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Routes of Atlantic Slave Voyages:
Revised Framework and New Insights

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Abstract

This study explores data on the Atlantic slave trade through a revised framework, focusing not simply on voyages of individual slave ships but on aggregating them by route, linking an African region of departure with an American region of arrival. The result shows a total of 40 slave routes, for which documented voyages are aggregated by decade from the 1650s through the 1860s. Within this framework, analysis is conducted at the level of documented voyages (by route and by decade) and also at the level of documented captive flows (by route and by decade). This intermediate frame of analysis lies between analysis of individual voyages and aggregate figures for the whole slave trade. Results of this analysis show the variation among routes: ten out of the forty routes account for 85% of the voyages. For each route, it is shown that the average numbers of captives departing Africa remained roughly constant from the 1650s through the 1830s; the same is true for the numbers of captives arriving in the Americas. These and other characteristics of the routes, as seen through voyages and captive flows, allow for new insights into the character and the changes in the Atlantic slave trade over two centuries.

Keywords: Slave trade, Voyages, Captives, Routes

This study is to expand the discussion of previous research on the volume and direction of the transatlantic slave trade. The analysis is intended to reconsider the currently acknowledged pattern of regional and temporal flows of captives across the Atlantic. It reviews data on known voyages of slaving vessels as well as known records on captives embarked in Africa, lost at sea, and disembarked in the Americas. Reconsidering these data, we offer a way to interpret them that gives more attention to detail yet maintains the overall picture of the expansion and decline in the slave trade: we document the "routes"—the forty different oceanic paths of slaving vessels from African regions to the destinations at which captives were disembarked, mostly in the Americas.

We focus on the "route" instead of a single voyage. Each route linked a departure region and an arrival region, including multiple voyages in each decade. Aggregating the data at the route level provides us a novel way to look at the dataset. For each route, we focus on the number of voyages per decade per route (Figure 4) and on the average number of captive passengers by voyage per route, also in each decade (Figure 5). What we find is that aggregation of voyages by routes shows a more concentrated distribution voyages by route, and more stable population characteristics than appear through analysis by departure region or arrival region or even a single voyage.

Background: The Available Dataset

Data on the Atlantic slave trade have been analyzed in detail since 1969. Philip Curtin, in the *Census* of the Atlantic slave trade that launched this collaborative research campaign, used a broadly eclectic range of data and estimation techniques to come up with a proposed total of some 9.6 million persons delivered in captivity to the Americas, from 1415 to 1870.[1] In the past half-century of estimation of the Atlantic Slave Trade, its volume and composition, the general strategy of all researchers has been to work from known data about the trade, estimating missing data and proposing historical totals of persons carried on the Atlantic slave trade—numbers of voyages and numbers of persons embarked or arriving on slave voyages. Other scholars pursued each of the methods Curtin had applied, but focused especially on documenting slave-trading voyages, including indications of the number of persons carried on each voyage, for as many voyages as possible.

The consolidated database of information on the Atlantic slave trade is the Transatlantic Slave Trade Database (TASTDB-2010), created and edited by David Eltis, et al.[2] It summarizes known voyages of slave-trading vessels and the available data on each. From the early 1990s, David Eltis and his associates began the construction of an overall dataset of transatlantic slave trade voyages, assembling a wide range of data on as many documented voyages as could be identified. Three

[1] Philip D. Curtin, *The Atlantic Slave Trade: A Census* (Madison: University of Wisconsin Press, 1969).

[2] David Eltis, et al., *Transatlantic Slave Trade Database*, http://www.slavevoyages.org/voyage/download. This is the version of the dataset we have used for our analysis. Other versions of the dataset, available on the same web page, are TASTDB-1999, TASTDB-2008, and an "expanded dataset," TASTDB-2016. This research, supported initially by the W. E. B. Du Bois Research Institute at Harvard University, was supported in successive stages by the National Endowment for the Humanities and Emory University.

successive publications of the results of this research, in 1999, 2008, and 2010, provide the most comprehensive documentation on the Atlantic Slave Trade. The online version of the latter dataset, known hereafter as TASTDB-2010, has been widely consulted by researchers and the general public. The Venn diagram in Figure 1 summarizes the nearly 35,000 voyages included in TASTDB-2010 for the period from 1415 to 1870—indicating, in circles, the numbers of voyages with documented ports of embarkation, with documented ports of arrival, and for which voyage length can be calculated; it shows the overlap of these key variables with each other.

Figure 1. TASTD Voyages by Types of Documentation

In addition to publishing raw data on known slave voyages in TASTDB-2010, Eltis and his colleagues calculated and published two additional types of variables: we label them as "calculated" variables, based on a deterministic recoding of the raw data, and "imputed" variables, in which the authors make estimates of unknown quantities. The calculated variables included the classification of raw data into regions of departure and arrival, decennial periods, and summaries of the documented numbers of captives per voyage. We rely heavily on these calculated variables in our analysis of the routes of Atlantic slave voyages.

The "imputed" variables calculated by Eltis and his colleagues represent efforts to fill in "missing data"—the blank spaces in the historical record. They are estimates of factual material that were not recorded in the documents known to researchers or were otherwise lost. The imputed variables of TASTDB-2010 include estimations of some unknown ports of call of slave ships; they focus especially on estimating numbers of captives departing Africa or arriving in the Americas where these are not listed in the records. The editors calculated imputations of the total number of persons embarked on slave voyages (by date and by African region) and the total number of persons who arrived (or disembarked) from slave voyages (by date and by region beyond Africa). These totals, periodically updated, gained wide acceptance as giving the best available estimate of the volume of Atlantic slave trade. The Eltis imputations of total flows of captives, published on the Slave Voyages website, involve calculation of numerous specific models.[3] These imputations,

[3] David Eltis and Paul F. Lachance, "Estimates of the Size and Direction of Transatlantic Slave Trade" (2010), http://www.slavevoyages.org/documents/download/2010estimates-method.pdf. This document of nearly thirty pages

while based on detailed knowledge of the records, are non-stochastic, in that they do not include estimates of the dispersion or reliability of these population estimates. In any case, this study does not address the estimations of the imputed variables—it focuses entirely on the raw data and the calculated variables created out of raw data. While there is interest in filling in the gaps left by missing data, our first concern is with what can be shown from historically recorded data—and the direct deductions that one can make from such data.[4]

Adjusting the Data: From TASTDB-2010 to WHCDB-2017

Our work begins with selecting and reorganizing aspects of TASTDB-2010 to create a new dataset.[5] We label our revised dataset as WHCDB-2017. We retain the original data, but modify certain calculated variables, especially by defining and calculating roughly 40 "routes" linking African and American ports. Our first step is to draw relevant data from the TASTDB-2010 database. We selected data for the variables shown in Table 1, for the decades from the 1650s to the 1860s.[6] Table 1 begins with seven "calculated variables" constructed from the raw data, the 33395 records in TASTDB-2010 for the decades from the 1650s to the 1860s.[7] These calculated variables are exhaustive, in that they include all the known data but no estimates of unknown data.[8]

provides textual descriptions of imputations for embarkations and arrivals according to categories of voyages by national carrier, routes of voyages, and time period. The imputations focus on total numbers of captives, without breakdowns by age and sex of the captives and without proposed margins of error for the estimates. The estimates are impressive, but the complexity of the presentation makes it difficult to replicate the estimations and difficult to confirm that the various estimates are mutually consistent.

[4] For an earlier effort to provide an alternative analysis of TASTDB-2010, see Patrick Manning, Yun Zhang, and Bowen Yi, "Volume and Direction of the Atlantic Slave Trade, 1650-1870: Estimates by Markov Chain Carlo Analysis" *Journal of World-Historical Information* 2-3 (2014-2015): 127-149. See also the commentary, David Eltis and Paul Lachance, "Comments on Manning, Zhang, and Yi's "Volume and Direction of the Atlantic Slave Trade, 1650-1870," *Journal of World-Historical Information* 2-3 (2014-2015): 150-153. This commentary notes some errors in the previous article's summarization of data from TASTDB-2010.

[5] The online version of TASTDB includes data on 74 variables; the downloadable version includes 293 variables.

[6] We begin our analysis with 1650 since the roughly 1500 documented voyages before 1650 are too small in number to sustain our methods of estimating missing data.

[7] TASTDB-2010 Codebook, available online at
http://www.slavevoyages.org/documents/download/SPSS_Codebook_2016.pdf

[8] TASTDB-2010. We distinguish "calculated variables" (constructed from raw data) from "imputed variables" (including assumptions about missing data); Eltis et al. label both categories as "imputed variables." All of the variables listed in Table 1 are "calculated variables," in that they are calculated by determinate algorithms from raw data coded in TASTDB-2010.

TASTDB-2010 "calculated variables" used in this analysis
voyageid: arbitrary voyage identification number; assigned by editors
year10: decade; calculated and numbered serially from 1650s to 1860s[9]
majbyimp: region of embarkation; calculated, based on port data
mjselimp: region of initial arrival; calculated, based on port data
voy2imp: calculated days of transatlantic voyage[10]
tslavesd: captive embarkations by region and decade; calculated from recorded captive embarkations by port
slaarriv: captive arrivals by region and decade; calculated from recorded captive arrivals by port

Table 1. TASTDB Variables Selected for Analysis. Source: TASTDB 2010 codebook.

For the data drawn from TASTDB-2012 according to the selection criteria, Table 2 shows the distribution of records of voyage departure, while Table 3 show the distribution of records for arrival, with a total of 33,395 records each for departure and arrival.

Embarkation region	60100 – 60800 Africa[11]	60900 Other Africa	80300 Asia	99800[12]	Missing	Total
Number of voyages	24018	1367	1	7	8002	33395

Table 2. TASTDB 2010 records by embarkation region, 1650s to 1860s.

Arrival region	10000 Europe	20000 North America	30000 Caribbean	40000 Spanish	50000 Brazil	60000 Africa	80000 Other	Missing	Total
Number of voyages	49	1753	16456	433	9605	599	18	4482	33395

Table 3. TASTDB-2010 records by arrival region, 1650s to 1860s.

[9] In WHCDB-2017 (available online), YEAR10 is the decade from 1650 through 1659, 1710 through 1719, etc. In TASTDB-2010, YEAR10 is calculated as 1651 through 1660, 1711 through 1720 etc.

[10] Variable voy2imp, calculated within TASTDB, proved to yield erratic results and we left it out of our calculations.

[11] These cases are broken into the following subgroups: Senegambia, Sierra Leone, Windward Coast, Gold Coast, Bight of Benin, Bight of Biafra, West Central Africa, and Southeast Africa.

[12] We have not found a description of region 99800 in TASTDB-2010, and treat these as missing values.

We turn next to recoding these data from TASTDB-2010 to create our new database, WHCDB-2017. Our purpose in recoding and creating the new WHCDB-2017 dataset was to verify that data were coded consistently for our purposes, especially with regard to the labeling of regions for voyages and also for accounting of populations. Tables 4 and 5 summarize the voyages after transformation from the TASTDB-2010 to the WHCDB-2017 dataset, after cleaning, selection, and recoding of relevant variables for analysis. For voyages, we transform TASTDB-2010 variables MAJBYIMP (embarkation region) and MJSELIMP (arrival region) into WHCDB-2017 variables MAJBYIMP2 and MJSELIMP2.[13] In recoding for region of embarkation, we recode to eliminate the category of "Africa Other" (60900): of these 1367 voyages, 535 were allocated to the Windward Coast (60300), while the remainder were coded with missing values for embarkation region.[14] For region of arrival, we mark the 18 voyages arriving in "Africa Other" as having unknown destinations. We treat the 599 voyages arriving in "Africa" as valid: they consisted overwhelmingly of voyages seized by anti-slavery squadrons in the nineteenth century, where captives were landed especially in Sierra Leone and St. Helena. Tables 4 and 5 show voyages by recoded regions, with eight departure regions (plus missing departures) and five arrival regions (plus missing arrivals). With these modifications, the number of voyages in the WHCDB-2017 database declines to 33345.[15]

Embarkation region	60100 Sene-gambia	60200 Sierra Leone	60300 Wind-ward	60400 Gold Coast	60500 Bight Benin	60600 Bight Biafra	60700 W.C. Africa	60800 S.E. Africa	Missing	Total
Number of voyages	1969	1104	1389	2822	4593	3549	8174	911	8834	33345

Table 4. WHCDB-2017 voyages by embarkation region, 1650s to 1860s.

[13] Cleaning: For MAJBYIMP2, we delete the case for the one voyage listed as going to Asia; we listed cases for the departure region code 99800 as "missing." For MJSELIMP2, we delete the 49 voyages listed as arriving in Europe. In addition, we set the embarkation population as missing in cases with zero or negative loss rate. That is, we found 615 cases in the existing records for which the embarkation population is equal to or less than the arrival population, which leads to an unreasonable non-positive loss rate. The phenomena may be because of the errors in entry, or conceivably the behavior of fertility during the voyage. We argue that the estimates are generally more reliable for arrival than for embarkation population, and we set the embarkation population as missing in those cases. Besides these cases, we also found a few cases where the regional code did not match and in which the imputed population was not an integer. TASTDB-2010 dataset, TASTDB-2010 Codebook.

[14] Recoding: "Africa Other" was created as a residual category rather than a region, so the voyages included in it needed to be allocated among regional categories.

[15] Further recoding of regions: In addition, we created two versions of the dataset, one with 8 African embarkation regions, following the regional coding of TASTDB (except for "Africa Other" as noted in the text), and the other with 10 embarkation regions. The latter divides the Bight of Biafra and West Central Africa of TASTDB into four regions. This version will be used in later analysis of African population trends.

Arrival region	10000 America	20000 Caribbean	30000 Spanish	40000 Brazil	50000 Africa	Missing	Total
Number of voyages	1753	16456	439	9604	599	4494	33345

Table 5. WHCDB-2017 voyages by arrival region, 1650s to 1860s.

Aggregate data on voyages and captives

Within WHCDB-2017, we now explore the documentation of the 33,345 known voyages from TASTDB-2010 according to whether data are missing for the variables under study: the region of departure and arrival, the departure population, and the arrival population. We begin with the "full dataset" or "Data0" (33345 documented slave trading voyages), as shown in Table 6. Then, "regional data" (Data1) is the subset of 22803 voyages including data on *regions of both embarkation and arrival*. Next, "embarkation data" is the subset of voyages listing embarkation population (Data2a) and "arrival data" is the subset of voyages listing arrivals population (Data2b). Further, "fully documented voyages" or (Data3) is the subset of 4899 voyages limited to those with non-missing data on all variables we analyze—embarkation and arrival regions plus embarkation and arrival populations

Category	**Definition**	**Cases (voyages)**
Data0	"Full dataset" – all documented slave voyages in WHCDB-2017	33,345
Data1	"Documented routes" – voyages with known regions of both African departure & American arrival	22,803
Data2a	"Documented embarkations" – voyages from Data1 listing population embarked	7,229
Data2b	"Documented arrivals" – voyages from Data1 listing population arrived	14,008
Data3	"Documented routes and captives" – voyages with known regions & known populations for both departure & arrival.	4,899

Table 6. Sub-datasets for known data in WHCDB-2017 dataset.

Figures 2 and 3 show two different ways of comparing available values and missing values for the variables for each voyage included in WHCDB-2017.[16] In Figure 2, the two left-hand columns show that we have no missing values for VoyageID or for YEAR10. The blank areas of the third and fourth columns show the distribution of missing values across time for embarkations and arrivals. The fifth column, showing routes, is the intersection of the previous two: that is, the

[16] Voyages are displayed vertically over time, with a blank horizontal line for cases with missing data.

route for a voyage is missing if either embarkation region or arrival region is missing. Similarly, blank areas of the sixth and seventh columns indicate the level of missing data for embarkations and arrivals: the final column, showing loss rates, is the intersection of the previous two: the loss rate is missing if either embarkations or arrivals are missing.

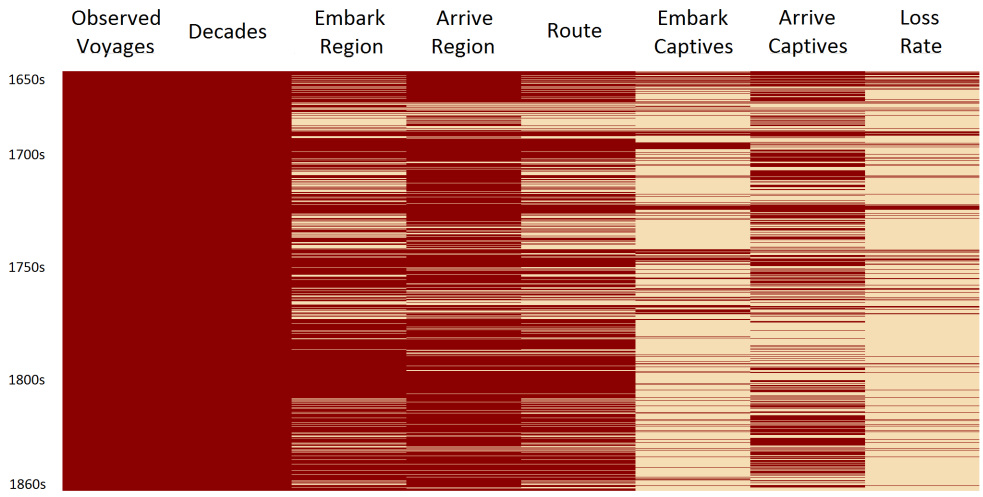

Figure 2. Missing Data (light spaces), by variable and by decade.

In sum, the time frame of Atlantic slave trade is very well documented. The *routes of slave trade* are better documented than the numbers of captives aboard; and the *arrivals of captives* in the Americas are better documented than either *African embarkations* or *rates of loss* at sea.[17] It is also important to note that the pattern of missing data in these variables is not fully random.[18]

[17] Actual estimates of losses at sea are reported only rarely in TASTDB-2010; loss rates are calculated as embarkations less arrivals as a proportion of embarkations.

[18] We are not estimating the value of missing data at this stage. For any further estimates to estimate missing data, we are fully aware of the potential bias under this strict assumption for population data, but this is the best we can do for now.

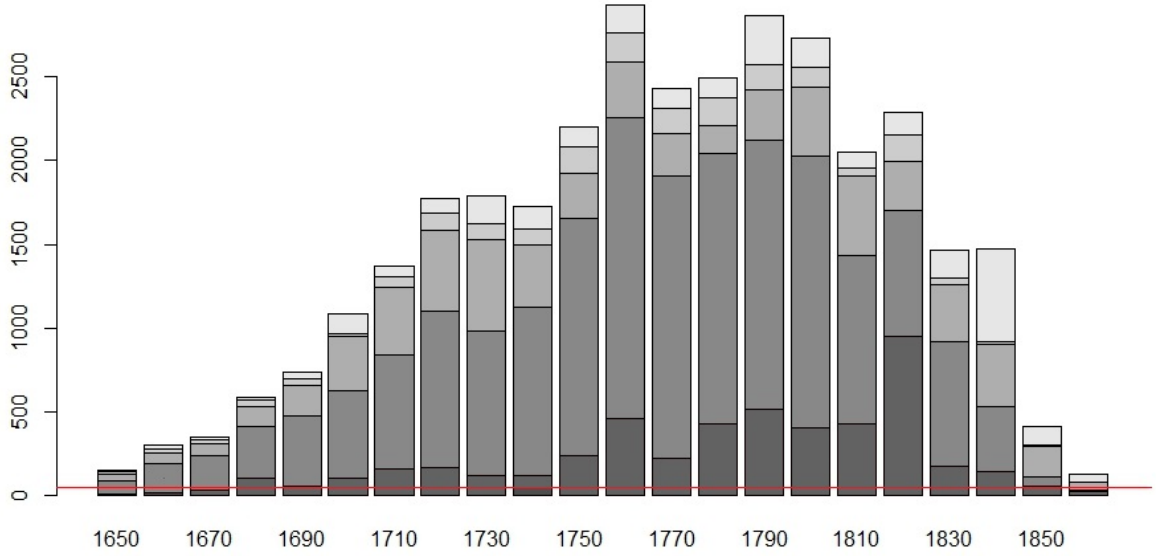

Figure 3. Total known voyages by decade.

Sections within each bar are defined as follows, from bottom to top: complete region and population data, complete region and incomplete population data, arrival region only, embarkation region only, no information on region.[19]
Source: WHCDB-2017 dataset.

As a second summary of the data in WHCDB-2017, we display in Figure 3 the total number of transatlantic slaving voyages by decade, indicating the proportion of voyages for which we have data on captive embarkation, arrival, or both. The total height of each bar reflects the number of known voyages for each decade. The sections within each bar—shades of gray—indicate categories of voyages. From bottom to top, they are: complete region and population data, complete region and incomplete population data, arrival region only, embarkation region only, and no information on region. Figure 3 thus confirms the implications of Figure 2, showing that we know much less about the captive populations than about their voyages.

In Figure 3, the number of documented voyages is shown by the height of the bar for each decade—this is thought to be rather close to the total number of slave-trading voyages that actually took place. But the documentation of voyages is uneven. Of most interest for our analysis of known routes and captive flows, the bottom two sections within each bar show the proportion of voyages listing *both* the departing and arriving regions of captives. The next two sections within each bar give the number of voyages for which regions of departure and not arrival are listed, and for which arrivals but not departures are listed. Finally, the height of the top section of each bar shows the

[19] The line in red near the bottom of the bars indicates 50 voyages per decade with complete region and population data. We concluded that 50 fully documented voyages per decade were necessary to conduct our route-based analysis; on that basis we neglected the decades before the 1650s.

number of voyages with no information on regional location. Overall, most voyage records listed both region of departure and arrival: for the period 1650s – 1830s, 68% of documented voyages listed both departures and arrivals. To break down this overall average by periods: for the earlier years (1650s–1740s), 62% of voyages listed both, while for the 1750s–1830s, 74% of voyages listed both. In the last years of illegal slave trade, the 1840s to 1860s, only an average of 30% of voyages reported both departures and arrivals. As a further point, a portion of our analysis (reported below in Figures 7 and 8) relies on numbers of captives departing and arriving, so it centers on the data shown in the bottom section of the bars in Figure 3.

Routes: Definition and Distribution

We now turn to exploring the patterns of voyages and captive populations in the WHCDB-2017 dataset. Our analysis of known data begins by tracing the regions and routes of slaving voyages. We begin by creating a list of "routes" labeled by regions of embarkation and arrival. We identify 40 potential routes linking Africa and the Americas, based on known trajectories of 22,000 voyages.[20] We name each route by joining the names of embarkation and arrival regions, but also by joining two digits: the first digit indicates the embarkation region, and the second digit indicates the arrival region. To specify some of the cases: route 1-3 links Senegambia to the Spanish Mainland, route 4-2 links Gold Coast to the Caribbean, and route 7-4 links West Central Africa to Brazil.[21] We separate this step—the distribution of voyages—from the populations of captives embarked and disembarked, making it an independent part of the analysis. Table 7 provides information for defining the routes.

Code	Embarkation Region	Code	Arrival Region
1	Senegambia	1	Mainland N. America
2	Sierra Leone	2	Caribbean
3	Windward Coast	3	Spanish Mainland
4	Gold Coast	4	Brazil
5	Bight of Benin	5	Africa
6	Bight of Biafra		
7	West Central Africa		
8	Southeast Africa		

Table 7. Embarkation and Arrival Regions.

Figure 4 displays the "voyage pattern" for the 22,803 voyages for which we have documented transatlantic routes.[22] The vertical axis at left lists decades from the 1650s to the 1860s; on the

[20] All of the possible routes but one are populated by recorded voyages.

[21] For instance, route 5-5 links Bight of Benin to African destinations, mostly for the cases of "recapture" of slaves on illegal voyages.

[22] [This note indicates the availability of the underlying dataset.]

right, the vertical axis lists the total number of voyages in each decade. The horizontal axis lists the forty routes in the order we have numbered them, beginning with departures from Senegambia on the left and ending with departures from Southeast Africa on the right. Each box in the table contains a shading indicating the number of voyages for route by decade: the eight shadings range from zero voyages per decade to over 1000 voyages per decade. Figure 4 clearly reveals the varied distribution of voyages by route. It is also clear that the distribution of voyages among routes shifted sharply with time—especially in that the pattern for the period from the 1750s through the 1800s differed greatly from the times before and after that period. In addition, the period from the 1840s through 1860s, at the end of the illegal slave trade, deviated sharply from earlier decades.

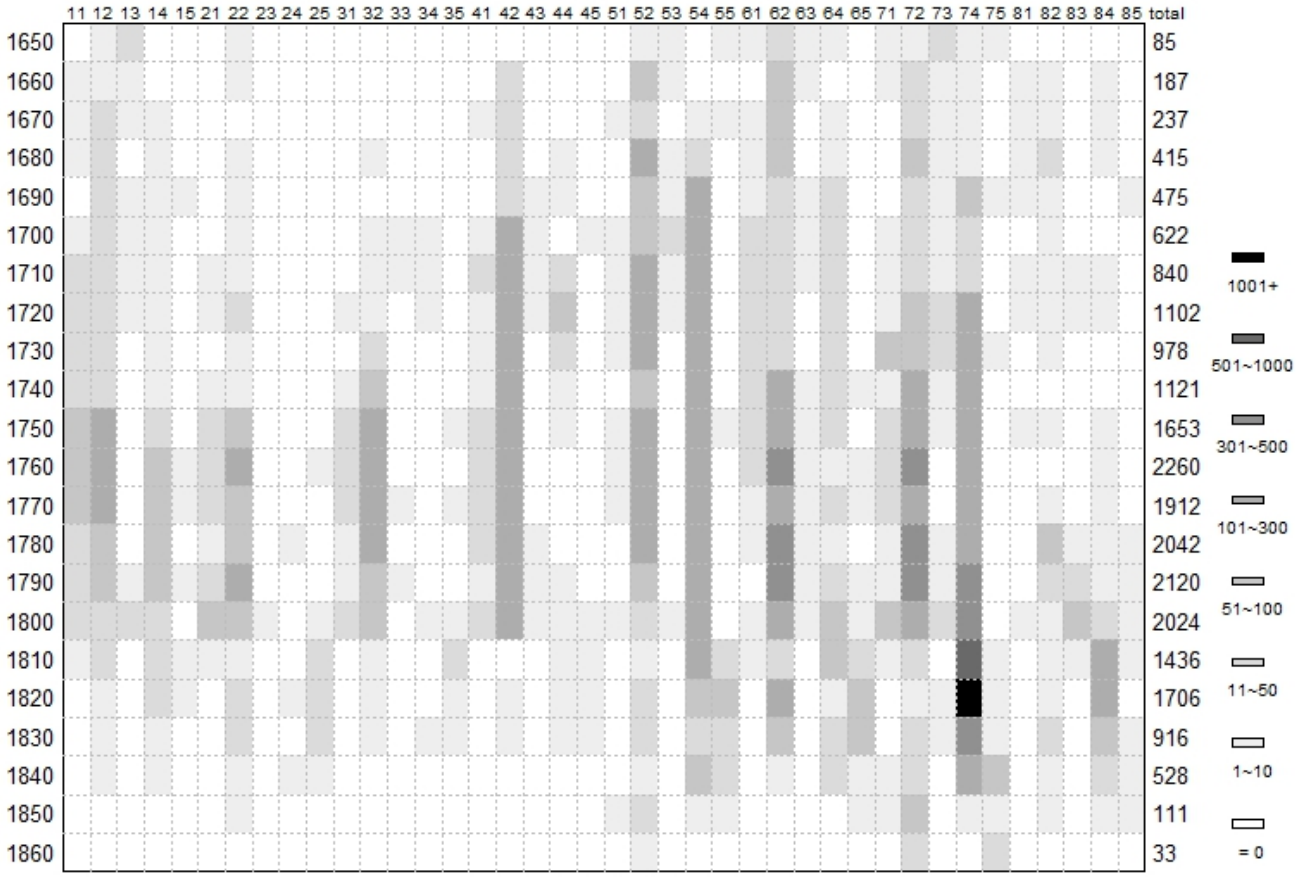

Figure 4. Number of Voyages per Decade, by Route (for Fully Documented Routes). {Data1, "Documented routes," 22,803 voyages.)

The great majority of slave trading ventures centered on roughly ten routes: Table 8, based on data presented in Figure 4, gives the number of known voyages per route for the ten most active routes, over the full period from the 1650s through the 1860s. These ten routes are easily picked out as the darkest columns in Figure 4.

Route	Route Name	Voyages
74	West Central Africa – Brazil	5028
54	Benin – Brazil	2619
62	Biafra – Caribbean	2547
72	West Central Africa – Caribbean	2317
42	Gold Coast – Caribbean	2151
52	Benin – Caribbean	1570
32	Windward Coast – Caribbean	1121
12	Senegambia – Caribbean	858
22	Sierra Leone – Caribbean	689
84	Southeast Africa – Brazil	545
Top ten total (85%)		19,445
Documented voyages		22,803

Table 8. Voyages along Principal Routes. (Data 1, "Documented routes," 22,803 voyages)

Based on the information from Figure 4, one could prepare a narrative of the Atlantic slave trade in terms of the dominant routes of each period and the relative numbers of voyages on each route as they changed with time. Since this story of slave trade would be based on roughly two-thirds of all the slave voyages that sailed after 1650, it would be a highly dependable story.

A related question is the numbers of captives carried along these routes. The shifting distribution of voyages among routes also affected the aggregate numbers of embarkations, disembarkations and losses at sea.

The Population Characteristics of Routes over Time

We turn next to analysis of the known captive populations on the known voyages, organized by the routes of the voyages. Figure 5, based on WHCDB-2017, shows known embarkations and arrivals for each route, for the decades from the 1650s to the 1860s. Within the graph for each route, the *red dots* give the average numbers of embarkations by decade, while the *blue dots* give the average numbers of arrivals, again by decade.[23] In cases for which both are available, embarkations are visibly more numerous than arrivals, thus evoking the number of losses at sea.[24] Figure 5 shows the remarkable temporal consistency of the average size of slave cargoes for each route.

[23] These calculated averages are the total number of persons embarked or arrived for each route, divided by the number of voyages for that route and decade. Note that data on embarkations are available for 7229 voyages, while data on arrivals are available for 14,008 voyages.

[24] Only pairs of population (embarkation and arrival) by voyage can yield loss rates. Further, since we delete the negative and zero-loss rate cases, the embarkation population should always be greater than arrivals.

Figure 5. Pattern of documented captive flows within calculated regions. Average embarkation (red) and arrival (blue) populations per voyage, by route by decade. **(**Data2a "Documented embarkations," 7,229 voyages; Data2b "Documented arrivals, 14,008 voyages).

The consistent pattern of numbers of captives for each route, nevertheless, masks a great deal of variety within each of these consistent averages. To illustrate this point, Figures 6a and 6b show the details of distribution underlying the averages for two routes. Figure 6a shows route 3-2, from the Windward Coast to the Caribbean. In it, the box for each decade shows the 75% and 25% quantile for embarkations (red) and arrivals (blue); lines extend beyond each box to reach the cases with minimum and maximum values for each decade. The horizontal line within each box is the

average level of embarkations or arrivals.[25] In addition, Figure 6a includes some red and blue dots that are treated as outliers. Figure 6b (route 6-3) shows that a small and scattered number of voyages are known to have sailed from the Bight of Biafra to the Spanish Mainland. In sum, Figure 5 shows (at low magnification) the consistent averages of embarkations and arrivals for each region; the same evidence, at higher magnification in Figures 6a and 6b, shows the dispersion of data.

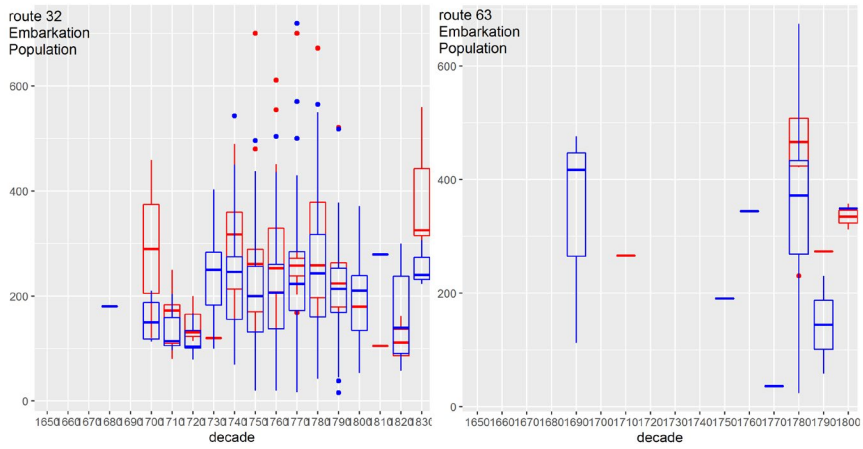

Figure 6a and 6b. Mean and sample distribution of voyages for two routes:
Windward coast to Caribbean (3-2); Bight of Biafra to Spanish Mainland (6-3). (Data2a "Documented embarkations")

We turn now to a look at 4899 voyages for which we have full data on routes, embarkations, and arrivals: these data are presented in Figure 7 as averages per voyage, by decade—for the whole of the Atlantic slave trade, without regard to distinctions among the routes. The three graphs in Figure 7 show average numbers of captives embarked, average numbers of captives arriving, and the average proportion of captives lost at sea (which ranged from 0.1 to 0.3 or 10% to 30% of embarkations per voyage).

[25] The lines representing averages in Figures 6a and 6b are shown in Figure 5 as red and blue dots.

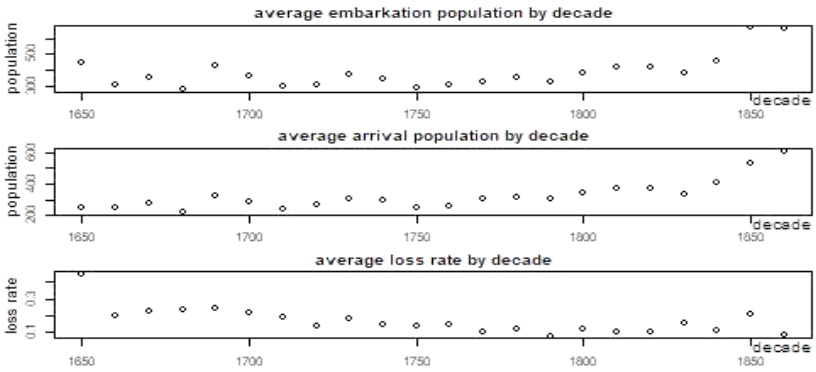

Figure 7. Captives: Total documented embarkations, arrivals, and percentage loss: average by decade. (Data3 "Documented routes & captives," 4899 voyages.)

Three remarkable conclusions emerge from this illustration. First is that, for both embarkations and arrivals, the average number of captives carried in transatlantic voyages remained remarkably consistent over the course of two centuries. The second is that the rate of loss of captives declined from the late seventeenth century to the early nineteenth century. Third is that the last three decades of Atlantic slave trade—from the 1840s through the 1860s—were erratic in their patterns and did not fit well with earlier data. The declining rate of loss during voyages is not surprising—it has been suggested commonly based on anecdotal evidence—but this is the largest-scale and arguably the most convincing evidence that mortality in the transatlantic slave trade declined steadily. The erratic character of slave trade during and after the 1840s is also not surprising—the results here confirm widely known patterns.

What is new, however, is the observation of the consistency in the average numbers of captives carried on slaving voyages over time. Figure 7 demonstrates this pattern for the slave trade at an aggregate and oceanic level; Figure 5 demonstrates the same pattern for almost all of the forty routes of the slave trade, and especially for the most heavily-traveled routes. A glance at the data for each route, as shown in Figure 5, will show that one can pick out the average number of persons embarked and disembarked from slaving voyages for almost the whole period of the slave trade. This result might seem counter-intuitive, since it is known that the volume of the Atlantic slave trade expanded steadily up to 1800 before declining thereafter. But we argue, first, that there are several reasons why such a result should have been expected.

Indeed, we conclude from these results that the volume of captives transported in the Atlantic slave trade can be modeled effectively by assuming a constant number of captives embarked on and disembarked from voyages along each route. We offer comments on the plausibility of this assumption, and follow up with a simulation exercise that demonstrates its strength. For the Atlantic slave trade overall, we note the several types of quantitative change that unfolded in the course of the history of transatlantic slaving. There was a steady expansion in the number of ships carrying captives, as shown in Figure 3. There were shifts in the proportions of slave trading among the various routes, as shown in Figure 4. There were changes in maritime technology, such that the relative size of crews became smaller even as the number of captives remained unchanged.

The steady decline in captive mortality in transatlantic voyages has to be seen as a benefit for the trade in addition to enabling survival for more captives.

Here we think it is worth expanding the concept of the route. More than just a connection between departure and arrival, the route included all the conditions of commercial relations, disease environment, collection, purchase, and loading of the captives at the point of departure; the winds and other conditions of the voyage; and the commercial relations, economic, and health conditions of arrival. For all these reasons, each route sustained conditions that tended to reproduce themselves, including the numbers of captives sent on each vessel.

To confirm our argument that the assumption of a constant flow of captives, for each route, is an effective model of the historical flow of captives across the Atlantic, we conduct a simulation. We project the average embarkations, arrivals, and loss rates as follows: we multiply the number of voyages for each route by the average embarkations, arrivals, and loss rate we have calculated for that route under the constant flow assumption—then sum them and report them as shown in the graphs in Figure 8. The simulated results, in red, describe the fluctuation in average arrival population very well: that is, the simulated red points linked by a red line are generally very close to the black dots from Figure 7.[26] This exercise confirms the validity of the assumptions, adopted above, that average known embarkations, arrivals, and loss rates for each route may be taken as parameters giving the number of persons embarked, arrived, and lost for all voyages on that route.[27] (As we have suggested above, patterns of slave trade for the 1840s and later were erratic.

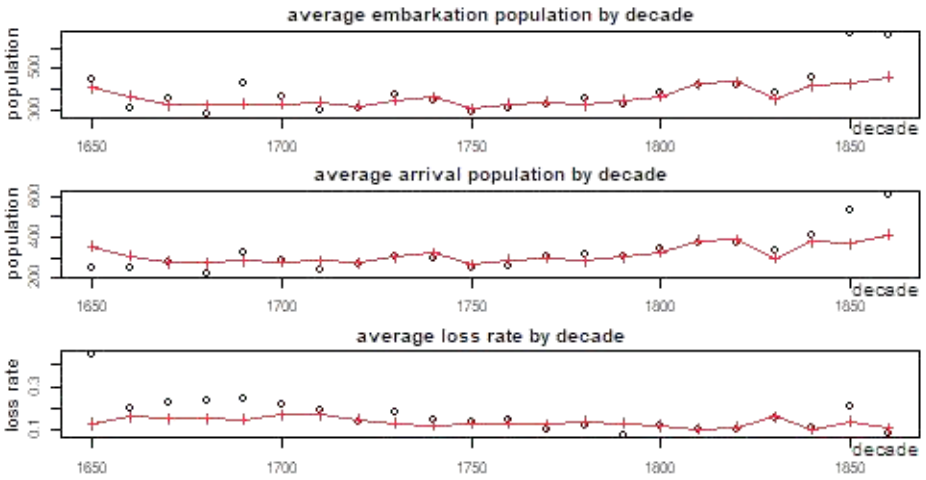

Figure 8. Captives: Documented embarkations, arrivals, and loss rates, averaged by decade (circles); and simulated data, assuming constant average flow per voyage (red lines).
(Data3 "Documented routes & captives," 4899 voyages.)

[26] As noted above, we underestimate the arrival population in the last two decades. The underestimation is because route 73 (from West Central Africa and St. Helena to Caribbean) plays an important part in the immigration pattern of the 1850s and 1860s.

[27] Another approach to confirming the consistency of the estimates would be to calculate regression lines for each route, calculating the dispersion of points about the mean.

Having confirmed the value of the assumption of constant numbers of captives in voyages along slave-trade routes, we emphasize an important implication of this reasoning. We have contradicted the intuitive assumption that the expanding volume of the slave trade relied not just on sending more voyages but on increasing the capacity of ships with time. Instead, we argue that the shifts of voyages among routes, gradually selecting the more productive routes, brought about overall growth of slave trade.

How could overall average embarkations and especially average arrivals rise with time if, as we assume, the average of embarkations and arrivals for each route remains constant over time? The response is that what changes over time is the distribution of voyages among routes. We provide the illustration of an anthill: if ants in a nest find food at a place some distance away, it is observed that the average time that it takes ants to carry food to their nest gets shorter with time. We can make an analogy to the slave trade: individual ants correspond to the voyages, the food they carry corresponds to captives carried by the voyages, and the paths taken by ants correspond to the routes of slave trade. For the case of the ants, their time of delivery becomes more rapid not because they move faster or carry more food, but because they find shorter paths, so that the overall time of delivery decreases, and the amount of food delivered in a time period increases. So also for the slave trade—with time, the trade concentrated increasingly on the most productive routes.

Conclusion

This study has emphasized that the routes of the Atlantic slave trade, documented from existing evidence on slave voyages, provide an alternative framework for interpreting the patterns of slave trade that could be valuable. Our survey has analyzed the forty routes we have identified, first in terms of data on the voyages along the various routes. We found that the allocation of voyages among the routes shifted significantly over the course of the slave trade, and that just a few routes accounted for the overwhelming majority of all voyages. Then we expanded the analysis to consider available documentation on the captives who were carried along known routes. We found, by inspection of the data on captives, that both embarkations and arrivals were roughly constant by route—with significant differences in the numbers carried on various routes. We adopted, as an analytical assumption on the patterns of slave trade, the notion that each slave route, over the course of its existence, carried a constant number of captives at embarkation and at arrival. To verify this assumption, we simulated the available data on captives by route, using constant averages for embarkation and arrival—and the results of the simulation (Figure 8) show that the simulation (in red) approximates very closely the overall sum of the historical data.

We conclude that, for the changes in the volume of the Atlantic slave trade over time, the reallocation of voyages among competing routes was a key factor. In an apparent contradiction, we noted that the calculated rates of captive loss at sea declined over time, which ought to make it difficult for both embarkation and arrival figures to remain constant. But here again, the reallocation of voyages among routes was central. Figure 8 shows that the simulated rates of loss were quite close to the historical results from Figure 7 (though with exceptions for the late seventeenth century). The resolution to the problem is that the aggregate decline in loss rates was especially because of shifts of voyages to routes where mortality rates were lower.

We see various possibilities for extending the insights that arise from this framework. Once the principle of analysis by route is recognized, we argue, more specific routes within these larger routes could be analyzed, to yield an even more precise picture of the regional and temporal details of the slave trade. For instance, the largest region of African departure in the existing data, West-Central Africa (from Gabon in the north to Benguela in the south), could be divided into three regions—Congo (north of the mouth of the Congo River), Angola (from the Congo River to the port of Luanda), and Benguela (from the south of Luanda to Benguela).

Finally, we note again that this study lies entirely within the framework of known and documented data. For study of the Atlantic slave trade, there remains the problem of missing data—the possibility of undocumented slave voyages and, especially, the certainty that we are missing evidence on numbers of captives. We believe that the framework of routes of Atlantic slave voyages may support new approaches to estimation of missing data, especially on numbers of captives.

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