of consumption goods called forth by 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..."

> and also in the following quote "Industrial expansion required finance. What man . . . was better able to afford the ready capital than a West Indian sugar planter or a Liverpool slave trade?'

Williams then argued that declining profitability of the slave trade led to its abolition.

Williams' hypothesis stimulated a large body of subsequent academic research on links between the triangular trade and industrial development in Britain. 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. Using data from the South Sea Company, Price and Whatley (2020) estimate the impact from financial returns from the monopoly on the trade of African slaves to Spanish America (the Asiento de Negros) that was initially granted by the British Parliament. While some studies focus on the profits from the slave trade, other historical research emphasizes the contribution of the wealth derived from colonial slavery plantations, including Darity (1990) and Inikori (2002). Using data from Maryland in the United States, González et al. (2017) provides empirical evidence that slavery wealth was an important source of collateral used to finance U.S. entrepreneurship. For the United States as a whole, 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. More broadly, Derenoncourt (2018) reviews the existing empirical literature on the role of slavery in the emergence of global inequality.

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. While the conceptual framework is similar to that of Williams, there is no detailed, quantitative data that would support the hypothesis in their work. Related research by Acemoglu and co—authors emphasizes that Atlantic trade, in general, led to better institutions, by strengthening the hand of merchants, in North—Western Europe (Acemoglu et al. 2005). However, these authors do not emphasize that much of this trade derived from the trafficking of African slaves.

Critical assessment of the Williams hypothesis falls into two broad categories – case studies of possible linkages and the profitability of Caribbean slavery, and quantitative assessments that seek to bound the maximum benefit that could have been derived from involvement in the slave trade (Engerman 1972). Some historians have argued that planters in the West Indies barely covered their cost and that profitability declined from the 1750s onwards (Ragatz 1928), but the notion is disputed (Ward 1978, Drescher 2010). Thomas and Bean concluded that Britain did not profit from the colonial system of slave—plantations producing colonial produce (Thomas and Bean 1974). Overall, the traditional conclusion from case studies is that the impact of slavery on Britain's economic development was relatively small. Eltis and Engerman (2000) concluded their analysis by saying, "African slavery ... did not ... cause the British Industrial Revolution ... its role was no greater than that of many other economic activities." In other words, while profitable, there was nothing special about slavery – the gains from it were just one of many activities that enriched Britons.

This rejection of the Williams hypothesis by economic historians has been questioned from a variety of angles. Solow (1985, 1993) emphasizes that the sugar trade was essential to the rise of the Spanish and Portuguese commercial empires. Related work has also argued that there are good theoretical reasons for why slavery in the 'periphery' benefited countries in the 'core' economically, along the lines of arguments more in line with the world—systems analysis of Wallerstein and others (Solow 1985, Findlay 1990). Findlay, for example, argues "slavery was an integral part 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."

Therefore, with a few exceptions, slavery currently stands as one of the – many – factors that economic historians appear to agree was not responsible for the transformation of Britain's economy – just like railways, empire, overseas trade, or the exploitation of women and children. However, recent reassessments are starting to change this picture. Summarizing the more recent research on the Williams hypothesis, Wright (2006) concluded by saying, "[t]aken together, the evidence suggests that there are more than a few grains of truth in the Williams thesis, long considered moribund." There nevertheless remains a scarcity of quantitative, well—identified evidence on the contribution of slavery towards Britain's Industrial Revolution.

Our research is also related to the wider literature on structural transformation and economic development, including Matsuyama (1992), Caselli and Coleman (2001), Lucas (2002), Antràs and Voth (2003), Ngai and Pissarides (2007), Uy et al. (2012), Herrendorf et al. (2012), Lagakos and Waugh (2013), Bustos et al. (2016), Gollin et al. (2016), Eckert and Peters (2018), Bustos et al. (2020), Caprettini and Voth (2020) and Fajgelbaum and Redding (2021). We contribute to research on the role of financial development in economic growth generally, and during the British Industrial Revolution in particular, including Gerschenkron (1962), Schumpeter (2017), King and Levine (1993), Guiso et al. (2004), Moll (2014), Itskhoki and Moll (2019), Heblich and Trew (2019), and Temin and

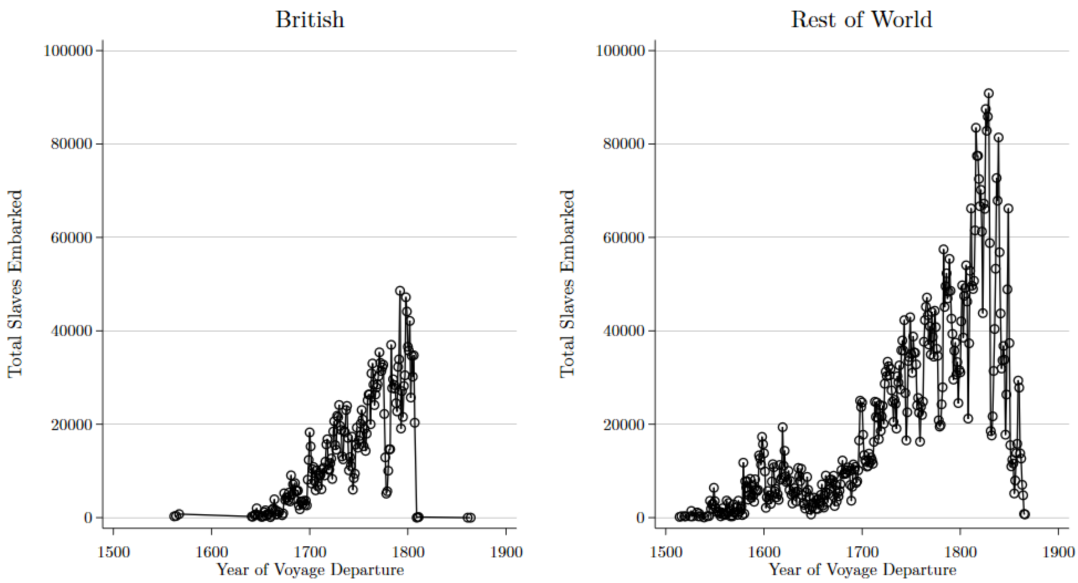
Voth (2013). Our main contribution relative to this research is to provide theory and evidence on the role of wealth from slavery in influencing structural transformation and economic development. The mechanism in our theoretical framework involves the relaxation of collateral constraints, which stimulates local capital accumulation, and leads to the expansion of capital-intensive sectors such as manufacturing.

3 Historical Background

Britain's involvement in the slave trade dates back to the 1560s to three voyages of Admiral Sir John Hawkins, a cousin of Sir Francis Drake. But its participation in the slave trade expanded substantially in the 1600s following the acquisition of its first American colonies. After the restoration of Charles II to the English throne 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, and from this point on most of the slave trade was financed and organized by individual ship owners.

By the 1700s, the "triangular trade" from Europe-Africa-Americas was the economic 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 slaves from the West Coast of Africa to the Americas; and the export of plantation products such as sugar, tobacco and cotton from the Americas to Britain. There was also substantial exchange of plantation products from the Caribbean for grain and livestock from the Eastern seaboard of what in 1776 became the United States of America.

Figure 1: Slave trade - annual total of enslaved persons shipped, British vs ROW



Note: Annual total number on enslaved persons transported across the Atlantic ocean using ships from British ports (left panel) and ships from the rest of the world (ROW) (right panel)

Figure 1 shows the annual number of slaves transported across the Atlantic by ships from British ports (left panel) and ships from the rest of the world (ROW, right panel). From 1701-1807, British ships are estimated to have have carried more than 2.5 million slaves across the Atlantic, more than one third of the more than 6 million slaves transported in total. The slave trade was 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. As the volume of the slave trade grew, the shares of each port in the total trade varied. London dominated in the period up to 1725, and was then overtaken by Bristol. From 1750 onwards, Liverpool surpassed both Bristol and London.

The wealth accumulated from slavery was far from evenly distributed within Britain. James Penny, who was heavily involved in the slave trade, predicted instant ruin from the abolition of the slave trade for 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).

For individuals, the levels of wealth achieved through slavery could be large. The Grade I-listed Harewood House in Yorkshire is one of England's finest country houses, and is still owned by the Lascelles family, who amassed much of their wealth from Slavery.

At the time of abolition in 1833, the Second Earl of Harewood received £26,307 in compensation payments for 1,277 slaves, which equals £19 million adjusted for inflation, or £128 million when expressed as the same share of GDP.[3] These wealthy slaveholders were politically represented by *The West India Interest*, centered on *The West India Club* on St. James's Street in fashionable Central London.

Over time, reports of the barbaric conditions on slave ships led to the formation of a campaign for the abolition of the slave trade, led by William Wilberforce, the Clapham Sect and the Quaker movement.[4] This campaign grew in strength following the especially heinous *Zong Massacre* of 1781. In the face of this growing campaign, the Abolition of the Slave Trade Act was ultimately passed in 1807, which prohibited the slave trade (but not slavery) in the British Empire.

Many abolitionists initially hoped that slavery would be unsustainable without the slave trade, but there was little voluntary movement towards emancipation from slaveholders. Further legislative progress was delayed by the French Revolutionary and Napoleonic Wars. Since enslaved people were treated as property, the West India Interest portrayed arguments for abolition as threats to private property. Eventually, a renewed abolitionist campaign led to the passage of the Slavery Abolition Act of 1833, which made the purchase or ownership of slaves illegal within the British Empire, with a few initial exemptions that were subsequently eliminated.

Under the terms of the 1833 Act, the British government raised £20 million for the compensation of slaveholders, equivalent to 40 percent of government revenue or 5 percent of GDP (Barro 1987). The resulting government debt was not fully paid off until 2015. Each slaveholder was required to register claims for the number of slaves held, which were systematically collected and processed by a Slave Compensation Committee. The compensation was divided up across different colonies and separate schedules were drawn up for each colony that specified a compensation rate per slave that depended on age and occupation. Compensation claims were paid from 1835 onwards.

These records from the Slave Compensation Committee provided the starting point for the *Legacies of British Slavery Database*, which over the course of more than a decade supplemented these records with a variety of additional sources of data, including genealogical information. In Section D.1 of the online appendix, we provide an example of

[3]The grandfather of the Earl of Harewood was Edwin Lascelles, born in Barbados without a title in 1712. A relative, Alan Lascelles, is The Queen's private secretary in Netflix's series The Crown.

[4]Black African writers played an important role in making these barbaric conditions more widely known, including Cugoano (1787) and Equiano (1789). For further discussion of the campaigns to abolish the slave trade and slavery, see Hague (2008), Scanlan (2020) and Taylor (2020).

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 slaves for each of these plantations.

At the anecdotal level, these records suggest that the profits from slave holding were indeed invested in new industrial activities. For example, of the 15 founders of Clarke, Acramans, Maze & Co (builders of the Great Western Cotton Works in Bristol), eight appear in slave compensation records, and one is the son of a slave owner. Similarly, Sir George Philips, owner of a cotton factory in Staffordshire and of Manchester textile warehouses, filed substantial claims for compensation. More generally, the Legacies of British Slavery Database provides numerous examples of slave wealth being invested in railways, port installations, and steel works (Hall et al. 2014). In the remainder of this paper, we provide theory and econometric evidence on the extent to which slavery wealth played a systematic role in Britain's industrial revolution.

4 Data

We construct a new spatially-disaggregated dataset on economic activity and slave holding within England and Wales.[5] We combine six main sources of data: (i) Individual compensation claims paid to slaveholders by the British parliament under the 1833 Abolition of Slavery Act; (ii) Individual slave-trading voyages from British ports; (iii) Population and employment structure; (iv) Property valuations; (v) Location of factories and mills; (vi) Family linkages ; (vii) Occupational structure.

Slave holding We use data from the British Legacies of Slavery Database as constructed over more than a decade by the Centre for the Study of the Legacies of British Slavery at University College London. Starting with the records of the Slave Compensation Committee, this database contains detailed information on compensation claims, the identity of the awardees, the legitimacy of their claims, and the ownership records of awardees. We use a digital version of this database, which includes information on 53,000 individuals connected to the slave trade, of whom 25,000 were awarded compensation for 425,000 slaves. Compensation claims report the amount of compensation awarded, the number of enslaved, and address information. We geocode the latitude and

[5]See the data appendix for further details about the data sources and definitions.

longitude coordinates for each slaveholder address in England and Wales.[6]

Slave voyages We use the slave voyages dataset constructed by Herbert Klein and collaborators.[7] This database contains information on 36,000 slave voyages, with a total of over 10 million slaves shipped across the Atlantic from 1526 onwards. Of these, 10,785 voyages were by British owners, involving the transportation of 2.9 million slaves 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; the number of enslaved embarked and disembarked; and the duration of the voyage. We use this information to calculate to the mortality rate for each slave voyage, which we use to construct our middle-passage mortality instrument.

Population and Employment Structure We obtain data on parish population from 1801-1891 from the population census of England of Wales. We construct data on employment structure for each parish from the individual-level records of the population census of England and Wales for 1831 (I-CeM), as documented in Schurer and Higgs (2020).[8] We distinguish employment in agriculture, manufacturing, and textiles, as a leading sector in the industrial revolution. We supplement these population census data with information on population and occupational structure from baptism records for years before 1801, as constructed by Shaw-Taylor and Wrigley (2014)

Mills and Factories We use data on the number of cotton mills and factories in each parish for the year 1839, 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.

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 experienced limited amendments,

[6]Slave holder addresses are also found in the Caribbean colonies, North or South America, or France and The Netherlands, since several British colonies were former French or Dutch colonies.

[7]Available online at `www.slavevoyages.org`.

[8]The individual level records from the 1871 population census have not yet been digitized.

because of political resistance to quota increases (Ginter 1992). In 1798, the Land Tax Perpetuation Act of Parliament made these land tax quotas unalterable by law, and they remained unchanged until the abolition of the land tax in 1963. For the years 1815, 1843, 1865, 1865, 1881, 1896, we digitized rateable values for each parish, which correspond to the 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 To link slave-traders with slave-holders in 1833, we exploit the fact that 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). We first use the slave trader data to identify individuals involved in the trade, and then examine the set of family trees on ancestry.com for possible matches. For each matched individual, we collect the universe of parents, grandparents, and great-grandparents (as far as they are available), to pinpoint geographical areas with which they have geneological links.

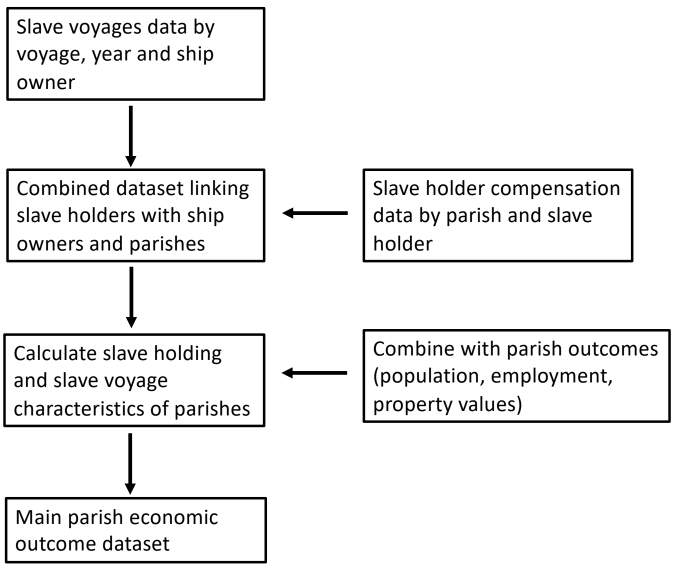
Occupational Structure To augment our measure of economic development, we collected data on occupational structure from city directories. We count the number of occupations at the vanguard of economic development (millwright, bookkeepers, engineer, clerk and manufacturer) in each location.

Data Structure Our main level of statistical analysis is the parish, which was historically the lowest level of local government in England and Wales, responsible for the provision of local public goods. Parish boundaries are relatively stable throughout most of the 19th century, but experience substantial changes after 1891, and for this reason we end our sample in that year. We construct constant boundary data on around 10,000 parishes using the classification provided by Shaw-Taylor et al. (2010).

We summarize the structure of our combined dataset in Figure 2 below. We first link the slaveholders who received compensation in 1833 to parishes. In our baseline specification, we allocate to each parish the total amount of compensation awarded and number of enslaved within 30 kilometers of the parish centroid.

We next link slave voyages before the abolition of the slave trade in 1807 to slaveholders who received compensation in 1833, exploiting the fact that many families who started out as slave traders ultimately ended up becoming slaveholders. In particular, we match the owners of slave voyages before 1807 to slaveholders in 1833 based on family names and the genealogical information on the ancestors of these slaveholders that is available in the Legacies of British Slavery Database. Using this ancestral link, we assign historical slave voyages to parishes based on our geocoded addresses of the slaveholders in 1833. We use this ancestral link to construct our middle-passage mortality instrument, as discussed further below.

Figure 2: Data Structure



Note: Our main level of statistical analysis is the parish; we assign compensation awarded and number enslaved to parishes based on the latitude-longitude coordinates of the addresses of slaveholders who received compensation in 1833; we connect the owners of slave voyages before 1807 to slaveholders in 1833 based on family names and the genealogical information on the ancestors of these slaveholders that is available in the Legacies of British Slavery Database. Using this connection between slave voyages before 1807 and slaveholders in 1833, we assign these historical slave voyages to parishes based on our geocoded addresses of the slaveholders in 1833.

5 Descriptive Evidence

We begin by providing descriptive evidence on the relationship between patterns of economic activity and slave holding within England and Wales. In Subsection 5.1, we examine this cross-section relationship at the time of the Abolition of Slavery in 1833. In Subsection 5.2, we use our historical data on property values to examine the timing of the emergence of this cross-section relationship.

5.1 Economic Activity and Slaveholding in the Cross-Section

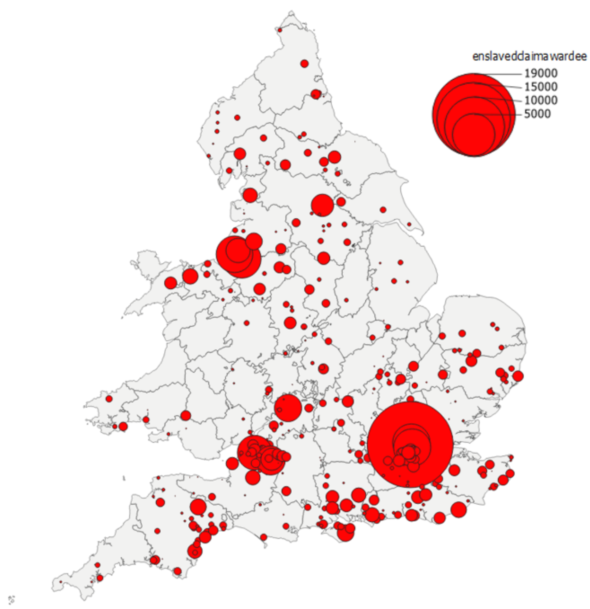
In Figure 3, we show the spatial distribution of slaveholder compensation in 1833 across parishes in England and Wales.[9] The grey polygons correspond to historical counties (e.g. Middlesex and Warwickshire). The size of the red circles is proportional the amount of slavery compensation awarded in current price 1833 pounds sterling.

We observe slaveholding throughout much of England and Wales. We find the greatest concentrations surrounding the three ports most heavily involved in the trade of slaves and the products of the slave economy (in particular, sugar, tobacco and cotton): Liverpool in the North-West, Bristol in the South-West, and London in the South-East. Slaveholder compensation is concentrated close to these ports, but extends throughout the interior areas of England and Wales, particularly in the main population concentrations of towns and cities.

In Figure 4, we show the agricultural employment share in each parish in 1851, as the first population census for which detailed data on occupational structure are available. Although the agricultural employment share for England and Wales as a whole had already fallen to 22 percent by 1851, there is substantial heterogeneity in agricultural specialization across parishes, with agriculture still accounting for more than 80 percent of employment in some parishes. Comparing Figures 3 and 4, we find a negative correlation between agricultural employment shares and slaveholder compensation.

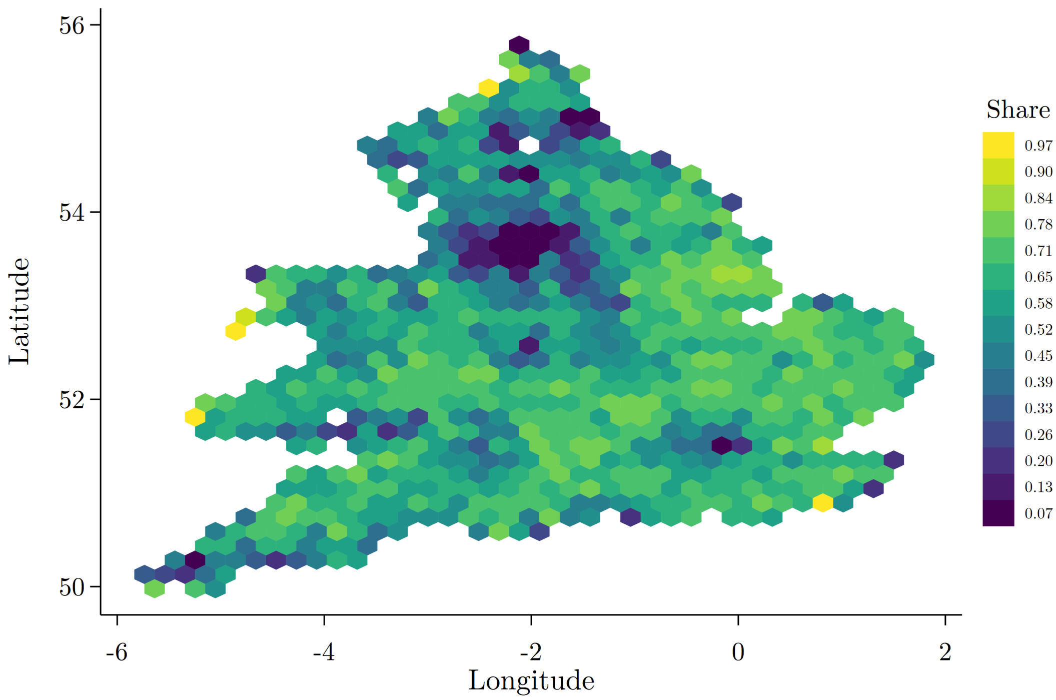
[9] We focus on England and Wales, because the population census is reported separately for these two countries; our historical property valuation data is unavailable for Scotland; and the Act of Union with Scotland occurs later in 1707 after the start of slave trading from the British Isles.

Figure 3: Slaveholder Compensation in 1833 in England and Wales



Note: Slaveholder compensation in each parish in 1833 current price pounds; grey polygons correspond to counties; size of red circles proportional to the total value of slaveholder compensation in each parish.

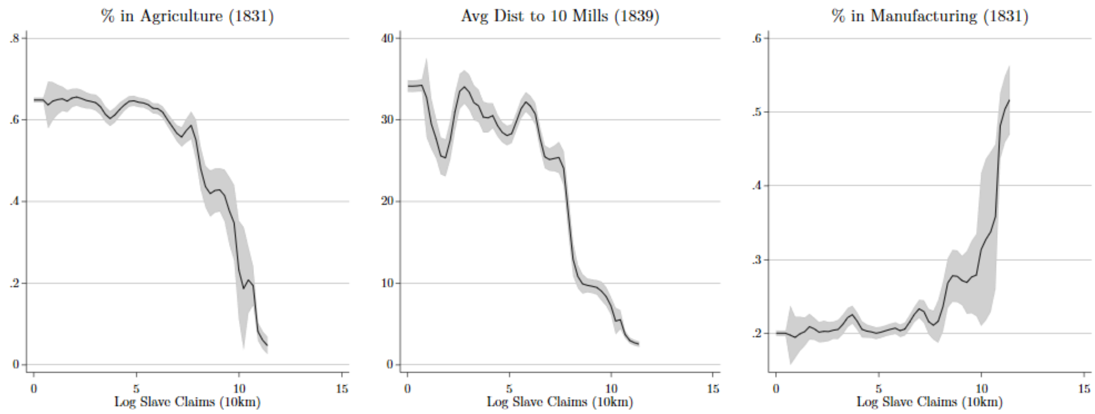
Figure 4: Agricultural labor share in 1831



Note: Agricultural employment share in each parish in the 1831 agriculture census; darker blue colors correspond to lower values; lighter yellow colors correspond to higher values.

In Figure 5, we provide further evidence on this correlation between structural transformation and slave holding at the time of abolition. We consider three measures of structural transformation: the agricultural employment share in 1851 (left panel), distance to the nearest cotton mill or factory in 1839 (middle panel) and the industry employment share in 1851 (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 claimed by slaveholders within 30 kilometers of a parish centroid in 1833. We find that areas with greater slave holding have lower agricultural employment shares, are closer to cotton mills or factories as the leading sector of the industrial revolution, and have higher industrial employment shares. While these relationships are purely statistical correlations, they motivate our theoretical framework below and our causal analysis of the impact of exogenous increases in slavery wealth on structural transformation and economic development.

Figure 5: Structural Transformation and Slaveholding at the Time of Abolition



Note: In all three panels, horizontal axis shows total number of enslaved within 10 kilometers of parish centroid in 1833; vertical axes show agricultural employment share in 1831 (left panel), average distance to nearest ten 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.

5.2 Economic Activity and Slave Holding over Time

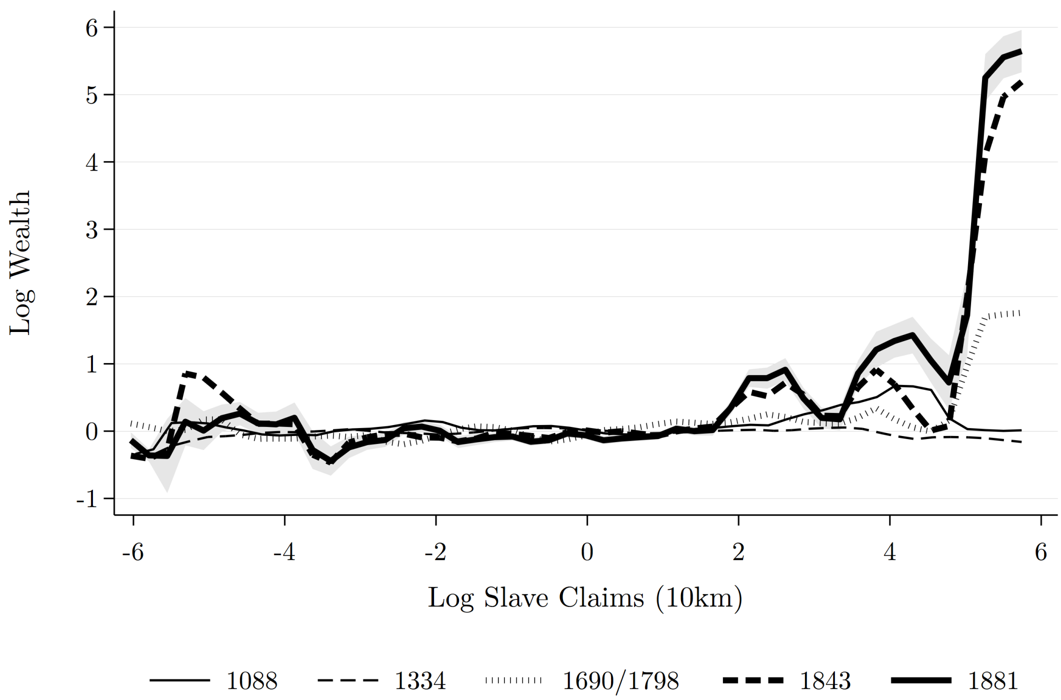
We next use our long historical time-series on property valuations to provide evidence on the timing of the emergence of this cross-sectional relationship between patterns of economic activity and slave holding. If causality runs from slavery wealth to industrialization and economic growth, we should expect to observe no relationship before large-scale British involvement in slavery from the 1600s onwards, and an emergence of a positive relationship from that date onwards.

We use slavery compensation in 1833 as a time-invariant measure of slave holding, exploiting the fact that the geography of slave holding within England and Wales is highly persistent over time.[10] We estimate non-parametric regressions of property valuations per land area in each year on this time-invariant measure of slave holding. We control for third variables that could affect both economic activity and slavery participation using the Frisch-Waugh-Lovell Theorem. We regress both property valuations and slave holding on these controls, generate the residuals, and then estimate our non-parametric regressions using these residuals. In our baseline specification, we control for latitude, longitude, distance to the coast, and distance to London. But we find that our estimated gradients are not sensitive to these controls, and we report robustness tests using a num-

[10] We use the genealogical information in the Legacies of British Slavery Participation to construct measures of the number of early slaveholders for each parish, and find these measures to be highly correlated with slave holding in 1833.

ber of different sets of controls.

Figure 6: Property Valuations and Slavery Participation over Time



Note: Local polynomial regressions; vertical axis is residual from regressing log parish property valuation per land area on the parish centroid's latitude, longitude, distance from the coast and distance from the City of London; horizontal axis is residual from regressing log 1833 slavery compensation within 10 kilometers of a parish centroid on the same control variables; gray shading shows 95 percent confidence intervals for 1881; see Section 4 of the paper and Section D of the online appendix for further details about the property valuation data for each year.

In Figure 6, we show the estimated gradient between the log of each of our measures of property valuation per land area and the log of our time-invariant measure of slave holding, after conditioning on our baseline set of controls. Both the residual property valuation and residual slavery participation measures have means of zero in logs. For 1086 (solid medium black line), we find a relatively flat relationship with only a slight upward slope. For 1334, we observe an even flatter relationship, with essentially no gradient. Therefore, we find little evidence of a relationship between levels of economic activity and our time-invariant measure of slave holding before large-scale British involvement in slavery in the 1600s.

In contrast, using our 1798 property valuation data based on the amended 1690 land tax quotas, we observe a substantial positive slope throughout most of distribution of slave holding, with a sharp upward tick at the highest levels of slave holding. By 1843, this positive slope steepens further, particularly at higher levels of slave holding. By

1881 towards the end of our sample period, there is a further steepening of this positive slope, which is again greater at higher levels of slave holding.

Therefore, following the beginning of large-scale British involvement in slavery in the 1600s, we observe the emergence of a strong positive relationship between economic activity and slavery participation within England and Wales. This corroborating evidence on timing provides additional motivation for our theoretical model of the relationship between structural transformation and slavery wealth in the next section, and our causal analysis of the impact of exogenous variation in slavery wealth further below.

6 Theoretical Model

To guide our empirical analysis, we develop a theoretical model of the impact of slavery wealth on structural transformation and economic development. We consider a set of small open economies that consists of many domestic locations $i \in N$ and an overseas colony N^*. There are three types of agents in the economy: capitalists and free workers in domestic locations and enslaved workers in the colony.

Agriculture and manufacturing are produced in the domestic economy. Plantation products are produced in the colony. Agricultural output is produced using free labor and land. Manufacturing output is produced using free labor and capital. Output of plantation products is produced using enslaved labor and capital.[11] All three goods are traded on world markets subject to bilateral trade costs.

Capitalists can allocate their wealth to domestic investments in manufacturing, colonial investments in plantation products, and/or a risk-free bond. They face collateral constraints, such that they can only pledge a fraction of their assets to finance new investments. These new investments satisfy a gravity equation, because of financial frictions that are increasing in geographical distance.

Slavery investments differ from domestic investments in two respects in the model. First, production costs for slavery investments depend on the cost of enslaved labor in the colony rather than the cost of free labor in the domestic economy. Second, slavery investments are more collateralizable, because enslaved people were treated as property that could be mortgaged and used as collateral.

[11]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 manufacturing both use capital, and manufacturing is more capital-intensive than agriculture.

We model the domestic economy's participation in slavery as a reduction in goods trade costs and financial frictions with the colony. Slavery participation affects structural transformation and economic development in the domestic economy, because of the combination of collateral constraints and financial frictions. In particular, slavery investments raise domestic wealth and increase the fraction of assets that are collateralizable, thereby increasing overall investment. Since investments satisfy a gravity equation, much of this increased investment occurs locally, which increases economic development, and induces structural transformation away from land-intensive agriculture towards capital-intensive manufacturing.

6.1 Preferences

Workers and capitalists in the domestic economy have the same logarithmic preferences. The indirect utility function for workers in location n at time t (u_{nt}) depends on amenities (b_{nt}), wages (w_{nt}) and a consumption goods price index (p_{nt}):

$$u_{nt} = \ln b_{nt} + \ln w_{nt} - \ln p_{nt}, \tag{1}$$

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.

Each location faces exogenous goods prices on world markets (p_t^{A*}, p_t^{M*}, p_t^{S*}). Each location is connected to these world markets through iceberg trade costs ($\tau_{it}^A \geq 1$, $\tau_{it}^M \geq 1$, $\tau_{it}^S \geq 1$), which we allow to vary across goods and over time. No-arbitrage implies that the prices of three goods in each location (p_{nt}^A, p_{nt}^M, p_{nt}^S), and hence the price of the consumption index (p_{nt}), are completely determined by the exogenous primitives of prices on world markets and bilateral trade costs.

6.2 Endowments and Factor Mobility

The domestic economy as a whole is endowed with a measure $\bar{L}_t$ of workers. Each worker has one unit of labor that is supplied inelasticity. Workers are perfectly mobile across locations within the domestic economy but perfectly immobile between the domestic economy and the colony.

From the indirect utility function (1), worker mobility implies that the wage in each domestic location is determined by amenities (b_{nt}), the price of the consumption index (p_{nt}), and the common level of worker utility across domestic locations ($\bar{U}_t$):

$$w_{nt} = \exp\left(\overline{U}_t p_{nt}/b_{nt}\right), \tag{3}$$

There is a unit continuum of capitalists in each domestic location who own the local stock of assets (a_{nt}) and are geographically immobile. Each domestic location is also endowed with an exogenous supply of land (m_n) that is owned by absentee landlords. We assume a perfectly elastic supply of slave labor in the colony available at an exogenous shadow cost of ω_{nt}, which is determined by the slave trade.

6.3 Technology

All three goods are produced under conditions of perfect competition using constant returns to scale Cobb-Douglas technologies.[12] Domestic agricultural output (y_{it}^A) is determined by inputs of labor (ℓ_{it}^A) and land (m_{it}^A) and productivity (z_{it}^A):

$$y_{it}^A = z_{it}^A \left(\frac{m_{it}^A}{\alpha^A}\right)^{\alpha^A} \left(\frac{\ell_{it}^A}{1-\alpha^A}\right)^{1-\alpha^A}, \qquad 0 < \alpha^A < 1, \qquad i \in N. \tag{4}$$

Domestic manufacturing output (y_{it}^M) depends on inputs of workers (ℓ_{it}^M) and capital (k_{it}^M) and productivity (z_{it}^M):

$$y_{it}^M = z_{it}^M \left(\frac{k_{it}^M}{\alpha^M}\right)^{\alpha^M} \left(\frac{\ell_{it}^M}{1-\alpha^M}\right)^{1-\alpha^M}, \qquad 0 < \alpha^M < 1, \qquad i \in N. \tag{5}$$

Colonial plantation output (y_{it}^S) is controlled by inputs of slaves (h_{it}^S) and capital (k_{it}^S) and productivity (z_{it}^S):

$$y_{it}^S = z_{it}^S \left(\frac{k_{it}^S}{\alpha^S}\right)^{\alpha^S} \left(\frac{h_{it}^S}{1-\alpha^S}\right)^{1-\alpha^S}, \qquad 0 < \alpha^S < 1, \qquad i = N^*. \tag{6}$$

[12]Throughout the following, we use n to denote the location of consumption or ownership, and i to denote the location of production, except where otherwise indicated.

6.4 Production

Using profit maximization in agriculture and land market clearing, equilibrium agricultural employment in each domestic location (ℓ_{it}^{A}) depends on prices (p_{it}^{A}), productivity (z_{it}^{A}), wages (w_{it}), and the exogenous supply of land (m_i):

$$\ell_{it}^{A} = \left(\frac{p_{it}^{A} z_{it}^{A}}{w_{it}}\right)^{\frac{1}{\alpha^A}} \left(\frac{1-\alpha^A}{\alpha^A}\right) m_i. \tag{7}$$

Given this exogenous supply of land (m_i), the equilibrium return to land (q_{it}) is determined by land market clearing:

$$q_{it} = \frac{\alpha^A}{1-\alpha^A} \frac{w_{it}\ell_{it}^{A}}{m_i}. \tag{8}$$

From profit maximization in manufacturing, equilibrium manufacturing employment is determined a similar way, except that the capital input is endogenous:

$$\ell_{it}^{M} = \left(\frac{p_{it}^{M} z_{it}^{M}}{w_{it}}\right)^{\frac{1}{\alpha^A}} \left(\frac{1-\alpha^M}{\alpha^M}\right) k_{it}^{M}. \tag{9}$$

Combining profit maximization and zero profits, the rental rate for capital (r_{it}) in each domestic location is pinned down by productivity (z_{it}^{M}), prices (p_{it}^{M}) and wages (w_{it}):

$$r_{it} = \left(p_{it}^{M} z_{it}^{M}\right)^{\frac{1}{\alpha^M}} \left(w_{it}\right)^{\frac{1-\alpha^M}{\alpha^M}}. \tag{10}$$

Using profit maximization in plantation production, equilibrium input of slave labor in the colony depends on exogenous prices ($p_{N^*t}^{S}$), productivity ($z_{N^*t}^{S}$) and the shadow cost of slave labor (ω_{N^*t}), and the endogenous capital allocation ($k_{N^*t}^{S}$):

$$h_{N^*t}^{S} = \left(\frac{p_{N^*t}^{S} z_{N^*t}^{S}}{\omega_{N^*t}}\right)^{\frac{1}{\alpha^S}} \left(\frac{1-\alpha^S}{\alpha^S}\right) k_{N^*t}^{S}. \tag{11}$$

Combining this implication of profit maximization with zero profits, the colonial rental rate for capital (r_{N^*t}) is fully determined by exogenous productivity ($z_{N^*t}^{S}$), prices ($p_{N^*t}^{M}$) and the shadow cost of slave labor (ω_{N^*t}):

$$r_{N^*t} = \left(p_{N^*t}^{S} z_{N^*t}^{S}\right)^{\frac{1}{\alpha^S}} \left(\omega_{N^*t}\right)^{\frac{1-\alpha^S}{\alpha^S}}. \tag{12}$$

With a continuum of capitalists and competitive markets, each individual capitalist perceives a constant rental rate for capital in each domestic location (r_{it}) and the colony (r_{N^*t}) from these two zero-profit conditions (10) and (12), respectively. In the presence of imperfect capital mobility, these rental rates for capital can differ across locations, but are linked through the endogenous supply of capital, as discussed further below.

6.5 Labor Market Clearing

Total employment in each location (ℓ_{it}) is equal to the sum of employment in agriculture (ℓ_{it}^A) and manufacturing (ℓ_{it}^M). Labor market clearing requires that the sum of total employment across all domestic locations equals the economy's supply of labor:

$$\sum_{i \in N} \ell_{it} = \sum_{i \in N} \ell_{it}^A + \sum_{i \in N} \ell_{it}^M = \overline{L}_t. \tag{13}$$

From equations (7), (9) and (13), the allocation of employment between agriculture and manufacturing in each domestic location is determined in a similar way to the conventional specific-factors model of international trade, with two key differences. First, the supply of capital in each domestic location (k_{it}^M) is endogenously determined by capital allocation decisions. Second, the total supply of labor in each domestic location (ℓ_{it}) is endogenously determined by population mobility.

As in the conventional specific factors model, an increase in the supply of capital in a given domestic location (k_{it}^M) increases the value marginal product of labor in capital-intensive manufacturing, and hence induces structural transformation by reallocating labor from land-intensive agriculture to capital-intensive manufacturing. Unlike the conventional specific-factors model, this increase in the value marginal product of labor also attracts population from other locations, until the real wage rises in other locations to restore worker utility equalization across all locations.

6.6 Capital Allocation Within Periods

At the beginning of period t, the capitalists in location n inherit an existing stock of assets a_{nt}, and choose consumption and asset accumulation. Capitalists can either invest their assets in manufacturing capital in domestic locations, plantation capital in the colony, or a risk-free bond that pays a constant rate of return ρ^*. Total investments in capital (summing across domestic manufacturing and colonial plantation products) are subject to a collateral constraint, such that $k_{nt} \leq \lambda_{nt} a_{nt}$ for $\lambda_{nt} > 1$. Both domestic and colonial investments in capital depreciate at a constant rate δ.

Once these asset allocation decisions have been made, production and consumption occur. At the end of period t, capitalists receive the returns from their asset allocation decisions, and the depreciation of existing capital occurs. In the remainder of this subsection, we characterize capitalists' asset allocation decisions for given consumption and asset accumulation decisions. In the next subsection, we characterize capitalists' optimal consumption and asset accumulation decisions.

We assume that capitalists are heterogeneous in terms of ideas for productive capital investments, such that each capitalist has a downward-sloping marginal efficiency of investment locus across locations. In particular, we assume that capitalist ς in location n experiences an idiosyncratic shock to the productivity of using capital in location i at time t ($\epsilon_{nit}(\varsigma)$), which corresponds to the number of effective units of capital for that use. We also assume that capitalists in location n face financial frictions in investing in each location i at time t, such that $\phi_{nit} \geq 1$ effective units of capital must be invested in order for one effective unit of capital to be available for productive use. Therefore, the realized return to capitalist ς in location n from investing in location i is:

$$v_{nit}(\varsigma) = \frac{\epsilon_{nit}(\varsigma) r_{it}}{\phi_{nit}}, \tag{14}$$

where recall that r_{it} is the rental rate for capital in location i at time t.

We assume that these idiosyncratic shocks to capital productivity are drawn independently across capitalists and locations from the following Fréchet distribution:

$$F(\epsilon) = e^{-\epsilon^{-\theta}}, \qquad \theta > 1, \tag{15}$$

where we have normalized the Fréchet scale parameter to one, because it enters the model isomorphically to financial frictions; and the Fréchet shape parameter (θ) controls the sensitivity of investments to the rental rate net of financial frictions.

A first key implication of this specification of idiosyncratic capital productivity is that the model provides microfoundations for a gravity equation in investment. In particular, the share of capital owned in location n that is invested in location i depends on relative rental rates for capital (r_{it}) and financial frictions (ϕ_{nit}):

$$\xi_{nit} = \frac{k_{nit}}{k_{nt}} = \frac{\left(r_{it}/\phi_{nit}\right)^{\theta}}{\left(r_{N^*t}/\phi_{nN^*t}\right)^{\theta} + \sum_{j \in N} \left(r_{jt}/\phi_{njt}\right)^{\theta}}, \tag{16}$$

where we assume that these financial frictions (ϕ_{nit}) are increasing in the geographical distance between locations.

Therefore, each location faces an upward-sloping supply function for capital (16) in the rate of return (r_{it}) that it offers relative to other locations. As the Fréchet shape parameter θ converges towards infinity, we obtain the limiting case of perfect capital mobility, in which the rental rate for capital is either equalized across locations, or all capital is allocated to the location with the highest rental rate. More generally, the rental rates for capital can differ between locations, and the extent of these differences is regulated by this upward-sloping supply function for capital.

Capital market clearing implies that manufacturing capital inputs in each domestic location (k_{it}^{M}) and plantation capital inputs in the colony (k_{nN^*t}) are equal to the sum of across locations of equilibrium capital allocations:

$$k_{it}^{M} = \sum_{n \in N} \xi_{nit} k_{nt}, \qquad k_{N^*t}^{S} = \sum_{n \in N} \xi_{nN^*t} k_{nt}. \tag{17}$$

A second key implication of this specification of idiosyncratic capital productivity is that expected returns to capital investments (taking into account the idiosyncratic productivity shocks) are equalized across all locations. Using the properties of the Fréchet distribution, the expected return for capitalists in location n conditional on investing in location i is the same across all locations i and given by:

$$v_{nt} = v_{nit} = \Gamma\left(\frac{\theta - 1}{\theta}\right) \left[\left(r_{N^*t}/\phi_{nN^*t}\right)^{\theta} + \sum_{j \in N} \left(r_{jt}/\phi_{njt}\right)^{\theta} \right]^{\frac{1}{\theta}}, \tag{18}$$

where $\Gamma(\cdot)$ is the Gamma function.

Therefore, although rental rates for capital (r_{it}) can differ across locations for finite values of the Fréchet shape parameter θ, the expected return to capital (taking into account the idiosyncratic productivity draws) is always equalized across locations. As a result, capitalists total income (V_{nt}) is linear in the existing stock of capital:

$$V_{nt} = v_{nt} k_{nt}. \tag{19}$$

Note that lower financial frictions with the colony (ϕ_{nN^*t}) imply a higher expected return to capital (v_{nt}) in equation (18), because more capital is available for production after incurring these financial transactions costs. More broadly, the expected return to capital

(v_{nt}) is increasing in the number of locations in which capitalists can invest in equation (18), because each location brings another Fréchet draw for capital productivity, and each capitalist allocates capital to highest return use after taking into account these capital productivity draws.

Given this linearity of capitalists' total income in the existing stock of capital, investment decisions are characterized by a corner equilibrium. If the rate of return on capital net of depreciation ($v_{nt} - \delta$) exceeds the rate of return on the risk-free bond (ρ^*), capitalists allocate all of their assets to investments in capital up to the collateral constraint (λ_{nt}). Otherwise, capitalists allocate all of their assets to the risk-free bond. We thus obtain the following characterization of optimal asset allocation decisions:

$$\begin{aligned} k_{nt}\left(a_{nt}\right) &= \quad \lambda_{nt} a_{nt} \cdot 1_{\{(v_{nt}-\delta)>\rho^*\}}, \\ k_{nit}\left(a_{nt}\right) &= \xi_{nit} \lambda_{nt} a_{nt} \cdot 1_{\{(v_{nt}-\delta)>\rho^*\}}. \end{aligned} \tag{20}$$

For sufficiently high financial frictions (ϕ_{nit}), capitalists have lower expected returns to capital net of depreciation ($v_{nt} - \delta$) than the return on the risk-free bond (ρ^*), and hence invest all of their assets in the risk-free bond. In contrast, for sufficiently low financial frictions (ϕ_{nit}), capitalists have higher expected returns to capital ($v_{nt} - \delta$) than the return on the risk-free bond (ρ^*), and thus invest all of their assets in capital up to the collateral constraint (λ_{nt}). A fraction of these capital investments are allocated to manufacturing in each domestic location and the remaining fraction is allocated to the colonial plantation. These capital investments satisfy a gravity equation, in which financial frictions increase with geographical distance. Therefore, domestic manufacturing investments are geographically concentrated locally.

6.7 Capital Allocation Across Periods

Capitalists make their consumption and asset accumulation decisions to maximize intertemporal utility subject to their budget constraint. Capitalists' intertemporal utility equals the net present discounted value of their flow of utility each period:

$$U_{nt}^k = \sum_{t=0}^{\infty} \beta^t \ln c_{nt}^k, \tag{21}$$

where the superscript k denotes the value of a variable for capitalists; β denotes the discount rate; and we omit the term in amenities for capitalists, because they are geographically immobile, and hence this term plays no role for equilibrium allocations.

Capitalists' intertemporal budget constraint requires that income from the existing stock of assets equals consumption plus the net accumulation of assets. We assume that the investment technology for accumulating capital uses the agricultural, manufacturing and plantation goods with the same functional form as consumption, such that one unit of capital can be produced using one unit of the consumption index. Given this investment technology, the intertemporal budget constraint is:

$$p_{nt}c_{nt}^{k} + p_{nt}\left(a_{nt+1} - a_{nt}\right) = R_{nt}a_{nt}, \tag{22}$$

where R_{nt} is the gross return to capital:

$$R_{nt} = \frac{\max\left\{\left(v_{nt} - \left(\rho^{*} + \delta\right)a_{nt}\right), 0\right\}}{a_{nt}} + \rho^{*}. \tag{23}$$

Given our assumption of logarithmic utility and the property that the intertemporal budget constraint is linear in the existing stock of assets, capitalists' optimal consumption-saving decision involves a constant saving rate, as in Moll (2014):

$$a_{nt+1} = \beta\left(R_{nt}/p_{nt} + 1\right)a_{nt}. \tag{24}$$

Using this constant equilibrium saving rate, we can characterize the evolution of assets over time. Capitalists in locations with high financial frictions (ϕ_{nit}) invest all their assets in the risk-free bond, and accumulate these assets at a rate determined by the return on this risk free bond (ρ^{*}). In contrast, capitalists in locations with low financial frictions (ϕ_{nit}) invest all their assets in capital up to the collateral constraint (λ_{nt}), and accumulate these assets at a rate determined by the expected return on investment net of depreciation ($v_{nt} - \delta$).

6.8 General Equilibrium

We now turn to the general equilibrium of the economy. The state variables of the economy are capitalists' assets in each location (a_{nt}). To characterize general equilibrium, it proves convenient to distinguish between a static equilibrium in period t for given values of these state variables, and a sequential equilibrium for all future points in time $s \geq t$ that endogenizes the evolution of these state variables over time. We begin by formally defining a static equilibrium.

Definition 1 *A static equilibrium is defined for given assets in each location (a_{nt}), goods prices on world markets (p_t^{A*}, p_t^{M*}, p_t^{S*}), the shadow cost of enslaved labor (ω_{N^*t}) and collateral constraints (λ_{nt}) in year t. Given these values, a static equilibrium is set of allocations $\{\ell_{nt}^A$, ℓ_{nt}^M, k_{nt}^M, $k_{N^*t}^S$, $\xi_{nit}\}$ and prices $\{p_{nt}^A$, p_{nt}^M, $p_{N^*t}^S$, w_{nt}, r_{nt}, $q_{nt}\}$ for year t that solves no-arbitrage in goods markets; profit maximization and zero profits; income equals expenditure; labor, capital and land market clearing; and population mobility.*

We next formally define a sequential equilibrium for all future points in time, taking into account the evolution of the state variables.

Definition 2 *A sequential equilibrium is defined for given initial assets in each location (a_{nt}) in year t and a sequence of future values for goods prices on world markets (p_s^{A*}, p_s^{M*}, p_s^{S*}), the shadow cost of enslaved labor (ω_{N^*s}) and collateral constraints (λ_{ns}) in years $s > t$. Given these values, a sequential equilibrium is a sequence of values for assets (a_{ns}), allocations $\{\ell_{ns}^A$, ℓ_{ns}^M, k_{ns}^M, $k_{N^*s}^S$, $\xi_{nis}\}$ and prices $\{p_{ns}^A$, p_{ns}^M, $p_{N^*s}^S$, w_{ns}, r_{ns}, $q_{ns}\}$ in years $s \geq t$ that solves no-arbitrage in goods markets; profit maximization and zero profits; income equals expenditure; labor, capital and land market clearing; and population mobility.*

6.9 Comparative Statics

We now use the model to examine the impact of participation in slavery on structural transformation and economic development in the domestic economy. Based on the uneven distribution of slave holding within England and Wales, we model participation in slavery as a reduction in financial frictions for colonial slavery investments (ϕ_{nN^*t}) for some domestic locations relative to others.

A reduction in a domestic location's financial frictions for colonial slavery investments (ϕ_{nN^*t}) has two main effects on asset allocation and accumulation decisions. First, from the capital allocation shares (16), the resulting increase in the colonial rental rate net of financial frictions (r_{N^*t}/ϕ_{nN^*t}) leads this domestic location to reallocate some of its existing capital from domestic manufacturing investments to colonial plantation investments. Given the gravity structure of investment, this reduces the existing capital used in domestic manufacturing in surrounding locations. Second, from the expected return to capital (18), the increase in the colonial rental rate net of financial frictions (r_{N^*t}/ϕ_{nN^*t}) also increases this domestic location's expected return on investment (v_{nt}), which increases its rate of capital accumulation and steady-state capital stock. Given the gravity structure of investment, this second response increases both the rate of growth and steady-state stock of domestic manufacturing capital in surrounding locations.

Proposition 1 *Given assets in each location (a_{nt}), goods prices on world goods markets (p_t^{A*}, p_t^{M*}, p_t^{S*}), the shadow cost of enslaved labor (ω_{N^*t}) and collateral constraints (λ_{nt}), a reduction in colonial financial frictions for domestic location i (ϕ_{iN^*t}), holding constant colonial financial frictions for all other domestic locations n, raises **(i)** the expected return to investment (v_{nt}); **(i)** the rate of investment; and **(iii)** the steady-state capital stock.*

Proof. See Section C of the online technical appendix. ■

Given the specific-factors structure of production, this more rapid growth of domestic manufacturing capital leads to both structural transformation and economic growth. First, as the stock of capital in domestic manufacturing increases over time, this raises labor's value marginal product of labor in that sector relative to its value marginal product in agriculture, which leads to a reallocation of employment from agriculture to manufacturing, until the value marginal product of labor is equalized across both sectors. Second, the higher value marginal product of labor increases wages and utility, which attracts population from other locations, until the value marginal product of labor in other locations rises to restore utility equalization across all locations.

Proposition 2 *Given assets in each location (a_{nt}), goods prices on world markets (p_t^{A*}, p_t^{M*}, p_t^{S*}), the shadow cost of enslaved labor (ω_{N^*t}) and collateral constraints (λ_{nt}), a reduction in colonial financial frictions for domestic location i (ϕ_{iN^*t}), holding constant colonial financial frictions for all other domestic locations n (ϕ_{nN^*t}) leads to **(i)** a higher steady-state manufacturing employment share; **(ii)** a lower steady-state agricultural employment share; **(iii)** a higher steady-state total population.*

Proof. See Section C of the online technical appendix. ■

In summary, this comparative static for a reduction in financial frictions for colonial slavery investments generates an exogenous increase in the rental rate net of financial frictions for slavery investments. This exogenous increase in the rate of return to slavery investments leads to greater capital accumulation, a rise in the manufacturing employment share, a decline in the agricultural employment share, and an increase in total population.[13] We now turn to provide empirical evidence in support of these theoreti-

[13] Although we focus on a reduction in financial frictions for colonial slavery investments (lower ϕ_{nN^*t}), similar predictions hold for a relaxation in collateral constraints (higher λ_{nt}), which again increases capital accumulation and induces structural transformation and economic growth.

cal predictions using an exogenous source of variation in the rate of return to slavery investments based on shocks to middle-passage mortality.

7 Identification and results

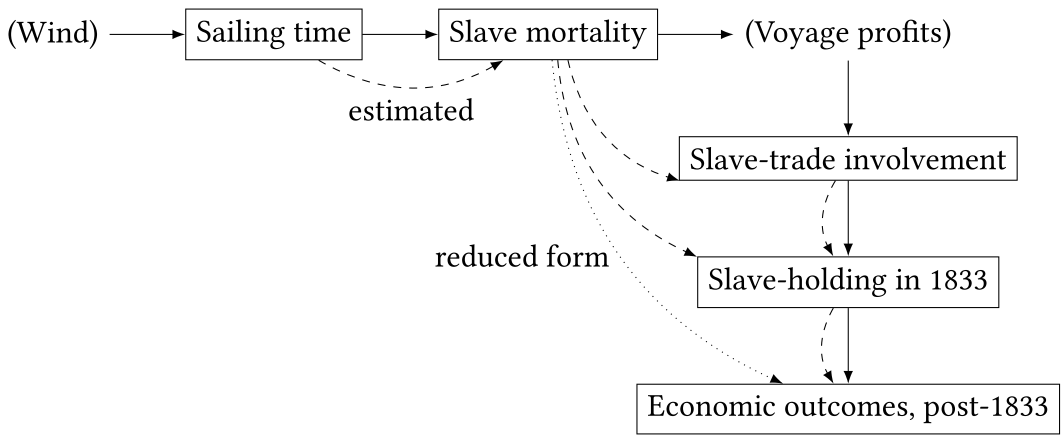
A key implication of our theoretical framework is that an exogenous shock to slavery wealth stimulates local capital accumulation and induces an expansion of the capital-intensive manufacturing sector. We now provide empirical evidence in support of this prediction using exogenous variation in slavery wealth based on middle-passage mortality. In Section 7.1, we explain the construction of our middle-passage mortality instrument. In Section 7.2, we provide some specification checks on the causal mechanism underlying our identification strategy. In Section 7.3, we report our main instrumental variables estimation results. In Section **??**, we provide further evidence in support of the model's mechanism of local capital accumulation.

7.1 Middle-Passage Mortality

Our identification strategy uses the well—known link between slave trading and slave holding. Many families started out slave trading, and through the resulting connections to the slave economy, transitioned into slave holding (as discussed in Hall et al. 2014). We therefore use our genealogical link between 1833 slaveholders and their slave-trading ancestors to construct an exogenous source of variation in slave holding based on realizations for middle-passage mortality on slave-trading voyages.

The key ideas underlying our identification strategy are shown in Figure 7. First, starting from the top-left, in the age of sail, idiosyncratic wind conditions had a substantial effect on voyage duration across the Atlantic. Second, voyage duration was an important determinant of slave mortality during their passage under crowded, insanitary and inhumane conditions on slave ships. As sailing times increased, water ran out and infectious diseases spread, leading to sharp increases in middle-passage mortality. Third, moving further to the right, higher middle-passage mortality reduced the profitability of slaving 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. Fifth, moving further downwards, lower involvement in the slave trade reduced the likelihood of traders making the transition to slave holding as plantation owners, and the wealth they could use to do so. In sum, as bad weather shocks both directly lowered trader wealth, and induced exit from the slave trade, they reduced slave holder wealth in 1833 at the time of abolition.

Figure 7: Identification strategy



Note: Solid arrows are causal relationships; dashed arrows are estimated relationships; variables in parentheses are unobserved; dotted arrows are reduced-form relationships.

7.2 Causal Mechanism

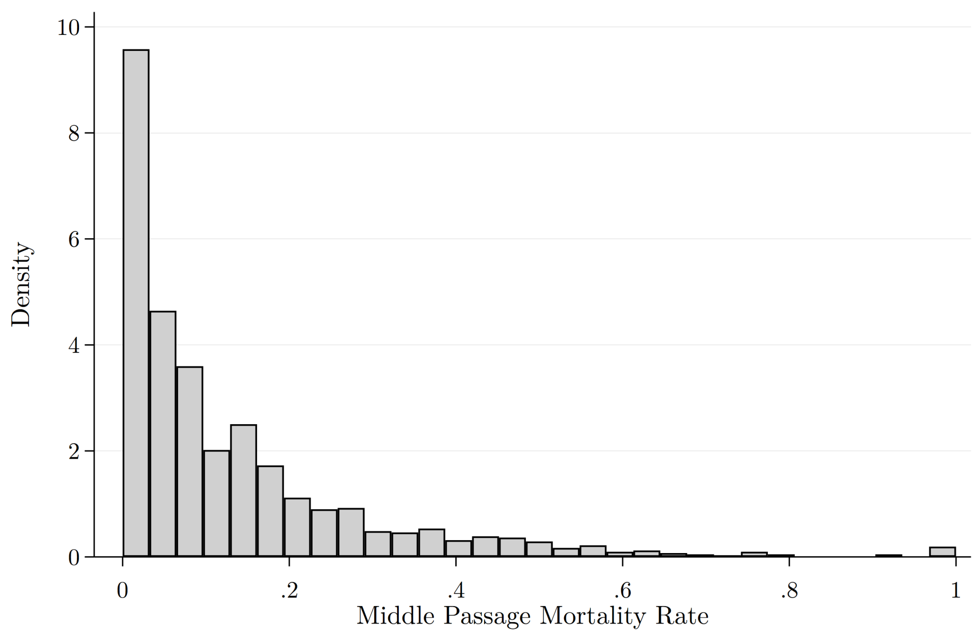
We now provide further evidence on each of the steps in this causal chain. Wind speed and direction were the main determinants of ship speed and voyage times in the age of sail (Pascali 2017). Both were subject to substantial fluctuations with atmospheric conditions. Based on analyses of ship log books, transporting slaves from West Africa to the West Indies typically took from 25-60 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 people led to sharp increases in mortality, as documented in Kiple and Higgins (1989).

We now use data from the Slave Voyage database to provide further evidence on these relationships. In Figure 8, we show a histogram of 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. Financing slave voyages required considerable upfront capital investments in ship and crew and to purchase slaves in West Africa. The main source of revenue was the sale of these slaves in the Americas. Therefore, high mortality rates on slave voyages could result in substantial losses for the slave traders involved.

In Figure 9, we show a binscatter of middle-passage mortality against the duration in days of the voyage from West Africa to the Americas. We find a strong and approximately linear relationship, consistent with the historical literature emphasizing voyage duration as the main determinant of middle-passage mortality.

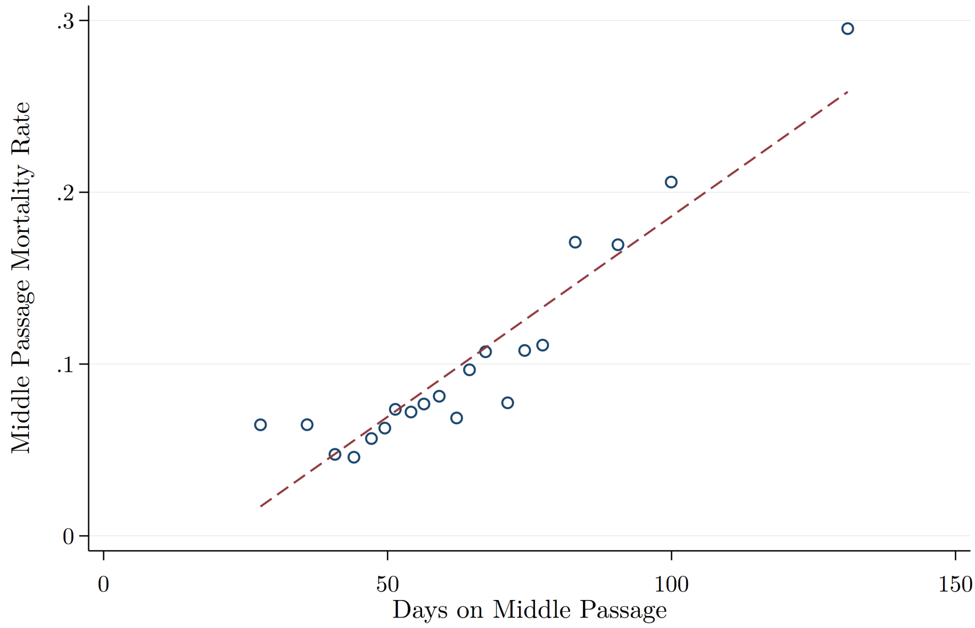
We now provide evidence on the role of voyage duration and middle-passage mortality in shaping continued involvement in the slave trade. In Figure 10, we display mean survival probabilities for slave traders across the number of slave voyages n. We compute these mean survival probabilities from voyage n to $n+1$ separately for slave traders that experienced above and below median middle-passage mortality during voyage n. Consistent with the idea that adverse wind conditions and low voyage profits made it less likely that individuals were able to continue in the slave trade, we find lower business 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 stayed involved, whereas less than 20 percent of those exposed to above-median mortality continued to participate.

Figure 8: Histogram of middle-passage mortality for slave voyages from British ports



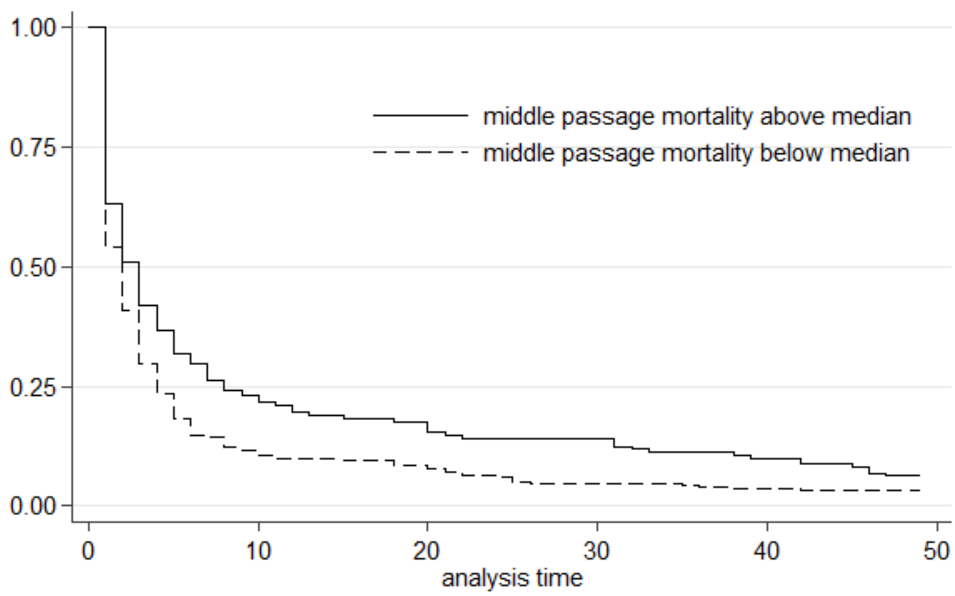
Note: Histogram of slave mortality rates ((slaves embarked - slaves disembarked)/slaves embarked) across slave voyages from British ports.

Figure 9: Middle-passage mortality and voyage duration



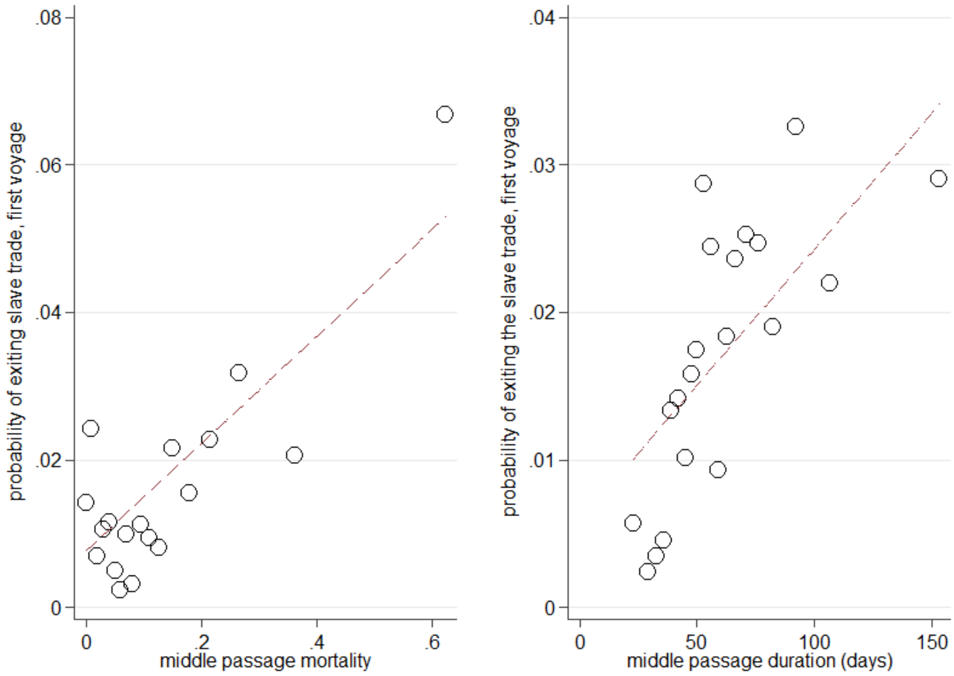
Note: Binscatter of slave mortality rates ((slaves embarked - slaves disembarked)/slaves embarked) against duration of slave voyages from British ports; bin scatter computed using data on individual slave voyages; circles correspond to ventiles of the data; red dashed lines shows the linear fit.

Figure 10: Survival probabilities for slave traders by middle-passage mortality



Note: Horizontal axes is number of slave voyages n; Vertical axis is survival probability from slave voyage n to slave voyage $n+1$; mean survival probabilities shown separately for middle-passage voyages with above and below median mortality during voyage n.

Figure 11: Determinants of exit from the slave trade, first voyage



Note: Horizontal axis shows middle passage mortality during the first slave voyage of a ship owner; vertical axis shows probability of exiting the slave trade after this first slave voyage; blue circles correspond to ventiles of this relationship; red line shows the linear fit.

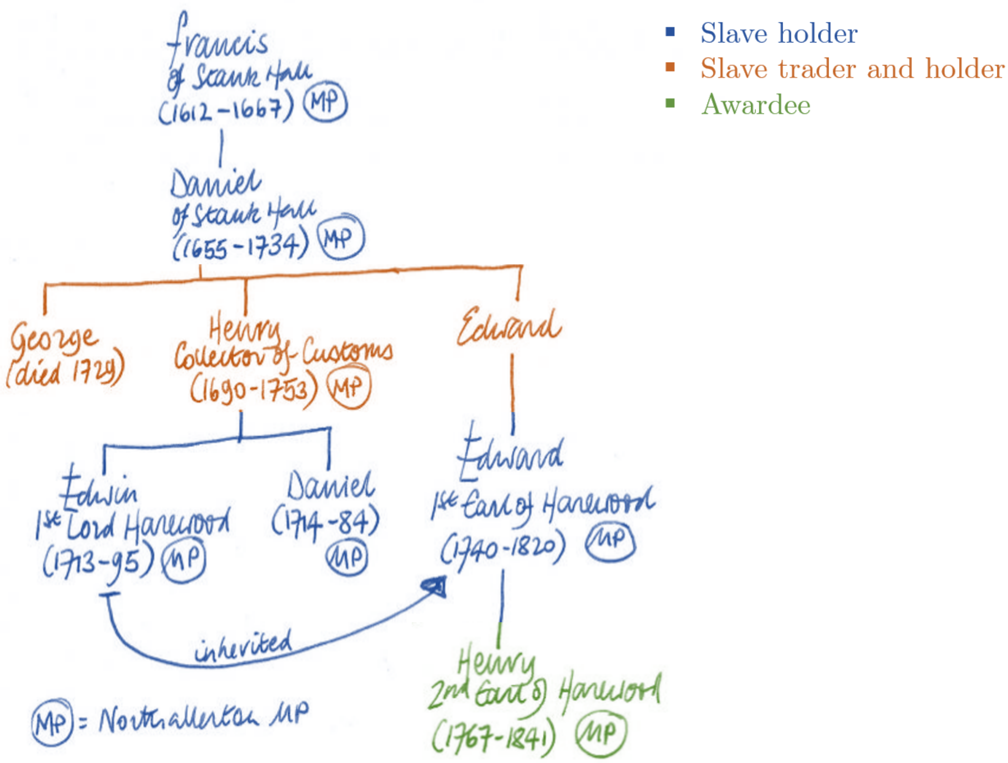
From Figure 10, we find that bad weather conditions and high middle-passage mortality are particularly influential in shaping continuing slave trade involvement for the first voyage, where some 40 percent of slave traders only participate in a single slave voyage. In Figure 11, we probe this relationship further by showing binscatters of the probability that a slave trader exits after a single voyage against middle-passage mortality (left panel) and voyage duration (right panel).

We find strong and approximately linear relationships between the probability of exit after a single voyage and both middle-passage mortality and voyage duration. This pattern of results is consistent with selection on profitability in the slave trade, where many first-time slave traders had relatively small levels of wealth. 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 saw their initial wealth levels fall, which could preclude further participation in the slave trade.

We thus find strong evidence in support of our causal mechanism where weather conditions and middle-passage mortality are strongly predictive of continued participation in the slave trade. In the next section, we provide further evidence that the accumulated sequence of realizations for middle-passage mortality experienced by slave trading ancestors in each parish is strongly predictive of slave holding in that parish in 1833 at the time of abolition.

We exploit the fact that mortality shocks conditioned the success of slave traders, and their continued involvement in the slave trade. Next, we trace the *ancestors of slave traders* through their family trees on Ancestry.com, and create two groups – successful traders's ancestors (where the trader engaged in more than one voyage), and the rest (with only one voyage). The idea of tracing the ancestors of slave traders provides an indirect method of linking locations all across England to the slave trade. 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 inherit or benefit from the business advice of a relative, remained near the ancestral home. For example, the Lascelles family initially hailed from Stank Hall, in 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, so that only one of them - Henry, second Earl of Harewood (1767-1841) - received slavery compensation in 1835 (Figure 12).

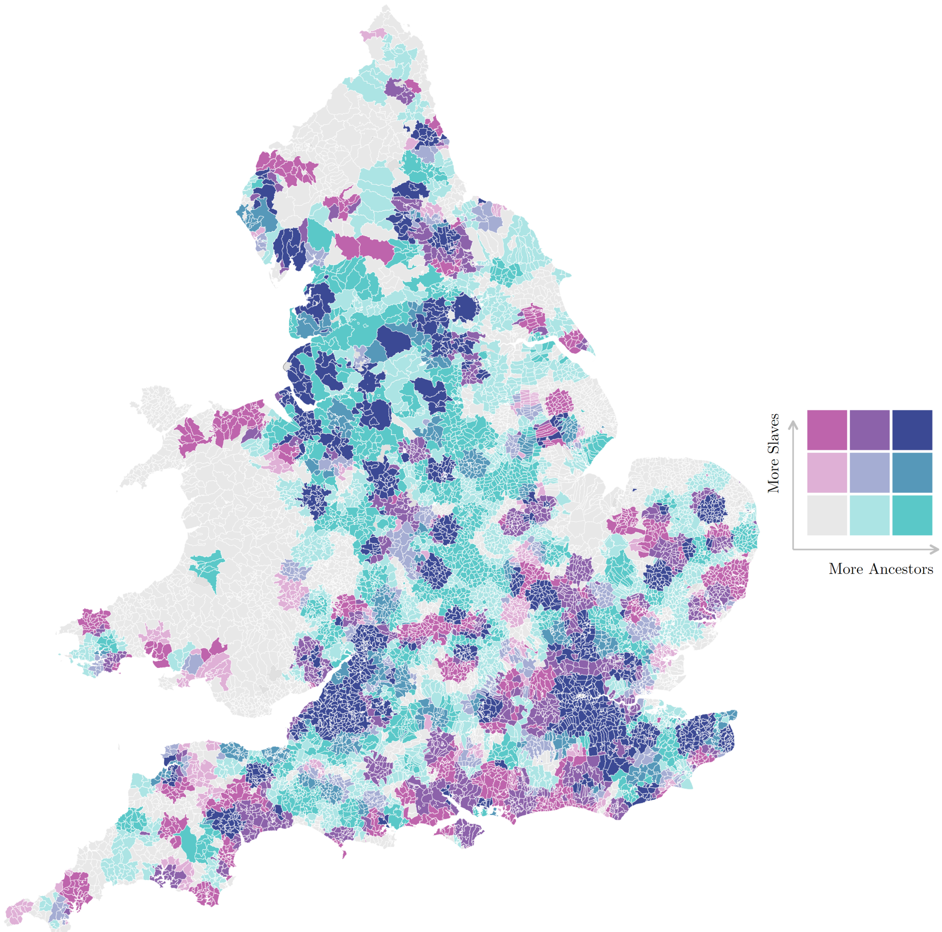
Figure 12: Lascelles Family Tree



Note: Figure shows a portion of the Lascelles family tree, annotated to highlight the members of the male line who were slave holders, slave trader and beneficiaries of the slave compensation act.

Figure 13 shows a bi-variate plot of the geographical distribution of ancestors of slave traders ("voyagers") and slave holdings in 1833. Grey areas show neither slave holding nor ancestors of traders; dark blue indicates a strong confluence of both. Where areas of the map are only green, there are many ancestors but no slave holdings; where the areas is shown as magenta, there are high slave holdings but few ancestors. The map shows how wide-spread both slave holding and ancestral exposure to the slave trade were; and in numerous areas, both coincided.

Figure 13: Bi-variate plot of slave voyager ancestors and slave holdings in 1833



Note: Plot shows the terciles of the distribution of both voyager ancestors and the log of slave holding across English and Welsh parishes. Variables are aggregated within a 10km radius of the parish centroid.

7.3 Instrumental Variables Estimation

We now report our main instrumental variables (IV) estimation results for the impact of exogenous variation in slave holding on economic development, using either our (ancestry-based) middle-passage mortality instrument or an indicator of success in the slave trade. As discussed above, we first trace ancestors of owners of slave voyages before 1807, and establish in which parishes they lived. This information we then link to slaveholders in 1833, using detailed genealogical information available in the Legacies of British Slavery Database and from family trees. Areas with and without ancestors involved in the slave trade may be systematically different. We first use a direct scaling of ancestor-driven exposure to the slave trade, by increasing the weight of observations connected to slaver traders who were involved in low-mortality voyages. Because information on mortality rates of slave voyages is not available for the majority of voyages, we also use a second measure, where we use the number of shipping ventures that slave traders were involved in to scale their ancestor's exposure.

IV-Strategy 1: Mortality-scaled ancestral exposure to the slave trade.

We construct our main instrumental variable as:

$$ancestor\_share\_mortality\_scaled_p = \frac{\sum\limits_{a \in A_p} \frac{1}{mortality\_decade\_scaled_a}}{\sum\limits_{p \in P} |A_p|} \tag{25}$$

where p are parishes, a are ancestors, A_p is the set of ancestors in parish p and P is the set of parishes. $mortality\_decade\_scaled_a$ is the average middle-passage mortality that ancestors of slave ship owners were exposed. To avoid the instrument reflecting the strong downward trend in middle passage mortality over time, we normalize mortality by decade.

In Table 1 we compare the characteristics of three groups of parishes – those without ancestors involved in the slave trade, and the two sets of parishes with some exposure to slave trading. For all indicators of economic conditions before 1700, we find no significant differences (except a small edge for slave-trading parishes in the Domesday book). However, by 1815, property wealth was already largest in parishes with ancestors of the successful slave traders – average wealth was more than twice as high as in parishes of unsuccessful traders (who, in turn, has slightly greater wealth than areas without any exposure). We also find that parishes with unsuccessful traders have 40 log points higher slave holding – but successful traders' ancestral parishes have 140 log points higher slave holding. The final two rows show patterns for geographical distance. We see that successful slave traders' ancestral parishes are further from historical ports; they as slightly closer to Liverpool.

Table 1: Balance Test – Ancestors and Shipowner Mortality

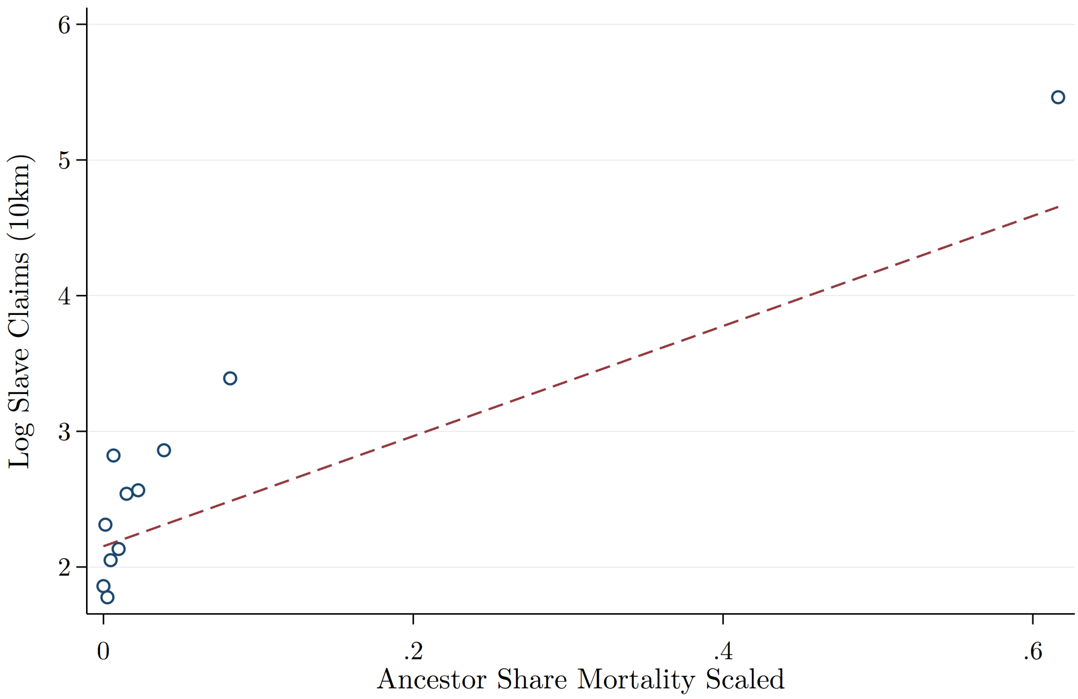
Variable	(1) None Mean/SE	(2) Unsucessful Mean/SE	(3) Successful Mean/SE	T-test Difference (1)-(2)	(1)-(3)	(2)-(3)
Domesday Wealth	9.78	10.30	9.97	-0.52	-0.19	0.32
	(0.28)	(0.33)	(0.45)			
Wealth Subsidy (1334)	4.57	4.50	7.10	0.06	-2.54	-2.60
	(0.13)	(0.15)	(1.80)			
Property Wealth (1690)	299.86	294.00	370.44	5.86	-70.58	-76.45
	(28.56)	(15.34)	(49.87)			
Log Avg Dist Mills (1788)	4.60	4.39	4.32	0.21***	0.28***	0.07
	(0.03)	(0.05)	(0.06)			
Property Tax (1815)	3,744.54	4,589.86	9,706.42	-845.32***	-5,961.88**	-5,116.55*
	(151.41)	(231.59)	(2,592.62)			
Log Slave Claims (10km)	1.86	2.44	3.29	-0.58***	-1.43***	-0.86**
	(0.12)	(0.18)	(0.32)			
% in Agriculture (1831)	0.65	0.63	0.59	0.02***	0.07***	0.04**
	(0.00)	(0.01)	(0.02)			
Longitude	-1.50	-1.13	-1.26	-0.37***	-0.24*	0.13
	(0.11)	(0.12)	(0.12)			
Latitude	52.22	52.17	52.12	0.05	0.10	0.05
	(0.05)	(0.06)	(0.07)			
Dist Historic Port	18.20	20.68	23.41	-2.48**	-5.20***	-2.72
	(0.81)	(1.14)	(1.64)			
Dist Liverpool	225.99	217.61	215.07	8.38	10.92	2.54
	(4.25)	(6.17)	(6.61)			
N	5556	2553	2441			
Clusters	514	268	264			

Note: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at level of 0.2°. The covariate variable population1700 is included in all estimation regressions. All missing values in balance variables are treated as the group mean. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

In Figure 14, we show the first-stage relationship across parishes between the number of enslaved in 1833 and mean ancestral middle-passage mortality within 10km of a parish centroid using a binscatter. We find a strong, positive, and precisely-estimated relationship between the two variables. At low levels of ancestor-exposure, the number of slave claims in 1833 is minimal; there many ancestors of successful slave traders lived, claims in 1833 were massive. The pattern shows an explosive increase as the share of (successful) ancestors rises above zero, with claims more than doubling on average as ancestral exposure rose from 0.1 to 0.3.

Table 2 shows the predictive power and construction of our instrument in more detail. In panel A, we show the first stage between the ancestor share (of slave voyage owners) and 1833 slave holding. The data suggest a strong link; even at the parish level, the F-statistic is above 10, and larger "bubbles" show even stronger patterns. We only have mortality data for about 10% of voyages. To demonstrate the power of using mortality interactions, we first restrict our data to those parishes where ancestors of voyage owners with mortality data lived (Panel B). The statistical relationship weakens, with two of our estimates (for parish-level and 10 km with controls) below the value of 10. However, once we interact with mortality data, scaling up exposure by the inverse of middle-passage mortality, we find highly significant coefficients for all variable definitions except the parish level (even using 0.2 degree clustering): We obtain a strong, positive coefficient and an F-statistic of 2 at the parish level, rising to 16-43 as we spatially aggregate. We consider a buffer of 10km to be the lowest plausible level of aggregation – not all effects of slave holding were necessarily felt just in the same parish. In order to use a greater share of our data in constructing our instrument, we can also use a second alternative, based on the relationship between mortality and continued involvement in the slave trade that we explored above. In panel D, we show that scaling ancestor-exposure with the number of voyages in which ship owners were involved increases coefficient size and F-statistics.

Figure 14: First stage - Slave holding in 1833 and middle-passage mortality scaled ancestors



Note: Binned scatter in ventiles of the log number of enslaved within 10 kilometers of a parish centroid (vertical axis) on mean slave mortality rate with 10 kilometers of a parish centroid (horizontal axis).

We next estimate the impact of the exogenous variation in slave holding induced by our instrument on economic development. In the second-stage equation (26), we regress the economic development (Y_i) of parish i on slave holding (S_i) at the time of abolition. In the first-stage equation (27), we regress slave holding (S_i) at the time of abolition for parish i on mean ancestral middle-passage mortality (MPM_i):

$$Y_i = C_2 + \beta \widehat{S}_i + \delta X_i' + \epsilon_i \tag{26}$$

$$S_i = C_1 + \alpha MPM_i + \gamma X_i' + \rho_i \tag{27}$$

where C_1 and C_2 are regression constants; X' is a vector of control variables for other determinants of economic activity; and ϵ_i and ρ_i are stochastic errors.

In Table 3, we examine the economic impact using IV-estimation, using our preferred (mortality-based) instrument. We find that (instrumented) slave claims strongly and positively predict the number of development-related occupations in reginal city directories (col. 1). It is also associated with higher property taxes in 1815 (col. 2), and negatively predicts employment in agriculture (col. 3). Employment in manufacturing is higher (col. 4), and the distance to cotton mills is lower (col. 5). Note that we are controlling for 1690 property wealth, so that our results capture changes in economic performance since then. We also cluster at the 0.2 degree level, for a total of 593 clusters across England and Wales.

A simple plausibility check of our IV-strategy in the spirit of Bound and Jaeger (2000), Angrist and Krueger (1994), and D'Haultfœuille et al. (2021) looks at never-takers – regions where ancestors of slave traders lived, but where we find no descendents making claims for slavery compensation in 1833. If our argument is correct, regions that merely had exposure to the slave trade – without slave-holding later – should **not** show any economic outperformance. Figure 15 plots the coefficients for our main outcome variables, for the never-taker regions and from our IV-estimation. As is readily apparent, we find much larger coefficients in our IV-exercise, whereas the never-taker areas mostly indicate precisely-estimated zeros.[14]

Taken together, these empirical results provide support for the mechanism in our theoretical model, in which exogenous increases in slavery wealth alleviate collateral constraints and stimulate local capital accumulation, which induces a reallocation of economic activity towards the manufacturing sector.

[14] Table A.1 gives the statistical estimates of our never-taker analysis.

Table 2: First Stages: Instruments on slave holding at various aggregations

	(1) Exact	(2) 10km	(3) 10km-Controls	(4) 20km	(5) 30km
A. Ancestor Share	89.16***	89.01***	73.95***	55.73***	37.04***
	(24.75)	(8.43)	(8.11)	(5.91)	(3.54)
F-Stat	12.98	111.54	83.15	89.05	109.65
B. Ancestor Share (mort. parishes)	21.95	76.66***	59.40***	43.41***	29.68***
	(20.15)	(22.27)	(18.60)	(10.19)	(4.78)
F-Stat	1.19	11.85	10.20	18.14	38.60
C. Mortality Scaling	2.582	4.144***	3.296***	2.331***	1.543***
	(1.63)	(0.94)	(0.80)	(0.46)	(0.23)
F-Stat	2.51	19.59	17.08	25.81	46.99
D. Count Voyages Scaling	41.87**	59.04***	48.38***	32.75***	20.85***
	(20.08)	(12.20)	(10.56)	(6.10)	(3.09)
F-Stat	4.35	23.42	20.99	28.78	45.58
Observations	10,699	10,699	10,090	10,699	10,699
Cluster	0.2°	0.2°	0.2°	0.2°	0.2°

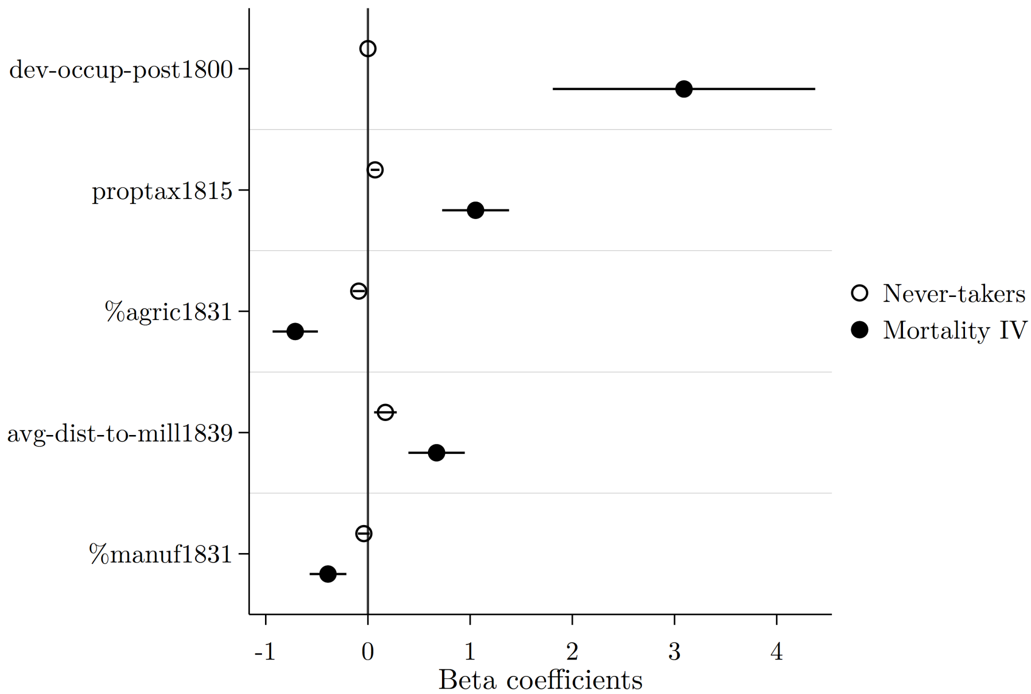
Note: *** $p<0.01$, ** $p<0.05$, * $p<0.10$. The outcome variable is log(1833 claims) at exact (parish level) aggregation and various buffers. Standard errors in parenthesis. Panel A uses the parish share of the ancestors of 853 slave traders. Panel B presents the same instrument, but only counting the ancestors of the 222 slave traders with ancestors and mortality data. Panel C presents the mortality-scaled ancestor share defined in Equation 25. Panel 4 presents the count of voyages-scaled ancestor share defined in Equation 28

Table 3: IV: Mortality-scaled ancestral exposure to the slave trade

	(1) dev-occup-post1800	(2) proptax1815	(3) %agric1831	(4) %manuf1831	(5) avg-dist-to-mill1839
Log Slave Claims (10km)	3.09***	1.05***	-0.71***	0.67***	-0.39***
	(0.57)	(0.14)	(0.10)	(0.12)	(0.08)
Log Population (1700)	-0.20***	0.48***	-0.06***	0.07***	-0.01
	(0.06)	(0.03)	(0.02)	(0.02)	(0.01)
Latitude	1.00***	0.50***	-0.27***	0.22***	0.01
	(0.24)	(0.07)	(0.05)	(0.06)	(0.05)
Longitude	-0.22***	-0.07***	0.16***	-0.11***	-0.22***
	(0.08)	(0.03)	(0.02)	(0.02)	(0.03)
Log Dist Country Bank	0.83***	0.37***	-0.17***	0.13*	-0.22***
	(0.25)	(0.08)	(0.06)	(0.07)	(0.06)
Log Avg Dist Mills (1788)	0.75***	0.20**	0.03	-0.11	0.48***
	(0.27)	(0.08)	(0.08)	(0.09)	(0.06)
Log Dist Post Town (1791)	0.53***	0.00	0.17***	-0.13***	-0.02
	(0.15)	(0.05)	(0.04)	(0.04)	(0.04)
Log Dist Coast	-0.21***	-0.14***	0.09***	-0.05**	-0.00
	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)
Log Property Wealth (1690)	-0.00	0.17***	-0.11***	0.11***	-0.10***
	(0.06)	(0.02)	(0.02)	(0.02)	(0.03)
Observations	10,090	9,807	9,339	9,339	10,090
N Voyagers	222	222	222	222	222
KPW F-stat	17.1	19.1	19.4	19.4	17.1
Anderson-Rubin	8.1	13.7	16.9	35.9	22.3
Cluster	0.2°	0.2°	0.2°	0.2°	0.2°

Note: *** p<0.01, ** p<0.05, * p<0.10. IV coefficients with standard errors in parenthesis. The coefficient of the independent variable is standardised. Instrument is the parish share of voyager ancestors, scaled by decade-normalised mean voyage mortality. See Equation 25 for details.

Figure 15: Beta coefficients of mortality IV and never-takers



Note: Beta coefficients from the IV estimates using the mortality instrument and from the reduced form OLS regression of mortality instrument on outcomes, only in parishes where there is no slave holding.

IV-Strategy 2: Voyage-count-scaled exposure to the slave trade.

Our second instrument is constructed as:

$$ancestor\_share\_count_p = \frac{\sum\limits_{a \in A_p} voyages_a}{\sum\limits_{p \in P} |A_p|} \tag{28}$$

where *p* are parishes, *a* are ancestors, $voyages_p$ is the total number of voyages an ancestor was connected to, A_p is the set of ancestors in parish p and P is the set of parishes.

Table 4 shows balance statistics for our second instrument. We find that Domesday Wealth was slightly higher in slave-trading areas than in non-slave-trading areas – but successful trading areas were not significantly wealthier than unsuccessful ones. The same pattern is visible for the 1334 wealth subsidy, and 1690 property wealth. Distances to mills in 1788 are somewhat lower for successful slave-owning districts; by 1815, we find massive differences in property tax by the success of ancestral slave trade involvement. There is a gradient in agricultural employment shares, and, as is to be expected, in slavery compensation claims. Distances to Liverpool, or to historic ports, show no clear pattern.

Table 4: Balance Test – Ancestors and Shipowner Voyage Number

Variable	(1) None Mean/SE	(2) Unsucessful Mean/SE	(3) Successful Mean/SE	(1)-(2)	T-test Difference (1)-(3)	(2)-(3)
Domesday Wealth	9.12	10.11	10.14	-0.99**	-1.02**	-0.02
	(0.34)	(0.33)	(0.30)			
Wealth Subsidy (1334)	4.59	4.70	5.70	-0.11	-1.11	-1.00
	(0.15)	(0.16)	(0.90)			
Property Wealth (1690)	217.17	369.68	321.97	-152.52***	-104.80***	47.72
	(13.06)	(45.52)	(26.85)			
Log Avg Dist Mills (1788)	4.64	4.52	4.39	0.12***	0.25***	0.13**
	(0.03)	(0.04)	(0.05)			
Property Tax (1815)	3,344.65	3,825.13	7,262.38	-480.47***	-3,917.72**	-3,437.25**
	(122.25)	(160.33)	(1,332.19)			
Log Slave Claims (10km)	1.57	2.04	2.86	-0.47***	-1.29***	-0.82***
	(0.13)	(0.14)	(0.20)			
% in Agriculture (1831)	0.66	0.66	0.60	0.00	0.05***	0.05***
	(0.01)	(0.01)	(0.01)			
Longitude	-2.03	-0.94	-1.33	-1.09***	-0.71***	0.39***
	(0.15)	(0.10)	(0.10)			
Latitude	52.34	52.20	52.09	0.14*	0.25***	0.11*
	(0.07)	(0.06)	(0.05)			
Dist Historic Port	17.54	19.55	21.41	-2.00	-3.87***	-1.87
	(1.07)	(0.97)	(1.14)			
Dist Liverpool	208.30	236.03	217.81	-27.73***	-9.51	18.22***
	(5.59)	(4.74)	(5.00)			
N	2396	3367	4936			
Clusters	375	377	405			

Note: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at level of 0.2°. The covariate variable population1700 is included in all estimation regressions. All missing values in balance variables are treated as the group mean. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

In Table 5, we repeat our IV-estimation using the voyage-frequency instrument. We find similar effects throughout – ancestral exposure to (successful) slave trading increased the share of development-related professions in a location, reduced the distance to cotton mills, lowered the agricultural share, increased employment in manufacturing, and raised property values in 1815.

Table 5: IV: Voyage-count-scaled exposure to the slave trade

	(1) dev-occup-post1800	(2) proptax1815	(3) %agric1831	(4) %manuf1831	(5) avg-dist-to-mill1839
Log Slave Claims (10km)	2.63***	0.90***	-0.57***	0.58***	-0.53***
	(0.70)	(0.19)	(0.13)	(0.12)	(0.10)
Log Population (1700)	-0.19***	0.49***	-0.07***	0.07***	-0.01
	(0.07)	(0.03)	(0.02)	(0.02)	(0.02)
Latitude	0.84***	0.45***	-0.23***	0.19***	-0.04
	(0.26)	(0.08)	(0.06)	(0.06)	(0.05)
Longitude	-0.19**	-0.06**	0.15***	-0.10***	-0.21***
	(0.08)	(0.03)	(0.02)	(0.02)	(0.03)
Log Dist Country Bank	0.67***	0.32***	-0.12**	0.10	-0.27***
	(0.24)	(0.07)	(0.06)	(0.07)	(0.06)
Log Avg Dist Mills (1788)	0.61**	0.16**	0.08	-0.14*	0.43***
	(0.26)	(0.08)	(0.07)	(0.08)	(0.06)
Log Dist Post Town (1791)	0.43***	-0.03	0.20***	-0.15***	-0.05
	(0.15)	(0.05)	(0.04)	(0.04)	(0.05)
Log Dist Coast	-0.17***	-0.13***	0.08***	-0.04**	0.01
	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)
Log Property Wealth (1690)	0.02	0.18***	-0.12***	0.11***	-0.09***
	(0.05)	(0.02)	(0.02)	(0.02)	(0.03)
Observations	10,090	9,807	9,339	9,339	10,090
N Voyagers	853	853	853	853	853
KPW F-stat	21.0	23.7	23.4	23.4	21.0
Anderson-Rubin	6.4	10.8	10.0	22.9	38.1
Cluster	0.2°	0.2°	0.2°	0.2°	0.2°

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.10$. IV coefficients with standard errors in parenthesis. The coefficient of the independent variable is standardised. Instrument is the parish share of voyager ancestors, scaled by count of slave voyages completed.

7.4 Steam power adoption

Steam power was arguably one of the key technologies of the Industrial Revolution. Adopting its use required a range of technological inventions and innovations, and was costly. Here, we present some evidence that areas with more slave compensation claims in 1833 had an increasing edge in steam adoption. Using data on steam engine diffusion from the British Newspaper Archive, we show in Table 6 that areas with more slave-holding showed more rapid steam adoption. It is already visible, but small, pre-1792. The effect increases over time – and the slave-owning areas' edge grows in magnitude after 1830.

Table 6: Steam Engines

	Steam Engines Pre-1792	1792-1830	1830-1850	Post-1850
Log Slave Claims (10km)	0.01***	0.12***	0.14***	0.18***
	(0.00)	(0.03)	(0.03)	(0.03)
Log Population (1700)	0.00	-0.15***	-0.18***	-0.19***
	(0.00)	(0.05)	(0.05)	(0.05)
Latitude	-0.01	0.04	-0.06	-0.27***
	(0.01)	(0.05)	(0.07)	(0.10)
Longitude	-0.00*	-0.03	-0.03	-0.04
	(0.00)	(0.02)	(0.03)	(0.05)
Log Dist Country Bank	0.01	0.04	-0.13	-0.21
	(0.01)	(0.08)	(0.10)	(0.15)
Log Avg Dist Mills (1788)	-0.04*	-0.16	-0.42***	-0.89***
	(0.02)	(0.11)	(0.13)	(0.16)
Log Dist Post Town (1791)	-0.01	-0.22***	-0.33***	-0.60***
	(0.00)	(0.05)	(0.06)	(0.09)
Log Dist Coast	-0.00	-0.02	0.02	0.02
	(0.00)	(0.02)	(0.03)	(0.04)
Log Property Wealth (1690)	-0.00	0.06	0.09*	0.10*
	(0.00)	(0.05)	(0.05)	(0.06)
Observations	10,090	10,090	10,090	10,090
Cluster	0.2°	0.2°	0.2°	0.2°

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.10$. OLS coefficients with standard errors in parenthesis. Outcome is log count of articles mentioning steam engines from BNA. Outcome and slavery variables are bubbled at 10km.

8 Conclusion

Before Europe's contact with the Americas, and its heavy involvement in the trafficking of slaves to the new colonies, the continent was an also-ran in economic terms. Growth accelerated as Atlantic trade increased, and all the more so in the countries that played a leading role in the trans-Atlantic slave trade – especially the UK (Acemoglu et al. 2005). Many historians have argued, based on the temporal and cross-sectional correlations, that Europe's rise to riches must have been driven by the profits of the slave trade (Williams 1944, Wallerstein 2004, Frank 2011). Most quantitative assessments of this argument by economic historians have remained sceptical of this view, pointing out that profits were not particularly high, and that the gains from trade were hence limited (Eltis and Engerman 2000, Engerman 1972).

In this paper, we argue that it was not slave-trading as such that provided an important boost to Britain during the Industrial Revolution – but the wealth from *slave-holding*. The most optimistic estimates of slave trading profits are in the range of 0.5% of GDP in the late 18th century; for slave-holding, the estimate is closer to 5% (Solow 1993). Additionally, slavery investments differed systematically from other investments in two key respects. First, the profitability of slavery investments depended on the shadow cost of enslaved labor rather than the wage of free workers. Second, slavery investments were more collateralizable, because enslaved people were treated as property, which could be mortgaged and used as collateral.

We develop a spatial general equilibrium model that formalizes the role of slavery wealth in economic development. Slavery wealth alleviates collateral constraints which induces local capital accumulation, and leads to economic growth and structural transformation towards capital-intensive sectors such as manufacturing.

For identification, we use the effect of weather on sailing time and slave mortality. Shipping slaves from Africa to the Americas took time, and conditions on board the ships were horrific. When passages took to long, mortality increased sharply. We show that shocks to slave mortality affected participation in the slave trade, and in turn, the slave-holding of descendents in 1833. Using this source of exogenous variation, we find that greater slavery wealth promoted economic growth and led to a reallocation of economic activity away from agriculture, and towards manufacturing, the diffusion of new manufacturing technology (cotton mills), and the spread of "new" occupations associated with the Industrial Revolution. Taken together, our results support the idea that slavery wealth played a causal role in Britain's Industrial Revolution.

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