Journal of International Economics 96 (2015) 412–425

Contents lists available at ScienceDirect

Journal of International Economics

journal homepage: www.elsevier.com/locate/jie

Dispersion and distortions in the trans-Atlantic slave trade☆

John T. Dalton [a,*], Tin Cheuk Leung [b]

[a] Department of Economics, Wake Forest University, Kirby Hall, Box 7505, Winston-Salem, NC 27109, United States
[b] Department of Economics, Chinese University of Hong Kong, 914, Esther Lee Building, Chung Chi Campus, Shatin, Hong Kong

A R T I C L E I N F O

Article history:
Received 6 February 2013
Received in revised form 13 March 2015
Accepted 13 March 2015
Available online 21 March 2015

JEL classification:
N77
F14
F54

Keywords:
Slave trades
Market distortions
Output dispersion
Productivity

A B S T R A C T

Market distortions can lead to resource misallocation, which can further lead to inefficiency. Throughout the history of the trans-Atlantic slave trade, qualitative evidence of various sources of distortion abounds. No study, however, has quantified the inefficiency in the slave trade due to these distortions. We use a structural approach to identify the dispersion of distortions in the slave trade from wedges in first order conditions. We then calculate the TFP gains had the dispersion of distortions disappeared. Two main results emerge. First, dispersion of distortions had the smallest damage to TFP in Great Britain, followed by Portugal, and then France. Second, dispersion of distortions in the product market had a bigger impact on TFP than that of the capital and labor markets.

1. Introduction

The institutional efficiency of different countries has long been a research topic for economic historians. Substantial evidence suggests that various distortions have existed in labor, credit, and product markets across and within major European countries throughout history. For instance, the wage dispersion across major European cities documented by Phelps Brown and Hopkins (1981) is one indicator of labor market inefficiency before the 1900s. While there are studies on institutional inefficiencies for the whole of Europe or in specific European countries such as Great Britain, there are few quantitative studies on the relative institutional inefficiencies of different European countries prior to the Industrial Revolution.

This paper aims to fill this hole in the literature by studying a large scale trading system between Europe, Africa, and the New World: the trans-Atlantic slave trade. The slave trade is ideal for such a study for several reasons. First, many Western European countries participated in slave trading, such as Great Britain, France, and Portugal. This allows us to compare the relative performance of voyages across countries. Second, data on slave voyages are very detailed. This allows us to document the variation in economic characteristics among voyages within and across different countries. We can then use this variation to uncover a measure of institutional efficiency for each country. The measure we consider is the dispersion in institutional efficiency, which we describe momentarily.[1]

Using the *Trans-Atlantic Slave Trade Database*, we first document a fact in the slave trade in the period 1700–1850: voyage output, measured as the number of slaves disembarked in the Americas, varied substantially across voyages within a European country. In particular, the dispersion in output is the highest across Portuguese voyages, lower across French voyages, and lowest across British voyages. Dispersion in output may be an indicator of resource misallocation, which can arise due to institutional inefficiencies. Of course, output dispersion is also an indicator of dispersion in productive efficiency, which we document for different countries. We measure voyage productivity in four different ways: slaves per ton, slaves per crew, total factor productivity (TFP), and distance per day traveled during the Middle Passage. Productivity is most dispersed across Portuguese voyages. Also, we find that Portuguese voyages were the most productive, followed by British voyages and then French voyages, corroborating the findings in North

☆ We thank Stanley Engerman, James Fenske, Jeffrey Williamson, and Robert Whaples for their many helpful comments. We also thank seminar participants at Clemson University, the Federal Reserve Bank of Minneapolis, University of Hong Kong, and Shanghai Jiao Tong University. We thank Caitlin Dourney for valuable research assistance. We thank two anonymous referees for their many comments and suggestions leading to substantial improvements in the paper. Financial support from the Dingledine Faculty Fund and Farr Funds at Wake Forest University is gratefully acknowledged. The usual disclaimer applies.

* Corresponding author.
E-mail addresses: daltonjt@wfu.edu (J.T. Dalton), tleung@cuhk.edu.hk (T.C. Leung).

[1] The data prevent us from measuring institutional efficiency for each country in terms of levels.

http://dx.doi.org/10.1016/j.jinteco.2015.03.002
0022-1996/

(1968) and Eltis and Richardson (1995).[2] But, dispersion in productivity may not capture everything. The dispersion in institutional inefficiencies can cause resource misallocation, which may be important because of its impact on a country's TFP in the slave trade.

To uncover relative institutional inefficiencies, we use the framework developed by Chari et al. (2007) and applied by Hsieh and Klenow (2009) and Song and Wu (2013), among others. This framework, which is commonly used in macroeconomics, identifies market distortions from wedges in first order conditions. To the best of our knowledge, our paper represents the first application of this structural approach in the literature on the African slave trades.

In particular, we assume that voyage owners are price takers in both the slaves and input markets. We then consider a decision problem for a voyage owner in which he chooses the amount of labor and capital necessary to produce slaves and maximize profits. Voyage-specific distortions in the slaves and input markets enter a voyage owner's decision problem in the form of wedges. These wedges represent the combination of taxes, regulations, and all other types of market distortions faced by individual voyage owners.

When the dispersion in market distortions is high, it means that the degree of differential access in the slaves and input markets is high across individual voyage owners, which leads to a higher degree of resource misallocation and represents less efficient institutions.[3] In an environment in which institutions are perfect, or market distortions do not exist, labor-output, capital-output, and labor–capital ratios would be constant across voyages. We then make use of the actual dispersion of labor-output, capital-output, and labor–capital ratios across voyages in the data to structurally identify the dispersion of distortions in the product, labor, and capital markets in Great Britain, France, and Portugal separately. Overall, we find that the dispersion of distortions in the product market is higher than the dispersion in labor and capital market distortions. The dispersion in the Portuguese product market distortions is the highest, followed by France and then Great Britain. Likewise, Portugal has the highest dispersion of labor market distortions, followed now by Great Britain and then France. However, the dispersions of the capital market distortions are more similar across the three countries.

In order to measure the impact of the distortions on TFP due to resource misallocation, we calculate the gain in each country's TFP in the slave trade had the dispersion of the distortions not existed. The TFP gains from eliminating the dispersion of the distortions in all three markets at the same time are large and significant. TFP would increase by approximately 22% in Great Britain, 45% in Portugal, and 123% in France. This result is broadly consistent with the view that British institutions were the most efficient prior to the Industrial Revolution.[4] The dispersion of distortions in the product market had the biggest impact on TFP in all three countries. TFP would increase by 17% in Great Britain, 36% in Portugal, and 118% in France with the elimination of the dispersion in product market distortions. These gains are at least 5 times (in the cases of Great Britain and Portugal) and 35 times (in the case of France) bigger than the TFP gains had only either the dispersion of capital or labor market distortions disappeared. Finally, the TFP gains from eliminating the dispersion of capital market distortions are slightly higher than those due to eliminating the dispersion of labor market distortions. Although our results are clearly specific to the slave trade industry, we believe that the slave trade may provide a window into the extent of resource misallocation in the economy as a whole for the countries we consider. If so, our results suggest significant aggregate TFP losses due to dispersion in market distortions.

A large and well-established literature in economic history exists on the African slave trades.[5] Recent contributions include the following: Eltis and Engerman (2000) on the slave trades and British industrialization, Eltis et al. (2010) on decomposing the transport costs of slave voyages, Eltis et al. (2005) on slave prices and productivity in the Caribbean, Eltis and Richardson (1995) on productivity of French and British slave voyages, Fenske and Kala (2012) on the role of supply-side environmental shocks in Africa, and Hogerzeil and Richardson (2007) on slave purchasing strategies and mortality.

Our paper will also interest economists working in the field of international trade. Melitz (2003) initiated an explosion in theoretical innovations driven by new insights from firm-level data. The slave trade data we present occur at the voyage-level, which is closer to shipment-level data. The data represent the largest and richest source of shipment-level data on the world economy, 1700–1850. New tools developed in the international trade literature should provide further insights on this important period of history surrounding the Industrial Revolution. Our method should also be easily adaptable to Melitz-style models, so trade economists can use a similar approach on firm-level data to study distortions and their impact on TFP in the traded goods sector.

2. Facts on output, productivity, and institutions

We begin by describing our data on slave voyages and documenting the distributions of various characteristics of economic interest across voyages. Viewing distributions of the data is useful, because it allows us to identify such regularities as the differences in dispersion in, say, output across slave voyages conducted by different countries.[6] We then consider the causes of the differences in dispersion in output by examining the differences in dispersion in productivity, i.e. one reason we might observe different distributions of output for different countries is that the distributions of productivity might also differ. However, dispersion in output may also be a sign of resource misallocation, which leaves open a role for output and input market distortions.

Our data on slave voyages come from the *Trans-Atlantic Slave Trade Database*, which consists of information on 34,948 voyages. The database resides online at http://www.slavevoyages.org and is widely used by historians and economic historians in their study of the African slave trades. Eltis and Richardson (2010) provide a useful visual summary in the form of an atlas. We consider the years 1700–1850, the time period when the bulk of the slave trade occurred. The database contains 30,874 voyages for these years. Although not all voyage observations contain the information we consider in this paper, our sample sizes are still quite large and allow us to observe variation across voyage size, output, and productivity. One of the potential drawbacks of the data is the lack of voyage-level price information, but this is less of a concern for us. The quantity data allow us to more cleanly identify the market distortions in Section 3.1.[7]

---

[2] Specifically, North (1968) shows that productivity was increasing in the shipping industry in general over the period we study, 1700–1850. Since Portuguese voyages tend to occur in the latter part of this period, our findings are consistent with North (1968). Eltis and Richardson (1995) find that British voyages were more productive than French voyages during the trans-Atlantic slave trade, as we do here.

[3] Hsieh and Klenow (2009) provide further discussion of this idea in the context of resource misallocation.

[4] Given our focus on market distortions, the reader might wonder why we do not also examine, in the case of Great Britain, the impact of the Royal African Company losing its monopoly by comparing the pre- and post-1698 periods. Unfortunately, the data are too sparse before 1698 to make any meaningful comparison.

[5] There is also a literature examining the link between the slave trades and current African development. Darity (1992) and Rodney (1972) represent earlier efforts along these lines, while more recent contributions include Dalton and Leung (2014), Fenske (2012), Nunn (2007), Nunn (2008), and Nunn and Wantchekon (2011).

[6] In general, studying firm heterogeneity in the data and building economic models incorporating this heterogeneity have been a major research focus in industrial organization, macroeconomics, and, more recently, international trade. Lucas (1978) and Hopenhayn (1992) are classic references in this area of industrial organization and macroeconomics. Melitz (2003) incorporated these earlier methods into an international trade model and has become the basis for heterogeneous firm models in international trade. Hopenhayn (2011) provides a recent review of the literature.

[7] Most papers in the literature related to Hsieh and Klenow (2009) must rely on firm-level revenue data.

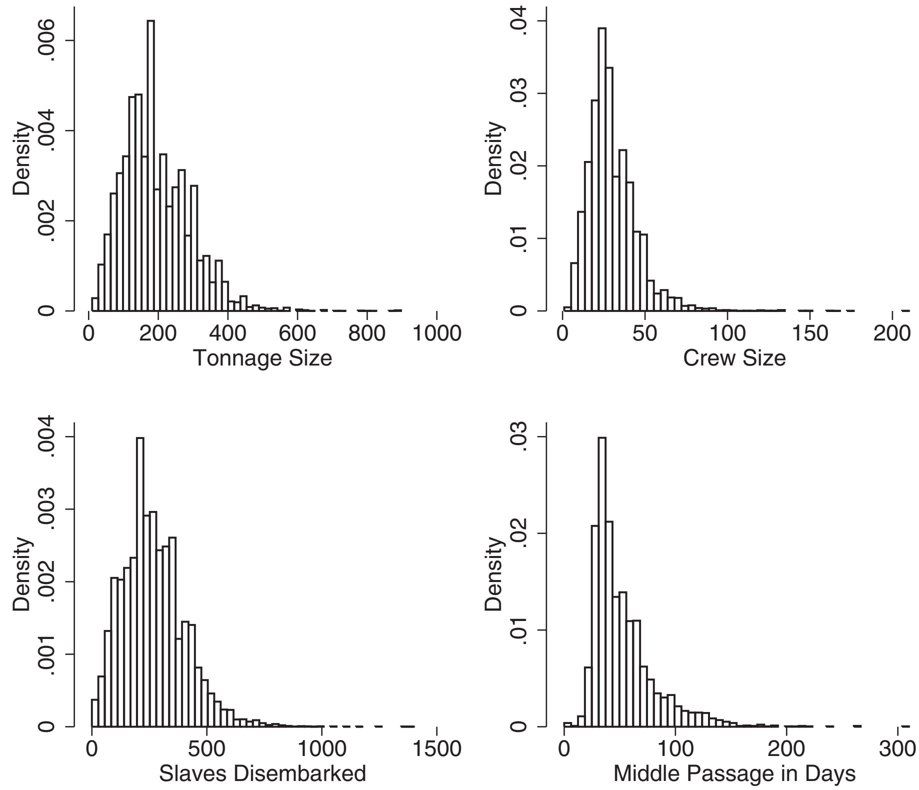

Fig. 1. Distributions of voyage characteristics, 1700–1850.

Fig. 1 documents the distributions of various voyage characteristics, including ship tonnage, number of crew members at the voyage's outset, number of slaves disembarked, and number of days spent completing the Middle Passage.[8] The voyage's ship tonnage and crew size correspond to capital and labor inputs, whereas slaves disembarked is a measure of voyage output. Since not every voyage observation contains information on all four characteristics, the number of voyage observations varies across the four distributions. Voyage-level heterogeneity is immediately apparent, and all four distributions appear log-normal. We suppress the x-axes of the graphs to more easily show the long and thin right tails of the distributions.[9] Table 1 reports summary statistics for the four voyage characteristics.

In order to address whether missing data in the *Trans-Atlantic Slave Trade Database* may later bias our results, we compare observable characteristics between those voyages with complete information and those voyages with missing information. As Table 2 suggests, there is no statistically significant difference between the means of the characteristics across the two groups of voyages within the three countries we are interested in (i.e. Portugal/Brazil, Great Britain and France). Moreover, the mean composition of slaves, as measured by the percentage that are male, does not vary significantly between the two groups and so should also not be a source of concern.

2.1. Voyage output

The distribution of output varies across countries. Fig. 2 documents the distribution of slaves disembarked over the period 1700–1850 for Portugal/Brazil, Great Britain, and France, the most heavily represented countries in our data. Summary statistics appear in Table 1. The average number of slaves disembarked is considerably higher for Portuguese/Brazilian voyages. Technological changes in shipping likely explain this difference, as the Portuguese/Brazilian voyages are heavily concentrated in the 1800s. The dispersion in output is the highest across Portuguese/Brazilian voyages, lower across French voyages, and the lowest across British voyages.

Two natural candidates come to mind when thinking about the causes of dispersion in output within and across countries: dispersion in productive efficiency and dispersion in institutional efficiency. Dispersion in productivity would contribute to dispersion in output. Countries also differ by their institutions, though. Even within a country, firms face different institutional constraints due, for instance, to political

Table 1
Summary statistics for voyage characteristics, 1700–1850.

	Mean	Min	Max	Std. dev.	Skewness	N
All voyages						
Tonnage size	194.7226	10	897.1	96.0795	0.8932	15,513
Crew size	30.2323	1	210	14.9142	1.8057	11,975
Slaves disembarked	267.5401	0	1400	136.6735	0.8198	29,201
Middle passage in days	52.5995	0	310	28.3594	2.0147	3735
Portugal/Brazil						
Slaves disembarked	322.8620	0	1400	140.1146	0.5681	9929
Great Britain						
Slaves disembarked	230.6686	0	898	103.1359	0.7774	10,383
France						
Slaves disembarked	275.3668	0	900	130.6422	0.5967	3939

[8] These characteristics appear as the variables *tonmod*, *crew1*, *slamimp*, and *voyage* in the *Trans-Atlantic Slave Trade Database*. The countries represented by the voyages include Spain/Uruguay, Portugal/Brazil, Great Britain, the Netherlands, the United States, France, Denmark/Baltic, and a residual category.

[9] Many empirical regularities in economics exhibit fat tails and follow power laws. Economists typically look at log–log plots when analyzing these phenomena. For example, we plotted the log of voyage rank in the distribution versus the log of voyage ship tonnage. We did this for all the distributions we consider. The log–log plots show that the distributions are log-normal overall and Pareto in the tail, i.e. the tails follow a power law. Since the focus of our paper is on the heterogeneity across voyages, not the examination of the tails in particular, we do not show the log–log plots. For an overview of power laws in economics, see Gabaix (2009).

Table 2
Missing data not a problem.

	Portugal/Brazil, 1800s		*Great Britain, 1700s*		*France, 1700s*	
	Complete info	Missing info	Complete info	Missing info	Complete info	Missing info
Tonnage size	158.4427	180.7483	189.1359	192.9502	247.6225	203.9453
	(81.4159)	(97.4840)	(78.4715)	(97.1997)	(100.3184)	(103.5438)
Crew size	19.7848	25.5485	28.6517	33.6594	40.6603	31.0704
	(8.4392)	(10.0009)	(11.5609)	(12.0378)	(20.1911)	(16.5108)
Slaves disembarked	353.4384	320.7342	244.8146	213.0504	288.6965	266.5141
	(170.1103)	(137.5427)	(106.5075)	(95.9124)	(134.0636)	(127.5805)
Middle passage in days	37.6405	41.5726	58.2162	56.0135	83.1154	70.5652
	(18.5277)	(15.5500)	(28.7903)	(14.9845)	(36.0663)	(32.7534)
Male slaves (%)	66.9857	66.7678	62.7281	65.2471	63.0090	62.6222
	(12.1695)	(13.9829)	(9.2807)	(9.7672)	(10.9743)	(10.8401)
N	646	9707	5759	5231	1572	2509

Standard deviations reported in parenthesis.

connections, which can lead to resource misallocation. After documenting the distributions of various productivity measures across voyages in Section 2.2, we examine the role played by institutional efficiencies in Section 2.3.

2.2. Productive efficiency

2.2.1. Four measures of voyage productivity

We consider four different measures of voyage-level productivity: slaves per ton, slaves per crew, distance, measured in kilometers, per day traveled during the Middle Passage, and TFP. The four characteristics in Fig. 1 help us to construct the productivity measures. We calculate slaves per ton and slaves per crew directly from the data. Distance per day and TFP require additional steps. Our construction of TFP requires a much more involved procedure, so we first turn briefly to our distance per day measure.

The denominator of our distance per day productivity measure is taken directly from the data presented in Fig. 1.[10] The distance traveled during the Middle Passage is constructed by using GIS software. Using the geographic coordinates of a voyage's last port of call before making the Atlantic crossing and the first port where a voyage lands slaves, we construct the Euclidean distance traversed during the Middle Passage.[11] Our measure of distance might be rough, but it allows us to capture the variation of the Middle Passage across different voyages in a simple, tractable, and commonly used way. Alternatively, great-circle distance could be used. The trade winds used to sail across the Atlantic influenced the "distance" of the Middle Passage, but we are unable to take into account their impact on our measure of distance.

2.2.2. TFP

In order to measure TFP, we adopt a Lucas span-of-control approach (Lucas, 1978) by assuming the following production function for each voyage *i*:

$$\begin{aligned} Y_i &= (A_i\phi_i)K_i^{\alpha}L_i^{\beta} \\ &= (A_i\phi_i)\left(\eta\hat{K}_i\right)^{\alpha}L_i^{\beta} \\ &= \hat{A}_i\hat{K}_i^{\alpha}L_i^{\beta}, \end{aligned} \quad (1)$$

where Y_i is the number of slaves disembarked in the Americas, φ_i is the captain's managerial input, K_i is the capital, and L_i is the number of crew, all for voyage *i*.[12] α and β, with $0 < \alpha + \beta < 1$, represent the shares of capital and labor in production, which we will assume constant across voyages due to data constraints. A_i is unadjusted TFP. We only observe a voyage's ship tonnage $\hat{K}_i$ in the data, which is a proxy for the voyage's total capital K_i. The manipulations in Eq. (1) show how we adjust ship tonnage by the factor η and incorporate the captain's effect to arrive at our final production function for disembarked slaves in terms of ship tonnage, number of crew, and TFP, $\hat{A}_i$.[13]

TFP measures all those determinants of the number of slaves disembarked not captured by a voyage's ship tonnage and crew size, such as the quality of a voyage's captain. Our Lucas span-of-control approach captures the role played by a captain's managerial ability in determining the number of slaves disembarked. In overseeing the preparation and execution of a slave voyage, captains performed a variety of tasks impacting the number of slaves successfully exported to the Americas.[14] Thomas (1997) writes

> The captain had to be a man of parts. He was the heart and soul of the whole voyage, and had to be able, above all, to negotiate prices of slaves with African merchants or kings, strong enough to survive the West African climate and to stand storms, calms, and loss of equipment. He had to have the presence of mind to deal with difficult crews who might jump ship, and he had to be ready to face, coolly and with courage, slave rebellions.

Thomas (1997) goes on to say that French captains were required to take exams before commanding a slave ship. Captains often carried libraries of books on maritime techniques and ship construction. Better knowledge of sailing would help captains deliver their cargo quicker and lower the risk of slaves dying on board. Rawley (1981) notes that captains needed to have knowledge of the African coastline and ocean currents. Postma (1990) points out that captains often oversaw the preparations for a slave voyage, including the mix of cargo loaded in

[10] Instead of using the distance of the Middle Passage for this measure of productivity, we could alternatively use the distance of the voyage's total journey. There are not enough observations in the data including this information to draw any conclusions, though. Likewise, we do not adjust our distance of the Middle Passage for seasonality. If we look at the observations with enough information to construct our distance per day measure by quarter, then the sample sizes become very small. There is not much variation in the distance per day measure by quarter, so seasonality does not appear to matter for this small number of observations.

[11] The variables we use for a voyage's last and first port are *npafftra* and *sla1port* in the *Trans-Atlantic Slave Trade Database*.

[12] We assume that slaves disembarked are homogeneous goods. In general, this is, of course, not true. For instance, both male and female slaves were exported. But, in our data, the average proportion of male slaves exported is approximately 0.63 in all three countries studied, with a standard deviation of below 0.1. We discuss this assumption further in Section 3.1.

[13] We acknowledge that η is not going to be constant across countries or time. Our analysis on accounting for the TFP gain from eliminating distortions is done within a country and a decade, which should minimize this concern. Nevertheless, assuming η to be constant may increase the variance of voyage TFP within a country.

[14] A captain's responsibilities could be made explicit in contracts. Postma (1990) reprints the contract for captains sailing ships for the Middelburgsche Commercie Compagnie, a Dutch slave trading company. To summarize the responsibilities in the contract, captains should 1) sail to the African coast as quickly as possible, 2) purchase high quality slaves, 3) not be attacked by the slaves, 4) make sure the slaves are not mistreated by the crew, 5) make sure the slaves are treated well and taken care of by the doctor, and 6) properly brand the slaves so as not to badly injure them.

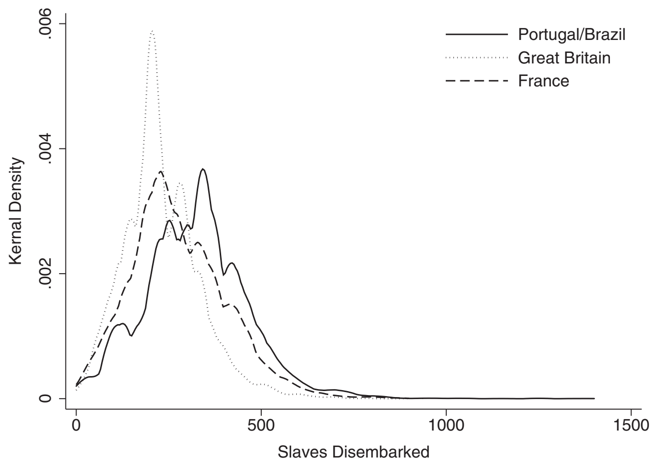

Fig. 2. Comparing distributions of voyage output across countries, 1700–1850.

Europe to trade for slaves on the African coast. As a result, their knowledge of demand conditions in Africa could impact the time required to purchase and load slaves and, thus, the amount of time slaves spent on a slave ship before departing from the African coast. Although slave ships often carried a doctor on board to help slaves survive the Middle Passage, Rawley (1981) notes the important role played by the captain in overseeing a ship's hygiene. If captains understood the role of air ventilation in fostering cleanliness, for example, it would lead to better practices on board the ship, which would help slaves survive the journey. Captains kept the doctor on task and made sure the doctor received any supplies required. Harms (2002) notes that captains were responsible for rationing food and water and maintaining discipline. Captains also had specialized knowledge related to which slaves were more prone to violence and rebellion. Rawley (1981), reporting on a Captain James Fraser, notes "…he seldom confined Angola slaves, "being very peaceable," took off the handcuffs of Windward and Gold Coast slaves as soon as the ship was out of sight of land, and soon after that the leg irons, but Bonny slaves, whom he thought vicious, were kept under stricter confinement." Overall, a captain's ability to manage a slave voyage played an important role in how many slaves completed the Middle Passage.

Transforming the above production function into logarithms allows linear estimation. A simple standard estimation equation of the production function is

$$ln\ Y_i = \alpha\ ln\ \hat{K}_i + \beta\ ln\ L_i + e_i. \tag{2}$$

The residual of the equation, e_i, is the logarithm of TFP.

An OLS estimation of Eq. (2) suffers from the simultaneity problem. As Marschak and Andrews (1944) first pointed out, part of the TFP (e_i) might be observed by the firm before it makes its factor input decision in that period. The regressors and the error term are, thus, correlated, which makes the OLS estimates biased.

The bias can go either way. On the one hand, in the cross section of the voyages, better captains (a high e_i) will require less labor to export the same amount of slaves. These voyages will export more with less labor. OLS will, thus, underestimate β.

On the other hand, in the time series data in which we observe the same ship over time, a ship may get a high productivity shock (a high e_i) and hire more labor. OLS will attribute the increase in exports to the change in labor. OLS will overestimate β in this case.

A solution to the problem is to include ship or captain fixed effects. In our data, voyages have information on the names of captains and ships. We use the captains' names to identify a unique captain. Unfortunately, there are a lot of duplications in the ships' names, so we decide not to include a ship fixed effect.[15] The regression becomes

$$ln\ Y_i = \Phi_i + \alpha\ ln\ \hat{K}_i + \beta\ ln\ L_i + e_i, \tag{3}$$

where Φ_i denotes the captain fixed effect.

In addition to regressing Eq. (3) in which α and β are estimated separately, we also use a second method that makes use of historical estimates on labor and capital shares in the slave trade to estimate the production function. In particular, the production function can be rewritten as

$$Y_i = (A_i\phi_i)\left(\hat{K}_i^{\overline{\alpha}} L_i^{1-\overline{\alpha}}\right)^{\gamma} = A_i\phi_i Z_i^{\gamma}, \tag{4}$$

where $\overline{\alpha}$ and $1-\overline{\alpha}$ represent historical estimates on capital and labor shares and γ is the so called span-of-control parameter governing the returns to scale. The natural log of output can be written as:

$$ln\ Y_i = \Phi_i + \gamma[\overline{\alpha}\ ln\ K_i + (1-\overline{\alpha})\ ln\ L_i] + e_i = \Phi_i + \gamma\ ln\ Z_i + e_i \tag{5}$$

The regression of Eq. (5) requires knowledge on the values for the capital and labor shares $\overline{\alpha}$ and $1-\overline{\alpha}$. We use the estimates reported in Eltis and Richardson (1995) to construct separate measures for the labor share during the 1700s and 1800s. Eltis and Richardson (1995) report values of 0.479, 0.492, and 0.532 for labor shares during the 1680s, the period 1764–1775, and the 1780s. The values reported for the periods 1826–1835, 1836–1845, and 1856–1865 are 0.346, 0.276, and 0.242. We average the two sets of values to calculate a labor share of 0.501 for the 1700s and 0.288 for the 1800s. Since the labor share differs in the 1700s versus 1800s, we cannot compare our measures of TFP across the two periods. This is an important point to keep in mind, because British and French voyages occur primarily, though not exclusively, in the 1700s, while Portuguese/Brazilian voyages are concentrated in the 1800s. From this point forward in the paper, we only consider British and French voyages in the 1700s and Portuguese/Brazilian voyages in the 1800s. However, the structural approach we use later to identify the dispersion in market distortions does not rely on the labor share, and, thus, we make comparisons between all three countries. Likewise, our main results on the TFP gains after eliminating the dispersion in market distortions can still be compared across all three countries.

Table 3 reports the results from different specifications of our two methods. Columns (1) and (2) report the estimates on the capital and labor shares from Eqs. (2) and (3), i.e. with and without captain fixed effects. Columns (3) and (4) report the estimates on the returns to scale parameter (γ) from Eq. (5), with and without captain fixed effects.

As discussed earlier, the bias of not controlling for the captain fixed effect can go either way. In particular, controlling for the captain fixed effect would lead to a lower labor share (β) in Great Britain while a higher labor share in France and Portugal/Brazil. Also note that the labor share in Portugal/Brazil is negative when the captain fixed effect is not controlled for. The capital share (α) is lower in France and Portugal/Brazil with the captain fixed effect, while that in Great Britain is similar.

The two specifications from Eqs. (3) and (5) also yield similar capital and labor shares in Great Britain and Portugal/Brazil. When estimated separately (column 2), the capital shares in Great Britain and in Portugal/Brazil are 0.36 and 0.54, and they are 0.36 (0.73 × 0.499) and 0.49 (0.69 × 0.712) when the ratio of the capital share to the labor share is restricted to historical averages. Similarly, the estimates of

[15] Thomas (1997) notes that slave ships within a country usually had similar names. For instance, "In one list of [Portuguese] slave ships to Bahia, *Nossa Senhora* appeared 1154 times, with fifty-seven different suffixes, above all *Nossa Senhora de la Conceição* (324 times); while male saints were used 1158 times, of whom *San Antônio* (of Padua, but with his identity moved to Lisbon) was the most popular (695 times). *Bom Jesus* appeared 180 times (above all, the *Bom Jesus do Bom Sucesso*)."

Table 3
TFP regression results.

	(1)	(2)	(3)	(4)
Great Britain				
Capital share (α)	0.34	0.36		
	(0.02)	(0.02)		
Labor share (β)	0.50	0.37		
	(0.02)	(0.02)		
Returns to scale (γ)			0.84	0.73
			(0.01)	(0.02)
Captain fixed effects	N	Y	N	Y
France				
Capital share (α)	0.42	0.26		
	(0.05)	(0.09)		
Labor share (β)	0.39	0.64		
	(0.05)	(0.10)		
Returns to scale (γ)			0.81	0.88
			(0.03)	(0.06)
Captain fixed effects	N	Y	N	Y
Portugal/Brazil				
Capital share (α)	0.62	0.54		
	(0.05)	(0.11)		
Labor share (β)	−0.14	0.11		
	(0.07)	(0.14)		
Returns to scale (γ)			0.64	0.69
			(0.06)	(0.11)
Captain fixed effects	N	Y	N	Y

Standard errors are in parenthesis.

labor shares are 0.37 in both specifications in Great Britain. The estimates of Portuguese/Brazilian labor shares are 0.11 and 0.20 (0.69 × 0.288), but the difference is not statistically significant. The labor and capital share estimates for French voyages are different across the two specifications. When estimated separately, the labor share estimate is higher than the historical average, and the capital share estimate is lower than the historical average.

2.2.3. Distributions of voyage productivities

We now turn to looking at our four measures of productivity from the data. When reporting our TFP results in Figs. 3 and 4 and Table 4, we use the full specification in Eq. (5), i.e. captain fixed effect with the returns to scale parameter or column (4) in Table 3. Fig. 3 shows the distributions of the four measures of voyage productivity during the 1700s. Each distribution is again log-normal. The correlations between the four types of productivities are all positive. Table 4 reports summary statistics for the voyage productivities for different cuts of the data, including for all voyages presented in Fig. 3, all voyages during the period 1800–1850, and voyages by different countries.

Fig. 4 compares the productivity distributions over the period 1700–1850 for Portugal/Brazil, Great Britain, and France. We show TFP for all three countries on the same graph only for space considerations, but, again, we cannot compare TFP across the two periods, 1700s and 1800s. We only have enough observations to report the distributions of distance per day for Portugal/Brazil and France.[16] In terms of the patterns in the data, we first compare British and French voyages during the 1700s and then consider Portuguese/Brazilian voyages during the 1800s. British voyages are more productive than French voyages on average, which is consistent with the findings reported in Eltis and Richardson (1995). This is true for both measures of productivity we are able to compare (slaves per ton and slaves per crew). We are also interested in any patterns in dispersion. Table 4 and Fig. 4 show that French productivity exhibits more dispersion than British productivity when measured as slaves per ton or TFP. French slaves per crew, however, is less disperse than British slaves per crew. Considering now the three measures of productivity we are able to compare with the British and French (slaves per ton, slaves per crew, and distance per day), Portuguese voyages appear more productive on average. Decreased dispersion does not accompany higher average productivity, though. Portuguese/Brazilian productivity is more dispersed than British and French for these three measures of productivity.

[16] There is only one British observation for distance per day.

2.3. Institutional efficiency

Not only did productive efficiency (i.e. TFP) vary across and within different countries between 1700 and 1850, there was also substantial variation in institutional efficiency, which impacted the workings of the factor (i.e. labor and capital) and product (i.e. slaves) markets. Much of the period of the slave trades can be characterized by well-documented mercantilist policies imposed by various European states and their associated inefficiencies. Eltis and Richardson (1995) make this same point. In these types of economies, firms with close connections to royal families would be in more advantageous positions than firms without such connections. Pearson and Richardson (2001) emphasize the importance of these networks and the differential access they afford during the period we study.[17] The degree of the mercantilist policies varied across the countries we study. For instance, the Royal African Company lost its monopoly over the English slave trade in 1698, while the royal families in France and Portugal still had a lot of influence on the slave trade throughout the 1700s. French slave trading was characterized by an elaborate subsidy system known as the Acquits de Guinée, and the Compagnie du Sénégal maintained monopoly rights over exporting slaves from Senegambia. Thomas (1997) goes so far as to assert “the prime mover in the slaving business was the state.”

Inefficiencies in the factor and product markets of the slave trades, which we document below, gave rise to variation in the prices of slaves. For example, the slave prices in non-British colonies were higher than that in the British colonies in the 1700s, as mentioned in a letter cited in Inikori (1981) from John Tarleton to his brother and partner in 1790:

> Since I wrote you last, I have seen Mr. H. Le Mesurier, who set out in the Mail last night for Liverpool, and had a long conversation with him respecting his scheme for our future adventures to St. Domingo, as a joint concern with the house at Havre; which from the continuance of the French bounties, and an uncommon demand for negroes, would, I am persuaded, turn out a most lucrative one, and far superior in every respect to what we can possibly expect in any of the English Islands, where the risk of bad debts is nearly equal with what it is in the French Islands, with only two-thirds of the price for each slave.

Eltis and Richardson (2004) also document substantial slave price variations across different ports in the New World. In their paper, they show that Jamaica and St. Domingue, which are close geographically, had different slave prices in the eighteenth century.

Thomas (1997) documents the many different state policies giving rise to product market distortions in the slave trades. During the time when the Royal African Company had its privilege over the British slave trade, independent traders paid an ad valorem tax to the company to engage in the trade. In the case of the Portuguese, slave traders were supposed to stop in the Cape Verde Islands to pay duties. Two state companies, the Maranhão created in 1755 and the Pernambuco created in 1759, were exempt from the export taxes paid by their competitors. In France, any merchant could engage in the slave trades, provided they sail from one of the five privileged ports of Rouen, La Rochelle, Bordeaux, Saint-Malo, and Nantes. French slave traders then paid a tax per slave to sell their product, which varied based on the French colony in which the sale was made. Taxes were not only levied by the European side of the colonial system but also by colonial assemblies themselves. Thomas (1997) mentions the Jamaican Assembly's imposition of a

[17] In a different context well-known to economic historians, Greif (1989) and Greif (1993) describe the important role played by reputation in smoothing international transactions.

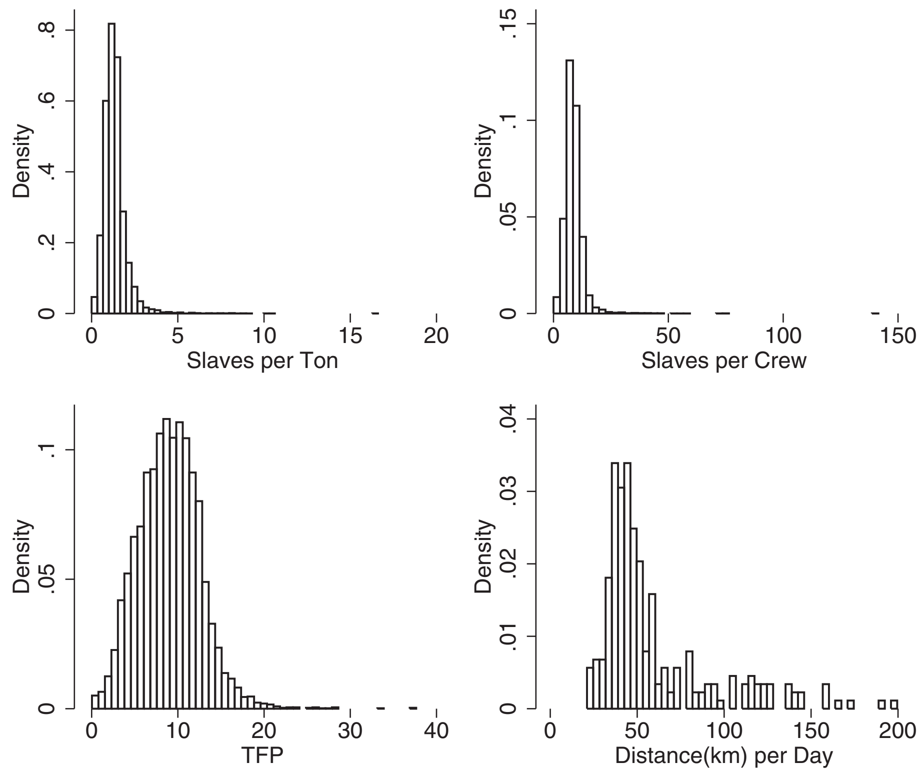

Fig. 3. Distributions of voyage productivities, 1700s.

local tax on slaves exported from Jamaica, including those being transshipped.

The levels of distortions that firms faced at the time were highly asymmetric due to differential access in the product market. Thomas (1997) notes that slave traders bought plantations in the New World to help establish networks for purchasing slaves. The networks of purchasing agents often included family members of slave traders. British access to non-British colonies serves as another example. It was either by special license from the European governments in charge or by underground arrangements. These set a high entry barrier which

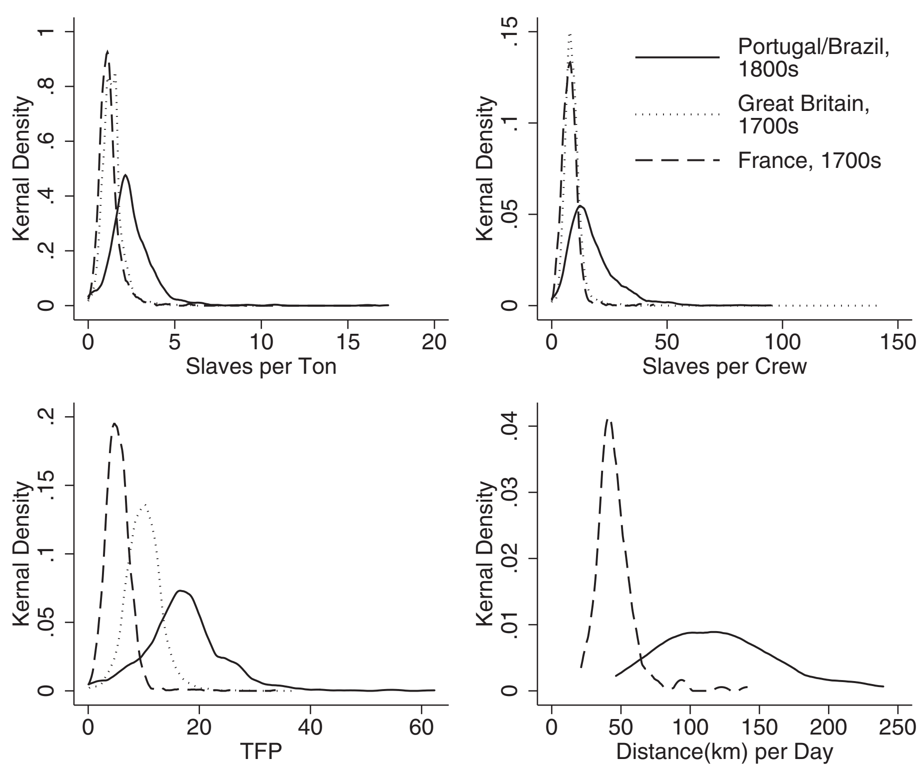

Fig. 4. Comparing distributions of voyage productivities across countries, 1700–1850.

Table 4
Summary statistics for voyage productivities, 1700–1850.

	Mean	Min	Max	Std. dev.	Skewness	N
All voyages, 1700s						
Slaves per ton	1.3408	0	16.6063	0.6929	3.9791	10,927
Slaves per crew	8.7250	0	141.4500	4.3210	6.7879	8461
Distance(km) per day	59.7129	21.1417	199.5254	33.8018	1.7735	248
All voyages, 1800s						
Slaves per ton	1.8355	0.0042	17.3306	1.2425	3.2407	3377
Slaves per crew	13.7272	0.0426	95	9.7955	2.4281	2710
Distance(km) per day	120.6148	46.3681	239.4305	42.6388	0.5825	69
Portugal/Brazil, 1800s						
Slaves per ton	2.5243	0.0042	17.3306	1.4473	3.5938	1105
Slaves per crew	17.5295	0.0667	95	10.8061	1.9586	1247
TFP	17.2550	0.0497	62.3145	7.4214	0.9772	646
Distance(km) per day	120.7905	46.3681	239.4305	42.3295	0.6199	67
Great Britain, 1700s						
Slaves per ton	1.3949	0	10.4250	0.6387	3.2202	7781
Slaves per crew	9.0546	0	141.4500	4.3938	8.1904	5803
TFP	9.9895	0.1609	37.6443	3.1666	0.6648	5759
France, 1700s						
Slaves per ton	1.2299	0	16.6063	0.7743	6.2570	2188
Slaves per crew	7.8475	0	44.2833	3.7042	2.7695	2156
TFP	5.3771	0.0345	33.7378	2.4184	2.5936	1572
Distance(km) per day	45.7658	21.1417	141.4387	14.9083	2.6161	195

favored the large firms that had connections. In 1789, John Dawson, the largest supplier of slaves to non-British colonies at the time, told a committee of the Privy Council that he signed a special contract with the Spanish government and had landed 12,000 slaves in the Spanish colonies between 1785 and 1788. Procurement of slaves from the African coast could also contribute to product market inefficiencies. Eltis and Richardson (1995) note that the French crown granted monopoly rights over exporting slaves from Senegambia for much of the 1700s to one firm, the Compagnie du Sénégal. Rival French traders were forced further south down the African coast to find alternative sources of slaves. As Harms (2002) points out, even though much of the slave trade began to open up to private traders during the 1700s, the former monopoly companies still retained ownership of important trading forts and castles along the African coast and, thus, maintained strategic access to slave markets in Africa.

The European labor market in the 1700s and 1800s was highly inefficient. One indication of labor market inefficiency is wage dispersion. Historical wage dispersion across European cities, as well as within a European country such as Great Britain and France, has been well documented. Allen (2001), making use of the wage and grain price data made available by Phelps Brown and Hopkins (1981), shows that wage dispersion existed in Europe in the 1700s. Williamson (1995, 1996) documents substantial wage dispersion among the OECD members in the 1800s. Hunt (1973), Pollard (1959), and Sicsic (1992) provide evidence of the wide wage gaps between the urban and rural areas in Great Britain and France in the 1800s.

The labor markets upon which slave traders depended were no exception. Eltis and Richardson (1995) cite the Five Great Farms, the internal French customs union, as an example of an institutional constraint on the equalization of costs across French ports. Rawley (1981) claims that Liverpool merchants "paid lower wages to seamen and captains and lower commission to factors than did merchants in other ports." According to Thomas (1997), this was "one reason why the former (Liverpool merchants) were able to sell their cargoes for 12 percent less than the rest of the kingdom, and return with an equal profit." In some cases, crew members were secured through crimping, and voyage owners presumably varied in their ability and willingness to crimp. Thomas (1997) describes the practice by relating the following:

> A carpenter in the navy, James Towne, told a House of Commons committee on the slave trade: "The method at Liverpool [to obtain sailors] is by the merchants' clerks going from public house to public house, giving them liquors to get them into a state of intoxication and, by that, getting them very often on board. Another method is to get them in debt and then, if they don't choose to go aboard of such guinea men then ready for sea, they are sent away to gaol by the publicans they may be indebted to."

The extent of the development of the credit markets servicing the slave trades varied across European ports, and access to the best markets would be an advantage to a slave trading firm. The case of Liverpool's prominence, for example, is well known. Rawley (1981) provides a thorough discussion of the advantages that connections to Liverpool provided. Capital expenditures for a voyage were often shared by small groups of investors. Thomas (1997) notes, "The most frequent type of association … was one of relations, the only tie which could be trusted to endure." As a result, families came to dominate the financing of the slave trades to a large extent. Viles (1972) notes that the slave traders of Bordeaux and La Rochelle were a minority group of Protestant merchants with close family ties. These Protestant slavers only exerted influence on the commercial institutions of their city in La Rochelle, not Roman Catholic controlled Bordeaux. The financiers themselves often had access to pools of capital through their many commercial interests.

The mercantile policies in different European states created additional capital market distortions. Rawley (1981) describes the French subsidy system, which included a bounty per ton for ships. Rawley (1981) notes the effect of the distortion: "The bounty for tonnage, intended to encourage use of larger ships, had the unhappy result of encouraging fraud. Ships miraculously doubled in size."

Small firms were also disadvantaged in the credit market such that they might have to pay a premium to secure labor services. A letter mentioned in Inikori (1981) from Joseph Canton, one of the small slave traders in Liverpool, to James Rogers, who owned a badly managed slave trade firm which went bankrupt in the 1790s indicated the importance of connections in the local credit market:

> When you sent me that Bill of £500 I put it into Mr. Heywood's Bank with that intent to take cash as occasion required. Mr. Heywood sent this bill up to Mr. Joseph Denison in London, their Banking house, to enquire into the utility of the Bill. Mr. Denison in his usual way as he often does sends this bill down again and says the Bill may be good but he knows nothing of the acceptor or Drawer and such bills is out of his way. So Heywood has sent it to me which I have by now.

Inikori (1981) argues that the more limited access to credit markets also affected the levels of munitions and insurance available to small firms. Donnan (1930) documents a marine insurer from London explaining to a slave trader from Newport, Rhode Island that "the premium for a winter voyage from Jamaica is never less than 8 percent and upon vessels not known in the trade can seldom be under 10." According to Thomas (1997), insurance rates varied from 5% to 25%. Price and Clemens (1987) find the same pattern of small firms disadvantaged in credit and insurance markets during the same time period as the slave trades but for a different trade, namely, the Chesapeake trade plied by British firms.

3. Accounting for TFP loss due to dispersion

3.1. A structural model for measuring distortions

Our method for analyzing the data resembles the business cycle accounting framework developed by Chari et al. (2007) and applied by Hsieh and Klenow (2009) and Song and Wu (2013), among many others.[18] The procedure relies on a structural model of the economy and infers the distortions in the input and output markets from the residuals, or wedges, in the first order conditions. For example, when used in examining the sources of the fluctuations in a series of GDP per capita, this approach allows the researcher to identify the relevant distortions, information which can then be used to think about the details and underlying mechanisms generating the fluctuations. The procedure can also be applied under various market structures and different types of models. Chari et al. (2007) base the discussion around a perfectly competitive environment but established equivalency results for a large class of models, whereas Hsieh and Klenow (2009) consider a monopolistically competitive environment à la Melitz (2003).

In order to examine the product, labor, and capital market distortions during the slave trades, we consider a simple decision problem where a firm, or a voyage, hires labor and invests in capital to produce output, slaves disembarked. Each voyage has access to the decreasing returns to scale production function shown in Eq. (1) and makes decisions in a competitive environment where prices, wages, and rental rates are given. Voyages differ by their TFP and the distortions they face in the output and input markets. Lastly, the slaves disembarked are homogeneous products. While slaves differed by age, gender, quality, etc., the data do not permit us to identify this variation. Also, newly arrived slaves may have been largely undifferentiated from the perspective of the buyer, because characteristics, such as field productivity and life expectancy, were difficult to measure before being tested by life in the Americas. Eltis et al. (2005) make this same point when assuming that slaves were largely homogeneous products. We now can turn to the voyage decision problem.

For a given productive capital stock $\hat{K}_i$, voyage i chooses Y_i and L_i to maximize profits subject to its production function

$$\max_{Y_i, L_i} (1-\tau_i^p) p Y_i - (1+\tau_i^w) w L_i \quad \text{s.t.} \quad Y_i = \hat{A}_i \hat{K}_i^{\alpha} L_i^{\beta} \tag{6}$$

where p is the price received for a slave in the Americas and w is the wage rate paid to a voyage crew member. τ_i^p and τ_i^w represent the distortions in the product market and labor market faced by an individual voyage i. Solving the voyage problem yields the following expressions:

$$L_i = \frac{\beta \Phi_i \hat{K}_i^{\alpha/1-\beta}}{(1+\tau_i^w) w}$$

$$Y_i = \frac{\Phi_i \hat{K}_i^{\alpha/1-\beta}}{(1-\tau_i^p) p}$$

$$\pi_i = (1-\beta) \Phi_i \hat{K}_i^{\alpha/1-\beta},$$

where π_i represents voyage i's profits and $\Phi_i = \left(\frac{\beta^{\beta} \hat{A}_i (1-\tau_i^p) p}{[(1+\tau_i^w) w]^{\beta}} \right)^{1/1-\beta}$.

We also model the distortions in the capital market. In particular, we use τ_i^r to summarize the effects of capital market distortions on the capital goods price that voyage i faces:

$$R_i = (1+\tau_i^r) R, \tag{7}$$

where R is the average capital goods price.

The law of motion for capital is as follows. Voyage i has an initial amount of capital, K_i, at the beginning of each period. It can purchase new investment, I_i, which contributes to the productive capital, $\hat{K}_i$. The capital will depreciate by the portion δ in the next period, which then determines K_i'. The law of motion for capital is then

$$K_i' = (1-\delta) \hat{K}_i = (1-\delta)(K_i + I_i). \tag{8}$$

The investment problem for voyage i is defined by the Bellman equation:

$$V(\Phi_i, K_i) = \max_{I_i} \left\{ \pi(\Phi_i, K_i, I_i) - R_i I_i + \frac{V(\Phi_i, K_i')}{1+r} \right\}, \tag{9}$$

where $1/1 + r$ is the discount factor. Define J as the Jorgensonian user cost of capital:

$$J \equiv R \left(1 - \frac{1-\delta}{1+r} \right). \tag{10}$$

Following Bloom (2009) and Song and Wu (2013), our timing assumption on investment allows for a closed form solution for investment, because it is straightforward to show, by guess and verify, that the value function is linear in K_i:

$$V(\Phi_i, K_i) = R_i K_i + C, \tag{11}$$

where C is a constant in K_i. The productive capital is then as follows:

$$\hat{K}_i = \left[\frac{\Phi_i \alpha}{(1+\tau_i^r) J} \right]^{\frac{1-\beta}{1-\alpha-\beta}}. \tag{12}$$

The input–output ratios and labor–capital ratio are then:

$$\frac{L_i}{Y_i} = \beta \frac{(1-\tau_i^p) p}{(1+\tau_i^w) w} \tag{13}$$

$$\frac{\hat{K}_i}{Y_i} = \alpha \frac{(1-\tau_i^p) p}{(1+\tau_i^r) J} \tag{14}$$

$$\frac{L_i}{\hat{K}_i} = \frac{\beta}{\alpha} \frac{(1+\tau_i^r) J}{(1+\tau_i^w) w}. \tag{15}$$

We assume that the log of the distortions is distributed normally with zero mean and that the distributions are independent. Song and Wu (2013) have a similar assumption on the labor and capital market distortions in China. The variances of the log of the ratios in Eqs. (13) to (15) are then:

$$\text{Var}\left[ln\left(\frac{L_i}{Y_i} \right) \right] = \sigma_{\tau_p}^2 + \sigma_{\tau_w}^2 \tag{16}$$

$$\text{Var}\left[ln\left(\frac{\hat{K}_i}{Y_i} \right) \right] = \sigma_{\tau_p}^2 + \sigma_{\tau_r}^2 \tag{17}$$

$$\text{Var}\left[ln\left(\frac{L_i}{\hat{K}_i} \right) \right] = \sigma_{\tau_w}^2 + \sigma_{\tau_r}^2. \tag{18}$$

The variances of the input–output ratios and labor–capital ratio are easily obtained for a large number of observations in the *Trans-Atlantic*

[18] The term *business cycle accounting* originates with the application to business cycles in Chari et al. (2007), but their method can be extended to many other applications, including the distribution of resources as done by Hsieh and Klenow (2009).

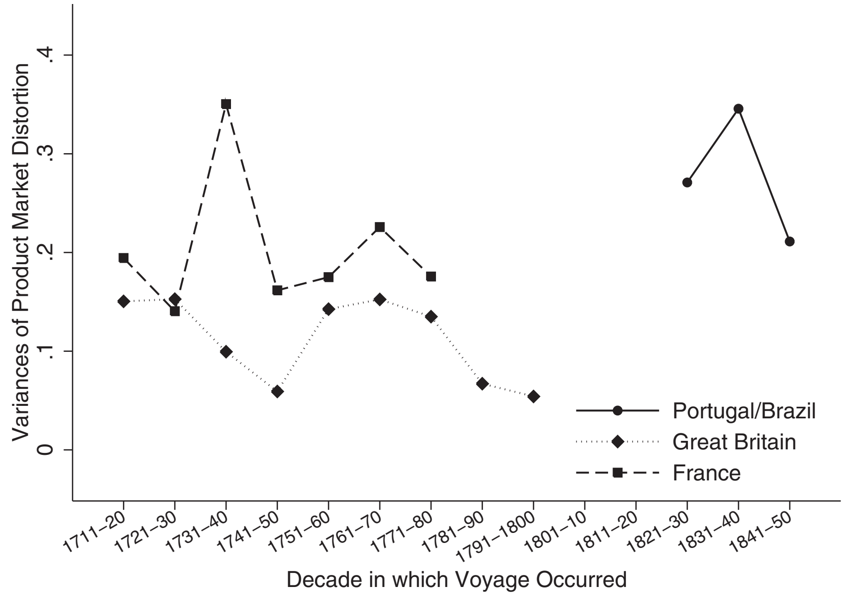

Fig. 5. Variances of product market distortions across countries, 1700–1850.

Slave Trade Database.[19] Figs. 5 to 7 report the variances of the distortions in the product market, the labor market, and the capital market, respectively. As Eqs. (16) to (18) show, the variances of the distortions are measured from simple manipulation of the available data and do not depend on our different TFP regression approaches in Table 3. We consider British and French voyages during the 1700s and Portuguese/Brazilian voyages during the 1800s. We only report a value for variances in those decades with a large number of voyage observations.[20]

The dispersion of distortions differs across countries. As Fig. 5 shows, the dispersion in the French product market distortions exceeds British dispersion in six out of seven decades for which we have values for both countries. The dispersion in the Portuguese/Brazilian product market distortions is higher than both French or British. Since there are no overlapping decades, we just compare the average dispersions across the three countries. The average Portuguese/Brazilian dispersion is 36% larger than the average French dispersion and 145% larger than the average British dispersion.

Fig. 6 shows that the dispersion in the labor market distortions is smaller than that in the product market. On average, the dispersion of distortions in the French, British, and Portuguese/Brazilian labor markets is 12%, 44%, and 51% of those in the corresponding product market. Across countries, Portuguese/Brazilian dispersion is the largest, which is roughly eight times and three times that in the French and British market.

Fig. 7 shows that the dispersion in the capital market distortions is also smaller than that in the product market. On average, the dispersions of distortions in the French, British, and Portuguese/Brazilian capital markets are 15%, 62%, and 37% of those in the corresponding product market. The dispersion across countries are, on average, very similar.

[19] There are a few things that our model does not capture which might distort our estimate of the variances of the market distortions. Measurement error in the input–output and labor–capital ratios is one example. Also, we do not capture variation, in particular inflation, in prices, wages, and rental rates, which would bias our estimate upward. There are two reasons why this is probably not a major concern. First, if inflation in all three sectors is the same, then the impact of inflation would be cancelled in the input–output ratios and labor–capital ratios in Eqs. (13), (14), and Eq. (15). Second, inflation may not have been very large. According to the available evidence in Allen (2001), the nominal wages of building craftsmen and building laborers in London increased 20% and 10% between the two 50-year periods in the 18th century. In order to minimize this source of bias, we consider the shortest time period possible, a decade (in which the wage inflations are roughly 2%–4% according to Allen (2001)), when estimating the variances of the market distortions.

[20] The average number of voyage observations in the decades that we report is 415.

3.2. Contribution of institutional efficiency to TFP

Backing out the variances is important in understanding the impact of distortions on the country's TFP in the slave trade. The country's TFP in the slave trade is:

$$\mathrm{TFP} = \frac{\sum_i Y_i}{\left(\sum_i \hat{K}_i\right)^{\alpha}\left(\sum_i L_i\right)^{\beta}}. \tag{19}$$

Our measure of the country's TFP in the slave trade is similar to the industry measure of TFP in Hsieh and Klenow (2009).

If $\hat{A}_i$, $(1-\tau_i^p)$, $(1+\tau_i^r)$, and $(1+\tau_i^w)$ are jointly but independently lognormal distributed, the aggregate output, aggregate labor, and aggregate capital can be shown as

$$\sum_i Y_i \approx \left[\frac{p^{\alpha+\beta}\alpha^{\alpha}\beta^{\beta}}{J^{\alpha}w^{\beta}}\right]^{1/1-\alpha-\beta} N\,exp\left[\frac{\hat{A}}{1-\alpha-\beta}+\frac{\sigma_{\hat{A}}^2+(\alpha+\beta)^2\sigma_{\tau_p}^2+\alpha^2\sigma_{\tau_r}^2+\beta^2\sigma_{\tau_w}^2}{2(1-\alpha-\beta)^2}\right] \tag{20}$$

$$\sum_i L_i \approx \left[\frac{p\alpha^{\alpha}\beta^{1-\alpha}}{J^{\alpha}w^{1-\alpha}}\right]^{1/1-\alpha-\beta} N\,exp\left[\frac{\hat{A}}{1-\alpha-\beta}+\frac{\sigma_{\hat{A}}^2+\sigma_{\tau_p}^2+\alpha^2\sigma_{\tau_r}^2+(1-\alpha)^2\sigma_{\tau_w}^2}{2(1-\alpha-\beta)^2}\right] \tag{21}$$

$$\sum_i \hat{K}_i \approx \left[\frac{p\alpha^{1-\beta}\beta^{\beta}}{J^{1-\beta}w^{\beta}}\right]^{1/1-\alpha-\beta} N\,exp\left[\frac{\hat{A}}{1-\alpha-\beta}+\frac{\sigma_{\hat{A}}^2+\sigma_{\tau_p}^2+(1-\beta)^2\sigma_{\tau_r}^2+\beta^2\sigma_{\tau_w}^2}{2(1-\alpha-\beta)^2}\right], \tag{22}$$

where $\hat{A}$ is the mean of $ln\,\hat{A}_i$ and N is the number of voyages.[21] Substituting Eq. (20) to (22) into Eq. (19), we can express the natural log of the country's TFP as a decreasing function of the variances of the distortions:

$$ln\,TFP = \hat{A}+(1-\alpha-\beta)\,ln\,N+\frac{\sigma_{\hat{A}}^2-(\alpha+\beta)\sigma_{\tau_p}^2-\alpha(1-\beta)\sigma_{\tau_r}^2-\beta(1-\alpha)\sigma_{\tau_w}^2}{2(1-\alpha-\beta)}. \tag{23}$$

[21] The appendix provides details for deriving Eqs. (20)–(22). We also show in the appendix how allowing the distortions to be correlated affects our results.

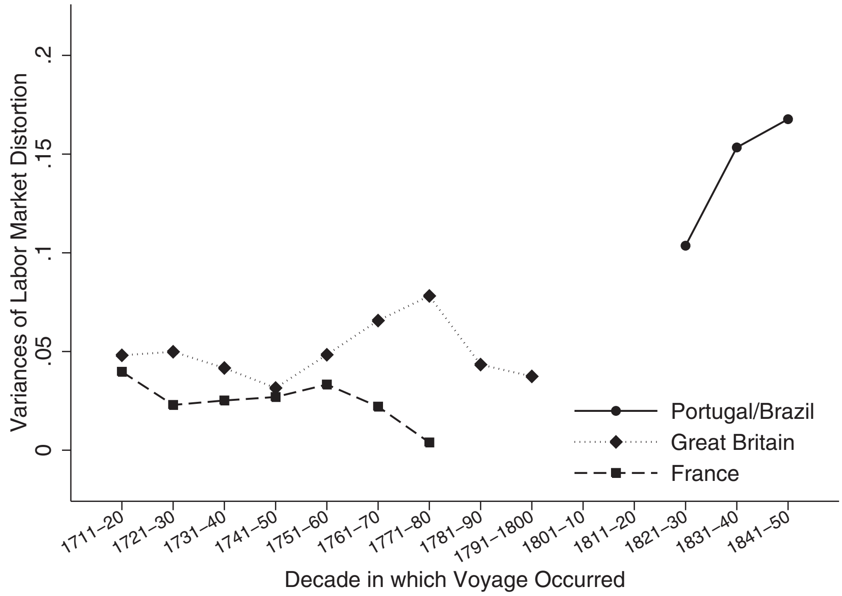

Fig. 6. Variances of labor market distortions across countries, 1700–1850.

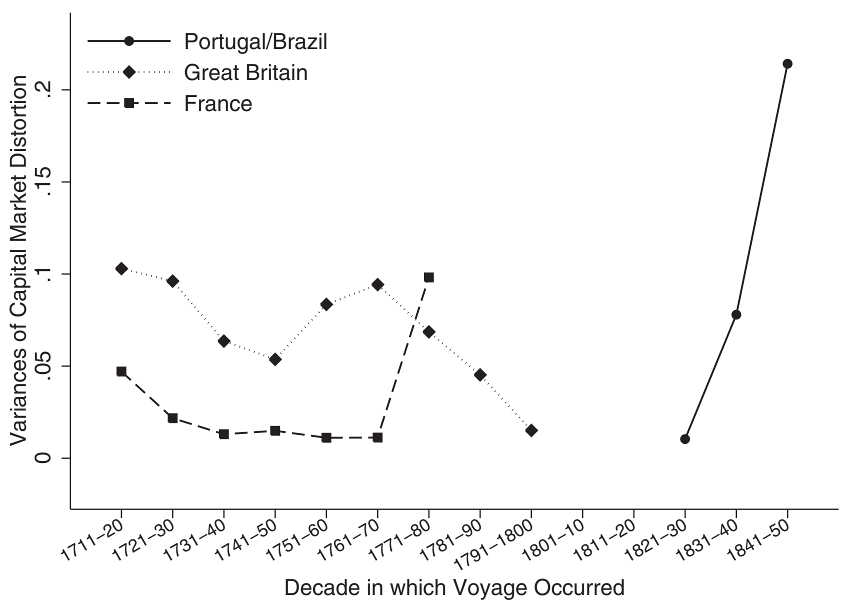

Fig. 7. Variances of capital market distortions across countries, 1700–1850.

Just like in Hsieh and Klenow (2009), dispersion in distortions worsens misallocation, because it generates higher dispersion in marginal products.

Tables 5 and 6 report the TFP gain for the three countries when the variances of distortions disappear. Table 5 shows results using the specification with the returns to scale parameter and captain fixed effects, i.e. column (4) of Table 3, whereas Table 6 shows results using the specification with capital and labor shares with captain fixed effects, i.e. column (2) of Table 3.[22] Several results emerge.[23] First, the TFP gains from eliminating all distortion dispersions are huge. The TFP would increase approximately 22% in Great Britain and 45% in Portugal/Brazil had all dispersions of input and output market distortions disappeared. The TFP would even more than double (123%) in France had these dispersions disappeared.

Second, the dispersion of distortions in the product market had the largest impact on a country's TFP for all three countries in our study. TFP would increase 17% in Great Britain, 118% in France, and 36% in Portugal/Brazil had the dispersion of the product market distortions disappeared. These gains are at least 5 times (in Great Britain and Portugal/Brazil) and 35 times (in France) bigger than the TFP gains had only either the dispersion of capital or labor market distortions disappeared.

Third, the TFP losses due to capital market distortions, while much smaller than that due to product market distortions, are slightly higher than that due to labor market distortions. In Great Britain, TFP loss due to capital market distortion dispersion is on average 3%, while the TFP loss due to labor market distortion dispersion is on average 2%. In France, the TFP losses from capital and labor market distortion dispersion are similar. In Portugal/Brazil, the TFP loss due to capital market

[22] We report the results from the specifications without captain fixed effects in the appendix.
[23] All the numbers cited here in the text refer to Table 5.

Table 5
TFP gains (%) when distortion variation disappears, 1700–1850.

(Z case with captain fixed effects)									
	Great Britain			*France*			*Portugal/Brazil*		
Decade	P	K	L	P	K	L	P	K	L
1711–20	22.56	4.50	2.09	103.99	4.93	4.18			
1721–30	22.94	4.20	2.17	67.40	2.25	2.39			
1731–40	14.39	2.76	1.81	261.31	1.34	2.63			
1741–50	8.33	2.32	1.37	80.89	1.54	2.82			
1751–60	21.26	3.64	2.10	89.99	1.14	3.49			
1761–70	22.88	4.12	2.87	128.83	1.15	2.30			
1771–80	20.02	2.98	3.42	90.42	10.56	0.41			
1781–90	9.49	1.96	1.89						
1791–1800	7.60	0.65	1.62						
1821–30							35.19	0.66	1.70
1831–40							46.92	5.07	2.53
1841–50							26.49	14.57	2.34
Mean	16.61	3.01	2.15	117.55	3.28	2.60	36.20	6.77	2.34

distortion dispersion is even higher at almost 7%, while the TFP loss due to labor market distortion dispersion is slightly higher than 2%.

4. Conclusion

The slave trading economy of the Atlantic was characterized by numerous distortions in output and input markets. These distortions gave rise to resource misallocation, which then impacted TFP in the slave trades. This paper is the first to quantify the inefficiency in the slave trades of Great Britain, France, and Portugal due to market distortions. We structurally identify the dispersion of the distortions in the output and input markets from wedges in first order conditions. Our procedure should prove useful as a diagnostic tool for economic historians working on a range of topics. Market distortions played a significant role in depressing TFP in the slave trades. Eliminating all the dispersion of the distortions in the output and input markets would have increased TFP by 22% in Great Britain, 45% in Portugal, and 123% in France. The dispersion of the distortions in the product markets had the biggest impact on TFP.

Our findings shed new light on the industrial structure of the Atlantic economy during the time of the slave trades. Although historians and economic historians have made great strides in documenting and analyzing the slave trades, there is still room for further research, especially given the wealth of firm-level data during this historical period. Future research should exploit the richness of the data, as we have tried to do in this paper.

Appendix A

A.1. Deriving aggregate output, labor, and capital

Eqs. (20) to (22) are derived assuming $\hat{A}_i$, $(1-\tau_i^p)$, $(1+\tau_i^r)$, and $(1+\tau_i^w)$ are jointly but independently lognormal distributed. Since the derivations for all three of the aggregate variables are similar, we only show the derivation for aggregate output here. Solving the voyage-level maximization problem (6) yields the following expression for voyage i's output:

$$Y_i = \frac{\Phi_i \hat{K}_i^{\alpha/1-\beta}}{(1-\tau_i^p)p}.$$

Summing over voyages and plugging in the expression for productive capital $\hat{K}_i$ from Eq. (12) gives

$$\sum_i Y_i = \sum_i \frac{\Phi_i}{(1-\tau_i^p)p}\left[\frac{\Phi_i \alpha}{(1+\tau_i^r)J}\right]^{\frac{\alpha}{1-\alpha-\beta}}.$$

After plugging in $\Phi_i = \left(\frac{\beta^\beta \hat{A}_i(1-\tau_i^p)p}{[(1+\tau_i^w)w]^\beta}\right)^{1/1-\beta}$ and some algebra, we arrive at

$$\sum_i Y_i = \sum_i \hat{A}_i^{\frac{1}{1-\alpha-\beta}}[(1-\tau_i^p)p]^{\frac{\alpha+\beta}{1-\alpha-\beta}}\left[\frac{\beta}{(1+\tau_i^w)w}\right]^{\frac{\beta}{1-\alpha-\beta}}\left[\frac{\alpha}{(1+\tau_i^r)J}\right]^{\frac{\alpha}{1-\alpha-\beta}}.$$

Grouping the terms indexed by i yields the following:

$$\sum_i Y_i = \left[\frac{p^{\alpha+\beta}\beta^\beta\alpha^\alpha}{J^\alpha w^\beta}\right]^{\frac{1}{1-\alpha-\beta}}\sum_i\left[\frac{\hat{A}_i(1-\tau_i^p)^{\alpha+\beta}}{(1+\tau_i^r)^\alpha(1+\tau_i^w)^\beta}\right]^{\frac{1}{1-\alpha-\beta}}.$$

We eliminate the summation over i in the RHS by taking the expected value of the expression within the summation sign, using our jointly but independently lognormal distributed assumption, and multiplying by the number of voyages N. This yields the approximate amount of aggregate output in Eq. (20):

$$\sum_i Y_i \approx \left[\frac{p^{\alpha+\beta}\alpha^\alpha\beta^\beta}{J^\alpha w^\beta}\right]^{1/1-\alpha-\beta} N\exp\left[\frac{\hat{A}}{1-\alpha-\beta}+\frac{\sigma_{\hat{A}}^2+(\alpha+\beta)^2\sigma_{\tau_p}^2+\alpha^2\sigma_{\tau_r}^2+\beta^2\sigma_{\tau_w}^2}{2(1-\alpha-\beta)^2}\right].$$

where $\hat{A}$ is the mean of $ln\hat{A}_i$.

Table 6
TFP gains (%) when distortion variation disappears, 1700–1850.

(LK case with captain fixed effects)									
	Great Britain			*France*			*Portugal/Brazil*		
Decade	P	K	L	P	K	L	P	K	L
1711–20	22.56	4.42	2.13	139.87	2.23	9.87			
1721–30	22.94	4.12	2.21	88.19	1.02	5.58			
1731–40	14.39	2.71	1.84	383.81	0.61	6.15			
1741–50	8.33	2.28	1.39	106.98	0.70	6.59			
1751–60	21.26	3.57	2.14	119.82	0.52	8.20			
1761–70	22.88	4.04	2.92	176.20	0.53	5.37			
1771–80	20.02	2.92	3.49	120.44	4.70	0.93			
1781–90	9.49	1.92	1.92						
1791–1800	7.60	0.64	1.65						
1821–30							28.61	0.72	0.75
1831–40							37.85	5.50	1.11
1841–50							29.37	15.84	1.22
Mean	16.61	2.96	2.19	162.19	1.47	6.10	28.19	7.35	1.03

Table A.1
TFP gains (%) when distortion variation disappears, 1700–1850.

(Z case without captain fixed effects)									
	Great Britain			*France*			*Portugal/Brazil*		
Decade	P	K	L	P	K	L	P	K	L
1711–20	48.45	8.12	3.74	51.35	3.02	2.56			
1721–30	49.33	7.57	3.88	34.69	1.38	1.47			
1731–40	29.83	4.94	3.23	111.02	0.83	1.62			
1741–50	16.77	4.24	2.43	40.97	0.92	1.78			
1751–60	45.41	6.54	3.76	45.22	0.70	2.14			
1761–70	49.20	7.41	5.14	61.81	0.71	1.41			
1771–80	42.57	5.32	6.17	45.26	6.38	0.25			
1781–90	19.22	3.49	3.38						
1791–1800	15.28	1.15	2.90						
1821–30							27.10	0.53	1.47
1831–40							32.94	3.94	2.14
1841–50							36.46	11.07	2.28
Mean	35.12	5.42	3.85	55.76	1.99	1.60	32.17	5.18	1.96

Table A.2
TFP gains (%) when distortion variation disappears, 1700–1850.

(LK case without captain fixed effects)									
	Great Britain			*France*			*Portugal/Brazil*		
Decade	P	K	L	P	K	L	P	K	L
1711–20	48.45	5.62	5.08	51.35	3.23	2.39			
1721–30	49.33	5.24	5.28	34.69	1.47	1.38			
1731–40	29.83	3.44	4.39	111.02	0.88	1.51			
1741–50	16.77	2.95	3.29	40.97	0.98	1.66			
1751–60	45.41	4.54	5.11	45.22	0.75	2.00			
1761–70	49.20	5.14	7.01	61.81	0.76	1.32			
1771–80	42.57	3.69	8.42	45.26	6.82	0.23			
1781–90	19.22	2.43	4.58						
1791–1800	15.28	0.08	3.93						
1821–30							13.26	0.70	−0.53
1831–40							15.93	5.22	−0.77
1841–50							17.52	14.82	−0.82
Mean	35.12	3.76	5.23	55.76	2.13	1.50	15.57	6.91	−0.77

A.2. TFP gains without captain fixed effects

Tables A.1 and A.2 report the TFP gain for the three countries when the variances of distortions disappear under the specifications without captain fixed effects. Table A.1 shows results using the specification with the returns to scale parameter, i.e. column (3) of Table 3, whereas Table A.2 shows results using the specification with capital and labor shares, i.e. column (1) of Table 3. The negative numbers for Portugal in Table A.2 result from the negative estimate on the labor share β in column (1) of Table 3, which, however, is not statistically significant.

A.3. Estimation bias

In this section of the Appendix A, we relax the assumption of the distortions being independent and evaluate the impact on the results from Tables 5 and 6. In particular, we assume that TFP and the distortions are jointly lognormally distributed[24]:

$$\begin{bmatrix} \ln \hat{A}_i \\ \ln(1-\tau_i^p) \\ \ln(1+\tau_i^r) \\ \ln(1+\tau_i^w) \end{bmatrix} \sim N\left[\begin{pmatrix} \hat{A} \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{bmatrix} \sigma_{\hat{A}}^2 & \sigma_{\hat{A}p} & \sigma_{\hat{A}r} & \sigma_{\hat{A}w} \\ \sigma_{\hat{A}p} & \sigma_{\tau_p}^2 & \sigma_{pr} & \sigma_{pw} \\ \sigma_{\hat{A}r} & \sigma_{pr} & \sigma_{\tau_r}^2 & \sigma_{rw} \\ \sigma_{\hat{A}w} & \sigma_{pw} & \sigma_{rw} & \sigma_{\tau_w}^2 \end{bmatrix}\right]. \tag{A.1}$$

Then, we can show that

$$\ln TFP = \ln \hat{A} + (1-\alpha-\beta)\ln N + \frac{\sigma_{\hat{A}}^2-(\alpha+\beta)\sigma_{\tau_p}^2-\alpha(1-\beta)\sigma_{\tau_r}^2-\beta(1-\alpha)\sigma_{\tau_w}^2}{2(1-\alpha-\beta)} + \frac{\alpha\sigma_{pr}+\beta\sigma_{pw}-\alpha\beta\sigma_{rw}}{1-\alpha-\beta}. \tag{A.2}$$

But, there remains the problem that we do not have enough moments to identify σ_{pr}, σ_{pw}, and σ_{rw}. There will be biases in our estimates of the TFP gain if the covariances are significantly different from zero. Let's assume $\sigma_{pr} = \sigma_{pw} = \sigma$. Then, let's define $\hat{\sigma}_{\tau_p}^2, \hat{\sigma}_{\tau_r}^2$, and $\hat{\sigma}_{\tau_w}^2$ to be our benchmark estimates of the variances which wrongly assume that the covariances are zero. It is straightforward to show that

$$\hat{\sigma}_{\tau_p}^2 = \sigma_{\tau_p}^2 - 2\sigma + \sigma_{rw} \tag{A.3}$$

$$\hat{\sigma}_{\tau_r}^2 = \sigma_{\tau_r}^2 - \sigma_{rw} \tag{A.4}$$

$$\hat{\sigma}_{\tau_w}^2 = \sigma_{\tau_w}^2 - \sigma_{rw}. \tag{A.5}$$

It is reasonable to assume $\sigma < 0$, i.e. the product market and input market distortions are positively correlated, and $\sigma_{rw} > 0$, i.e. the labor market and capital market distortions are positively correlated. As a result, our benchmark estimate of $\hat{\sigma}_{\tau_p}^2$ is going to overestimate the true one, and our benchmark estimates of $\hat{\sigma}_{\tau_r}^2$ and $\hat{\sigma}_{\tau_w}^2$ are going to underestimate the true ones.

Define $\Delta T\hat{F}P_i$ as the log TFP gain if distortions in market i disappear and if we use the benchmark estimates by assuming covariances are zero. Define ΔTFP_i as the log TFP gain if market i distortions disappear and if we use the true variances and covariances.

Then, using Eq. (A.2), when product market distortions disappear,

$$\Delta T\hat{F}P_p = \frac{\alpha+\beta}{2(1-\alpha-\beta)}\hat{\sigma}_{\tau_p}^2 = \frac{(\alpha+\beta)\left(\sigma_{\tau_p}^2-2\sigma+\sigma_{rw}\right)}{2(1-\alpha-\beta)}$$

$$\Delta TFP_p = \frac{\alpha+\beta}{2(1-\alpha-\beta)}\sigma_{\tau_p}^2 - \frac{(\alpha+\beta)\sigma}{1-\alpha-\beta}.$$

Thus,

$$\Delta T\hat{F}P_p - \Delta TFP_p = \frac{\alpha+\beta}{2(1-\alpha-\beta)}\sigma_{rw} > 0.$$

Similarly, when the capital market distortions disappear,

$$\Delta T\hat{F}P_r = \frac{\alpha(1-\beta)}{2(1-\alpha-\beta)}\hat{\sigma}_{\tau_r}^2 = \frac{\alpha(1-\beta)\left(\sigma_{\tau_r}^2-\sigma_{rw}\right)}{2(1-\alpha-\beta)}$$

$$\Delta TFP_r = \frac{\alpha(1-\beta)}{2(1-\alpha-\beta)}\sigma_{\tau_r}^2 - \frac{\alpha\sigma-\alpha\beta\sigma_{rw}}{1-\alpha-\beta}.$$

Then,

$$\Delta T\hat{F}P_r - \Delta TFP_r = \frac{\alpha}{2(1-\alpha-\beta)}(2\sigma-(1-\beta)\sigma_{rw}) < 0.$$

When the labor market distortions disappear,

$$\Delta T\hat{F}P_w = \frac{\beta(1-\alpha)}{2(1-\alpha-\beta)}\hat{\sigma}_{\tau_w}^2 = \frac{\beta(1-\alpha)\left(\sigma_{\tau_w}^2-\sigma_{rw}\right)}{2(1-\alpha-\beta)}$$

$$\Delta TFP_w = \frac{\beta(1-\alpha)}{2(1-\alpha-\beta)}\sigma_{\tau_w}^2 - \frac{\beta\sigma-\alpha\beta\sigma_{rw}}{1-\alpha-\beta}.$$

Table A.3
TFP gains (%) when distortion variation disappears, 1700–1850.

(Z case with captain fixed effects)									
Correlation	*Great Britain 1711–1800*			*France 1711–1780*			*Portugal/Brazil 1821–1850*		
	P	K	L	P	K	L	P	K	L
$\rho = 0$	16.61	3.01	2.15	117.55	3.28	2.60	36.20	6.77	2.34
$\rho = 0.1$	15.60	4.67	3.89	115.60	6.82	6.16	34.40	11.26	4.00
$\rho = 0.3$	12.69	8.13	7.40	109.20	15.23	14.57	29.00	20.39	7.59
$\rho = 0.5$	7.64	11.69	10.91	98.02	26.27	25.50	19.83	29.28	11.40
$\rho = 0.7$	4.09	19.16	18.12	74.63	42.80	41.73	26.95	64.20	23.65

[24] We simplify the notation in the appendix by dropping the τ's from the covariance terms, e.g. σ_{pr} denotes the covariance between the distortions in the product and capital markets, not the covariance between the price of slaves and the rental rate of capital.

Table A.4
TFP gains (%) when distortion variation disappears, 1700–1850.

(LK case with captain fixed effects)									
Correlation	*Great Britain 1711–1800*			*France 1711–1780*			*Portugal/Brazil 1821–1850*		
	P	K	L	P	K	L	P	K	L
$\rho = 0$	16.61	2.96	2.19	162.19	1.47	6.10	29.37	7.35	1.03
$\rho = 0.1$	15.60	4.59	3.95	159.33	4.01	12.43	27.94	11.67	1.84
$\rho = 0.3$	12.69	8.02	7.50	150.01	10.00	27.80	23.62	20.29	3.58
$\rho = 0.5$	7.64	11.54	11.04	133.91	17.84	48.53	16.21	28.32	5.42
$\rho = 0.7$	4.09	18.94	18.32	100.97	29.78	79.82	21.84	59.93	10.97

Then,

$$\Delta T\hat{F}P_w - \Delta TFP_w = \frac{\beta}{2(1-\alpha-\beta)}(2\sigma-(1-\alpha)\sigma_{rw}) < 0.$$

As mentioned above, we do not have enough moments to identify the covariances. Instead, we try different values of correlation (ρ) to have a sense of the magnitude of the bias in the TFP gain estimates. We assume that the correlations between the product market and input markets are -ρ and the correlation between the labor market and capital market is ρ.

Tables A.3 and A.4 report the results. Both tables suggest that when the correlation between the distortions is not too high (less than 0.5), eliminating the variation in the product market distortions would yield the largest TFP gain in all three countries. In France, the TFP gain from eliminating product market distortion variation is still larger than the gain from eliminating other distortion variation even if the correlation is very high ($\rho = 0.7$).

References

Allen, R.C., 2001. The great divergence in European wages and prices from the Middle Ages to the First World War. Explor. Econ. Hist. 38 (4), 411–447.
Bloom, N., 2009. The impact of uncertainty shocks. Econometrica 77 (3), 623–685.
Chari, V., Kehoe, P.J., McGrattan, E.R., 2007. Business cycle accounting. Econometrica 75 (3), 781–836.
Dalton, J.T., Leung, T.C., 2014. Why is polygyny more prevalent in Western Africa? An African slave trade perspective. Econ. Dev. Cult. Chang. 62 (4), 599–632.
Darity Jr., W., 1992. A model of "original sin": rise of the west and lag of the rest. Am. Econ. Rev. 82 (2), 162–167.
Donnan, E., 1930. Documents Illustrative of the History of the Slave Trade to America vol. 3. Carnegie Institution of Washington, Washington, D.C.
Eltis, D., Engerman, S.L., 2000. The importance of slavery and the slave trade to industrializing Britain. J. Econ. Hist. 60 (1), 123–144.
Eltis, D., Richardson, D., 1995. Productivity in the Transatlantic slave trade. Explor. Econ. Hist. 32, 465–484.
Eltis, D., Richardson, D., 2004. Prices of African slaves newly arrived in the Americas, 1673–1865: new evidence on long-run trends and regional differentials. In: Eltis, D., Lewis, F.D., Sokoloff, K.L. (Eds.), Slavery in the Development of the Americas. Cambridge University Press, London, UK, pp. 181–218.
Eltis, D., Richardson, D., 2010. Atlas of the Transatlantic Slave Trade. Yale University Press, New Haven, CT.
Eltis, D., Lewis, F.D., Richardson, D., 2005. Slave prices, the African slave trade, and productivity in the Caribbean, 1674–1807. Econ. Hist. Rev. 58 (4), 673–700.
Eltis, D., Lewis, F.D., McIntyre, K., 2010. Accounting for the traffic in Africans: transport costs on slaving voyages. J. Econ. Hist. 70 (4), 940–963.
Fenske, J., 2012. African Polygamy: Past and Present. Working Paper.
Fenske, J., Kala, N., 2012. Climate, Ecosystem Resilience, and the Slave Trade. Working Paper.
Gabaix, X., 2009. Power laws in economics and finance. Ann. Rev. Econ. 1, 255–293.
Greif, A., 1989. Reputation and coalitions in Medieval trade: evidence on the Maghribi traders. J. Econ. Hist. 49 (4), 857–882.
Greif, A., 1993. Contract enforceability and economic institutions in early trade: the Maghribi traders' coalition. Am. Econ. Rev. 83 (3), 525–548.
Harms, R., 2002. The Diligent: A Voyage Through the Worlds of the Slave Trade. Basic Books, New York, NY.
Hogerzeil, S.J., Richardson, D., 2007. Slave purchasing strategies and shipboard mortality: day-to-day evidence from the Dutch African trade, 1751–1797. J. Econ. Hist. 67 (1), 160–190.
Hopenhayn, H.A., 1992. Entry, exit, and firm dynamics in long run equilibrium. Econometrica 60 (5), 1127–1150.
Hopenhayn, H.A., 2011. Firm microstructure and aggregate productivity. J. Money, Credit, Bank. 43 (5), 111–145.
Hsieh, C.-T., Klenow, P.J., 2009. Misallocation and manufacturing TFP in China and India. Q. J. Econ. 124 (4), 1403–1448.
Hunt, E.H., 1973. Regional wage variations in Britain 1850–1914. Clarendon Press, Oxford, UK.
Inikori, J., 1981. Market structure and the profits of the British African trade in the late eighteenth century. J. Econ. Hist. 41 (4), 745–776.
Lucas Jr., R.E., 1978. On the size distribution of business firms. Bell J. Econ. 9 (2), 508–523.
Marschak, J., Andrews, W.H., 1944. Random simultaneous equations and the theory of production. Econometrica 12 (3), 143–205.
Melitz, M.J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71 (6), 1695–1725.
North, D.C., 1968. Sources of productivity change in ocean shipping, 1600–1850. J. Polit. Econ. 76 (5), 953–970.
Nunn, N., 2007. Historical legacies: a model linking Africa's past to its current underdevelopment. J. Dev. Econ. 83 (1), 157–175.
Nunn, N., 2008. The long-term effects of Africa's slave trades. Q. J. Econ. 128 (1), 139–176.
Nunn, N., Wantchekon, L., 2011. The slave trade and the origins of mistrust in Africa. Am. Econ. Rev. 101 (7), 3221–3252.
Pearson, R., Richardson, D., 2001. Business networking in the Industrial Revolution. Econ. Hist. Rev. 54 (4), 657–679.
Phelps Brown, E.H., Hopkins, S.V., 1981. A Perspective of Wages and Prices. Methuen, London, UK.
Pollard, S., 1959. Labour in Great Britain. In: Mathias, P., Postan, M.M. (Eds.), The Cambridge Economic History of Europe. The Industrial Economies: Capital, Labour, and Enterprise vol. 7. Cambridge University Press, Cambridge, UK, pp. 97–179.
Postma, J.M., 1990. The Dutch in the Atlantic Slave Trade 1600–1815. Cambridge University Press, New York, NY.
Price, J.M., Clemens, P.G.E., 1987. A revolution of scale in overseas trade: British firms in the Chesapeake trade, 1675–1775. J. Econ. Hist. 47 (1), 1–43.
Rawley, J.A., 1981. The Transatlantic Slave Trade: A History. W.W. Norton and Company, New York, NY.
Rodney, W., 1972. How Europe Underdeveloped Africa. Bogle-L'Ouverture Publications, London.
Sicsic, P., 1992. City-farm wage gaps in late nineteenth-century France. J. Econ. Hist. 52 (3), 675–695.
Song, Z.M., Wu, G.L., 2013. Identifying Capital Market Distortions. Working Paper.
Thomas, H., 1997. The Slave Trade: The Story of the Atlantic Slave Trade, 1440–1870. Simon and Schuster, New York, NY.
Viles, P., 1972. The slaving interest in the Atlantic ports, 1763–1792. Fr. Hist. Stud. 7 (4), 529–543.
Williamson, J.G., 1995. The evolution of global labor markets since 1830: background evidence and hypotheses. Explor. Econ. Hist. 32, 141–196.
Williamson, J.G., 1996. Globalization, convergence, and history. J. Econ. Hist. 56 (2), 277–306.