Slave Ship Provisioning in the long 18th Century
A Boost to West African Commercial Agriculture?

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Abstract[1]
To what extent did the 18th century rise of demand for food provisions by European slave ships boost West African commercial agriculture? Exploring the provisioning strategies of British, French, Dutch and Danish slave ships, we show that a considerable share of the calories and proteins required to maintain African slaves were supplied from Europe or the Americas. We argue for a major downward adjustment of previous estimates of the slave-trade induced demand impulse. We document considerable variation in provisioning strategies among slave trading companies, across major regions of slave embarkation and over time. We explain these patterns in terms of the relative costs of provisions and related security of food supplies at different parts of the West African coast.

[1] We gratefully acknowledge comments by Herbert Klein and Robert Ross on previous versions of this paper. We thank Anna van Dam for excellent research assistance.

1. Introduction

The political and economic effects of the transatlantic slave trade on African societies have been intensively debated ever since the late 18th century[2]. Few scholars, if any, doubt that the drain of millions of children and young adults from West and West-Central Africa had a transformative impact on the economies and societies involved (Lovejoy 2011). However, the extent to which this transformation was beneficial or detrimental to long-term economic development remains a matter of dispute. Inikori (2007), echoing the dependency views of Rodney (1972), has argued that the commodification and export of humans effectively reversed African economic prosperity after 1450, by stifling processes of internal market development and adverse demographic consequences (Manning 2010). Others have pointed to long-term distortions of mutual trust (Nunn and Wantchekon 2011). On the other hand, Thornton (1998) has argued that in some areas such as the Bight of Biafra the exchange of goods with Europeans helped stimulate local industry not retard it. Johnson et al. (1990) have shown that volumes of commodity trade expanded rapidly in the wake of the slave trade, which also suggests that the strengthening of North-South trade relations had stimulating effects on long-term economic development (c.f. Eltis and Jennings 1988).

More recently, scholars have started to explore the potential effects of the slave trade on the development of commercial agriculture in Atlantic Africa (Law et al. 2013). New crops from the other side of the Atlantic such as maize, potatoes and manioc enlarged the choice-set of food crops for African farmers and played an important role in the organisation of the slave trade, in a similar way as African crops underpinned the expansion of American plantation economies (Carney & Rosomoff 2011). Large numbers of captives needed to be fed during their transport to the coast, during their stay at the coast before embarkation, during their stay at the slave vessels before departure and also during the middle passage. Slave captains that failed to take in sufficient stocks put their cargo at higher risks of starvation and disease[3]. David Eltis (2013) has suggested that the growing demand for food provisions by slavers during the long 18th century has given a substantial boost to commercial agriculture in West Africa. In an attempt to estimate the magnitude of the slave trade demand impulse to West African commercial agriculture Eltis reached the provisional conclusion that it exceeded the total value of West African commodity exports to Britain up to the mid-19th century.

In this paper we examine European slave ship provisioning strategies during the long 18th century with two objectives. First, to re-assess the comparative magnitude of the Atlantic slave trade's demand impulse to West African commercial agriculture. Second, to gain deeper insight into patterns of temporal and spatial variation in slave ship provisioning, and through this lens, also obtain a better understanding of the development of food markets at the African Atlantic coasts. We use primary sources on *actual provisions* taken on board in European ports of departure and along the West African coast from a sample of 164 British, Dutch, French and Danish slave ships sailing off to the West African coast in various periods during

[2] See for example the arguments put forth by early abolitionists such as Thomas Clarkson (1788) or those who supported the trade such as Norris (1789).

[3] For an overview of the entire cycle of a slaving voyage see Behrendt (2001). Newson (2007) and Miller (1979) suggest that the poor diets of slave from the Angolan port of Luanda both during their stay at the coast before embarkation onto slave ships and during the middle passage led to higher rates of mortality than other regions.

the 18th century. Our sources include voyages conducted by privateers as well as by trading companies such as the British *Royal African Company* and the Dutch *West-Indische Compagnie*. We also analyse the instructions captains received for the provisioning of crews and slaves, as well as ship-logs and chartered company correspondence to get a closer view on the logistics of provisioning and the role of coastal West African food markets therein.

Our two main findings are that over the course of the 18th century a growing proportion of the required calories and proteins for slaves were taken on board in Europe, and that the relative costs of these provisions decreased significantly. We estimate that Eltis has overstated the demand-impulse by roughly 80%. We thus challenge his conclusion that the aggregate value of slave-trade induced agricultural commerce exceeded the total value of West African commodity exports during the early stages of the commercial transition. We also document some surprising differences in the provisioning strategies of British vessels as compared to continental slavers, the former relying on African provisions to a much bigger, albeit strongly declining extent. Our evidence further suggests that African supplies of food provisions varied considerably across the seven main regions of embarkation along the Atlantic coast. We explain the different provisioning strategies of British versus continental slave ships by the different positions the British had built up at the West African coast, and we suggest that declining relative prices of European provisions versus African slave purchasing prices was the main driver of changing British provisioning strategies.

2. How big was the demand impulse of the Atlantic slave trade?

The export of non-food items from West Africa rose in the wake of the mounting Atlantic slave trade in the long 18th century. Most of West Africa's tropical commodity exports consisted of collected natural and mineral products, such as gold, ivory, hides, dyewoods, beeswax or gum Arabic. These exports did little to support the development of commercial agriculture. Before 1650, sugar exports from São Tomé accounted for almost all of the cultivated crops exported, and the volumes of cash-crops traded in the 18th century paled in comparison to West Africa's export boom during the long 19th century (Eltis 2013, 35-36, Frankema et al. 2015). Eltis has pointed out that the food supplies going into slave exports were the big exception to this rule. He estimated that the total value of food provisions exceeded one million British Pounds at the peak of the slave trade, an amount bigger than the total value of West African commodity exports to Britain up to the 1850s.

Eltis used a shortcut estimation procedure based on two key assumptions: a) that the lion-share of provisions were sourced from Africa and, b) that these provisions represented c. 25% of the exchange value of slaves following the work of Curtin (1973) on the Senegambian slave trade[4]. Table 1 replicates Eltis' estimates of the average annual value of African-sourced

[4] In Economic Change in Pre-Colonial Africa Curtin discussed the estimated costs for African slave merchants of feeding slaves around Saint Louis in Senegambia. He showed that prices of millet (the main staple) varied considerably depending on rains and other harvest circumstances. In the 1750s the price varied between £2.60/ton in a good year, to £19.50/ton in a very severe year. Curtin settled on an average of £6.80/ton. By asking how much millet a slave might need to live he suggested a figure of £2.74 per year of millet, including costs for housing, clothing, guards and additional foodstuffs. As an average slave would sell for between £10 to £12, this implied that slave-owners had to pay between a quarter (in a very good year) to a half (in an average

provisions in the Atlantic slave trade during 1681-1807 (see Appendix Table 5 for 5-year intervals derived from Eltis Table 1.2, p 39). By taking 25% of slave purchasing prices for 1681-1807 and multiplying these figures with slave export volumes (column 1) from the Trans-Atlantic Slave Trade Database (Eltis and Richardson 2010, TSTD hereafter), Eltis expressed the average annual value of West African food exports in European exchange goods f.o.b. (column 2)[5]. These were then multiplied by two to account for the costs of freight and insurance (c.i.f.) in the transportation of European exchange commodities to the regions of slave purchase (column 3). Adding a small share of 3% to account for African-sourced provisions for slave ship crews (column 4), Eltis arrives at his final estimates (column 5). The figures for the period 1781-1807 indeed suggest a total annual average demand of close to one million British Pounds[6], although he clearly stressed that these estimates should be considered as a stimulus for further research into this matter, because he cannot claim these estimates to be either objectively valid or reliable.

Table 1: Average values of African-sourced provisions in the Atlantic slave trade, 1681-1807 (in constant prices of 1700)

	Average annual value of slaves purchased (fob Europe/Americas)	Average annual value of African-sourced provisions (fob Europe/Americas)	Average annual value of African-sourced provisions (cif Africa)	Average annual value of African-sourced provisions for slave ship crews	Average annual value of African-sourced provisions (total)
	1	2	3	4	5
1681-1720	188,810	47,203	94,405	2,832	97,237
1721-1760	417,665	104,416	208,832	6,265	215,097
1761-1807	1,515,626	378,907	757,813	22,734	780,547
1781-1807	**1,878,937**	**469,734**	**939,469**	**28,184**	**967,653**

Source: Eltis (2013) Table 1.2, p. 39; Column 1 is taken from Table 1.1, p. 33.

Eltis' approach invokes three comments upfront. The first point is an obvious one, namely that whatever demand impulse the slave trade may have given to West African *commercial* agriculture, it can never have offered an impulse to total agricultural output. As most of the captives had been engaged in agricultural production before they were captured, the rise of the Atlantic slave trade has obviously destroyed productive capacity in the areas where slaves were raided. Hence, the net effect of the slave trade constituted a relocation and

year) to four fifths (in a very bad year) of the eventual selling price. Curtin then went on to say that the difference between the costs of buying slaves in the interior were very different from the f.o.b costs on the coast. In Gajaaga, a kingdom on the upper Senegal, slaves could only be delivered once a year in the annual high season. This meant that slaves brought to this market had a price "*on a sliding scale, rising by 80% from a low point after the departure of the annual fleet to the high point just as the last boats prepared to sail at the end of the next high season*."

[5] Slave prices series for 1681-1699 were derived from Eltis (2000, 296) and for 1700-1807 from Richardson (1991, 52-56).

[6] West Africa was exporting a number of important commodities in addition to slaves throughout the period of transatlantic slavery including dyewoods, wax, gum and palm oil. Increasing demand from an industrialising Europe combined with the slow decline of export slavery in the 19th century saw such commodity exports increasing rapidly from the 1820s (Law 2002, Frankema et al. 2015)

concentration of demand, which promoted the development of markets for food at the coast and along major transport arteries at the expense of agricultural production in raided hinterlands.

The second point is that Curtin's 25% estimate of the food component of slave prices is not the only estimate one can select for this type of analysis. Alternative figures suggest different orders of magnitude. In an essay on the French slave trade Klein and Engerman (1979) state that:

"*Given that certain minimal daily needs of food and water were required to maintain slave health and to reduce susceptibility to disease, there were clearly demands for space for this purpose. Any increase in the number of slaves put abroad would be at the expense of provisioning and cargo space. The constraint here, it should be noted, was on space, and not on costs, for the bulk of foodstuffs consumed by Africans in the crossing were purchased on the African coast, with rice and yams serving as the staples of the diet (note: not true, ignores corn and for West Central Africa Manioc/Cassava). The costs for these foods and for the water represented less than 5% of the total costs of outfitting the vessels and therefore offered little financial restrain on adding extra food*." (p. 270)

Klein and Engerman thus support Eltis assumption that the bulk of food provisions is sourced from Africa, but they give a much smaller estimate of the relative weight of provisions in total outfitting costs. Kit should be noted that Klein and Engerman have based their estimate on just one French slaving vessel, La Reine de France, which we have in our dataset along with 6 other French slave ships (Rinchon 1964). Nevertheless, we will arrive at an estimate for the late 18th century that comes quite close to Klein and Engerman's.

A third point is that despite the huge disparities between Curtin's 25% and Klein and Engerman's 5% estimate, all studies seem to assume that the lion-share of food was bought in Africa and therefore produced by African farmers. Indeed, Eltis (2013, 38) explicitly states that European provisions constituted a negligible share, somewhere in the order of 1 to 2% of the costs of slaves. Over 90% of total food requirements must therefore have stemmed from African sources. Carney and Rosomoff (2011) also conclude that the majority of the foodstuffs in slave ships was produced in Africa, by Africans[7]. This statement is also supported by Mandeblatt's (2008) study of the French slave trade. In his survey of the Trans-Atlantic slave trade Klein (2010) seems to be a bit more cautious though, stating that only all "….the condiments used came from Africa…" (p. 94). Klein gives no idea of the relative proportions of staple foods sourced from Africa.

Interestingly, a more thorough quantitative analysis of surviving trading accounts of slave ships and companies has never been conducted to shed light on this issue. Carney and Rosomoff (2011) and Thomas (1997) draw on a number of secondary sources from the long 18th century, but they do not even suggest the possibility that there might have been (major) variation in the patterns of provisioning over time, nor do they talk much about possible

[7] Carney and Rosomoff (2011) state that "When European slave ships arrived along the African coast, they carried only partial stores of foodstuffs. Most of the food needed to provision the human cargo was grown in Africa." p47. Eltis (2013) agrees "The greater share of food consumed by slaves was nevertheless grown in Africa, and by Africans." p42

differences across embarkation regions. It is this quantitative outlook, in combination with patterns of temporal and spatial variation, that this study seeks to offer. Our conclusions challenge the consensus view: in the course of the 18th century more than half of all calories and proteins required to keep slaves alive on board of a slave vessel were sourced from European or American ports of departure, not at the West African coast, and the costs of provisions were much lower than the assumed 25%, especially after the 1740s.

3. Data and Method

The provisions that slave ships took in from European ports typically included a few main staples, principally beans, peas, rice and barley. Ships departing from Brazil used to store manioc flour (Newson 2011). In Africa, captains picked up foodstuffs most common to the regions where they conducted their trade; rice from the Upper Guinea and Windward coasts, maize from the Gold Coast, yams from Biafra and Gabon and cassava from the Congo and Angola. Plantains, coconuts, limes and oranges and other fresh provisions supplemented these staple foods. Palm oil and malagetta pepper were widely used as condiments[8]. As a rule slaves were fed a kind of gruel comprised of whatever combination of the above had been bought, seasoned with salt, palm oil and pepper. Small portions of salted meat may have been sparingly handed out, but did not constitute a fixed component of daily slave rations. Given the frequent references in the sources to crew member resorting to violence to induce slaves to eat it is unlikely that this constituted a terribly rewarding diet[9].

3.1 Data

Our sample consists of 164 trading accounts from slave ship voyages conducted between 1680 and 1807. Our data thus covers two distinct eras in the slave trade. Until the early 18th century, the slave trade was a jealously guarded government monopoly. In Great Britain, the Royal Africa Company (RAC) and in the Netherlands the West-Indische Compagnie (WIC) were the sole permitted traders. The French government experimented with a series of government owned companies. Slaves to the Spanish empire could only be handled through the *asiento* contract. All of these companies were unable to prevent interlopers and smugglers from carrying slaves, partly due to fact that they couldn't meet the demands of their markets, but also because they operated notoriously inefficient business models (Thomas 1999, Klein 2010, Den Heijer 2013). By the 1730s most nations, with the exception of Spain, had accepted

[8] For British Ships see - Phillips (1693) p229, William Smith A New Voyage to Guinea 1726, Atkins, A voyage to Guinea, Falconbridge (1788) p21, Minutes of the South Sea Company 1713 Donan II p157, Tobin to Hutt Committee 1846 quoted in Thomas (1999) p418. For French ships see (Savari 1706, 1757, 1777) p435, p558, p229, Harms (2008), Mandelblatt (2008). For Danish ships see Svalesen (2000). For Dutch ships den Heijer (1997).

[9] Atkins (1737), a slave captain stated that during meals slaves had an "*overseer with a cat-o-nine tails to force it upon those that are sullen and refuse.*" p90. Falconbridge (1788), a surgeon on a number of slaving vessels (and also an abolitionist) wrote that "*Upon the negroes refusing to take sustenance, I have seen coals of fire, flowing hot, put on a shovel, and placed so near their lips as to scorch and burn them. And this has been accompanied with threats, of forcing them to swallow coals, if they any longer persisted in refusing to eat*." (p. 23).

that private trade was a better option. The chartered companies were by and large wound up, or focused their attention elsewhere.

For the chartered companies era we rely on the account books of the RAC which detail the cargoes bought in England and, in the 1720s, the provisions bought in Africa. For the earlier period we rely on the 3 volume collection of correspondence from the British forts on the West Coast of Africa (1680 to 1699) compiled by Law (1997). We also have records of 5 ships owned by a private trader, Humphrey Morice, who sent vessels to slave in the 1720s. These ships, like most at the time, bought most of their slaves along the Gold Coasts and in the Bight of Benin. We use the appendix of Leo Balai's (2011) book *Het Slavenschip Leusden* for the provisioning of 3 WIC ships in the 1720s, including detailed information on the instructions for ships' captains from the company.

For the private trade era (post-1740) our main source are the archives of the Middelburgse Commercie Companie (MCC). These are by far the most complete records we have been able to identify and detail exactly what provisions were bought in Europe, what was bought in Africa, and where. They include around 130 voyages of which we have selected around 50 to study the period 1740-1790[10]. Crucially, they also provide prices of Dutch (Province of Zeeland) provisions as well as some scattered food price observations at the African coast, which allows us to cursorily explore the relative costs of European and African provisions. All trade along the coast was conducted by barter, but the MCC converted all of the trade goods into either guilders or Flemish pounds allowing us to compare prices of individual items, which can be used for wider estimations of spending by other slave ships.

A further advantage of the MCC archives is that the MCC traded regularly in all areas of Africa with the exception of the Bight of Biafra[11]. We have filled this gap with two English sources. The first are the papers of the Liverpool merchant William Davenport who sent around 20 vessels to Africa from the 1760s to the 1780s and specialised his commercial operations in the Biafra region[12]. The second are the Bristol Presentments, a weekly register of shipping from the port of Bristol which begin in 1789 and record the cargoes and arrival and departure dates of 40 slaving vessels. These also are concentrated on ships going to Biafra and the Cameroons, but like the Davenport papers also include ships trading in other regions. The downside to these records is that they do not record what provisions were bought in Africa, so we combine these with various secondary sources to estimate the costs and volumes of yams, the principle foodstuff of the region, loaded onto slave ships[13].

For other nations, we are relying exclusively on secondary sources. For Danish shipping we use the work by Svalesen (2000). Although it provides detailed information of only one ship, it also presents detailed instructions from The Royal Chartered Danish Guinea Company on exactly how much to buy in terms of provisions and exactly what slaves should

[10] We are presently downloading more and hope to include the majority in our final paper

[11] This was probably due to the fact that when trade in the Biafra region reached its apogee the MCC were entering a period of crisis due to increased insecurity throughout the Atlantic but more specifically due to the 4th Anglo Dutch war.

[12] These papers were only brought to light in the 1990s and represent the most complete account of any British merchant for later 18th century. A full investigation of the documents can be found in: Radburn, Nicholas James. "William Davenport, the Slave Trade, and Merchant Enterprise in Eighteenth-Century Liverpool." (2009).

[13] See (Behrendt, Latham, and Northrup 2010) pp 90, 91, 102, 108, 135, 140, 170, (Behrendt 2001) p182, (Thomas 1999) p418

be fed on daily basis (p. 112). For the French we rely on the work of Rinchon (1964) which details the voyages of one particular slaving captain, Van Alstein, who sailed on the Bight of Benin and the West-Central African coast (Congo and Angola; WCA hereafter). These provide full details of both food purchases in Europe and Africa as well as the prices paid in some instances. For Portuguese vessels the main sources are (Miller 1979, 1986, Miller 1997) and Newson (2007). Unfortunately, these do not provide the same level of detail as the primary sources mentioned above.

Table 2 offers an overview of our sample. The complete overview of these voyages, the provisioning data and the sources is offered in Appendix Table 1, published online at the African Economic History Network (www.aehnetwork.org). This appendix serves as the basis for all the estimates presented in section 4. We have a relatively good coverage of Dutch, Danish and British ships. The biggest limitation of our sample is the lack of Portuguese/Brazilian voyage records, which accounted for about a quarter of all voyages between 1681 and 1807 according to the TSTD. To obtain estimates of Portuguese/Brazilian provisioning we thus have to draw inferences from indirect evidence, that is, the provisioning strategies of European ships sailing on their major trading region, that is, West-Central Africa. Our secondary and primary sources strongly suggest that food supplies at the West-Central African coast were more insecure than in most other regions at the Atlantic coast. The bottom-line, however, is that despite the uneven coverage of our dataset, it offers a much bigger and broader empirical basis than all other studies have hitherto adopted. It does not make our estimates infallible, but we dare say that it makes them more plausible.

Table 2: Sample of slave ship voyages by nationality (flag), 1681-1807

	1681-1740 Chartered companies era			1741-1807 Private trade era		
	No. of voyages	Our sample	%	No. of voyages	Our sample	%
Spain/Uruguay	7	0	0	74	0	0
Portugal/Brazil	1,954	0	0	3,918	0	0
Great Britain	3,749	33	0.88	7,384	80	1.08
France	865	1	0.12	2,557	6	0.23
Netherlands	398	3	0.75	705	39	5.53
USA	182	0	0	1,725	0	0
Denmark/Baltic	89	0	0	296	2	1
Totals	**7,244**	**37**	**0.51**	**16,659**	**127**	**0.76**

Source: TSTD and for our sample see text and Appendix Table 1

In our dataset we separated the provisions for crewmen and agents at European forts along the African coast from what was commonly referred to as 'Negro Provisions'. Sailors and fort personnel were almost exclusively fed on European provisions which were separately recorded in the account books of most of the slave trading companies. Provisions for personnel included butter, cheese, suet, stock-fish, bread, beef, pork, flour, sweet oil and peas. Throughout the century supply ships brought fairly large quantities of such provisions to the forts, suggesting that consumption of local food was fairly minimal. On the slave ships themselves provisioning was usually strictly segregated. For 4 MCC ships we have surviving

accounts of the daily quantities of food used showing separate diets for sailors and captives, presumably also to emphasize the social or racial hierarchy between the two groups. For example, on the voyage of the Nieuwe Hoop from 1766 – 1768 the crew consumed bread, meat, bacon, blue & grey peas, salt fish, rice, sweet and rape oil, while the slaves were given horse beans, barley, yams and African beans called *gobbegobsen*. French and Danish ships are also recorded as stocking separate food supplies for their personnel, who also ate at different times than slaves. Interestingly, our British sources do not speak to such a strict separation of slave and crew provisions, in particular regarding the consumption of staple foods. We will get back to this point below, when we dig deeper into an apparent British 'exceptionalism' in slave ship provisioning.

3.2 Method

For 36 of the 164 voyages in our dataset we have information on the total intake of foodstuffs in both Europe and Africa. In 114 cases the non-African provisions are fully specified, while the African provisions are not. In 12 cases we have full information for African-sourced provisions, but lack info on European provisions. To tackle the problem of incomplete information, we develop a benchmark estimate of the number of day-rations required for the entire period that slaves were kept on board, including a considerable security margin that captains would have commanded. We use this benchmark to deduct how much of these day-rations were covered by African or non-African provisions. Our estimation procedure involves six steps.

1) We distinguish African and non-African provisions and separate out provisions for crew members, the latter only if the sources allow us to do so.

2) We express all foodstuffs taken on board of slave ships in metric weights (kilos) and standard units of nutrition. We convert all food types (rice, barley, corn, yams, beans etc.) into their total caloric value and total grams of protein, according to nutrition tables of the FAO[14]. Appendix Table 2 list all metric and nutritional conversion rates.

3) We develop a benchmark 'day-ration' of food consumed by slaves on board. We assume a subsistence diet with 2,000 kilocalories (Kcal) and 40 grams of protein per slave per day. This is a bare minimum compared to the WHO recommendation of around 2,500 Kcal per adult male with a sedentary lifestyle, but it does suffice to keep people alive without losing too much muscular strength. It is also in line with the instructions captains received for feeding their slaves during their stay on board. While studies on the diet of sailors in the British navy show they consumed around 4,500 Kcal per day, the latter were clearly far more active than slaves who were confined for most of the day (Macdonald 2006, 177). If we factor in that many of the captives were children requiring fewer calories than an adult male, these caloric and protein assumptions are in line with what is commonly assumed to be a 'bare-bones subsistence diet' in the literature on comparative living standards (Allen 2001, Allen et al. 2011, see for an application to Sub-Saharan Africa Frankema and van Waijenburg 2012).

[14] http://www.fao.org/docrep/w0073e/w0073e08.htm#P14552_1185427

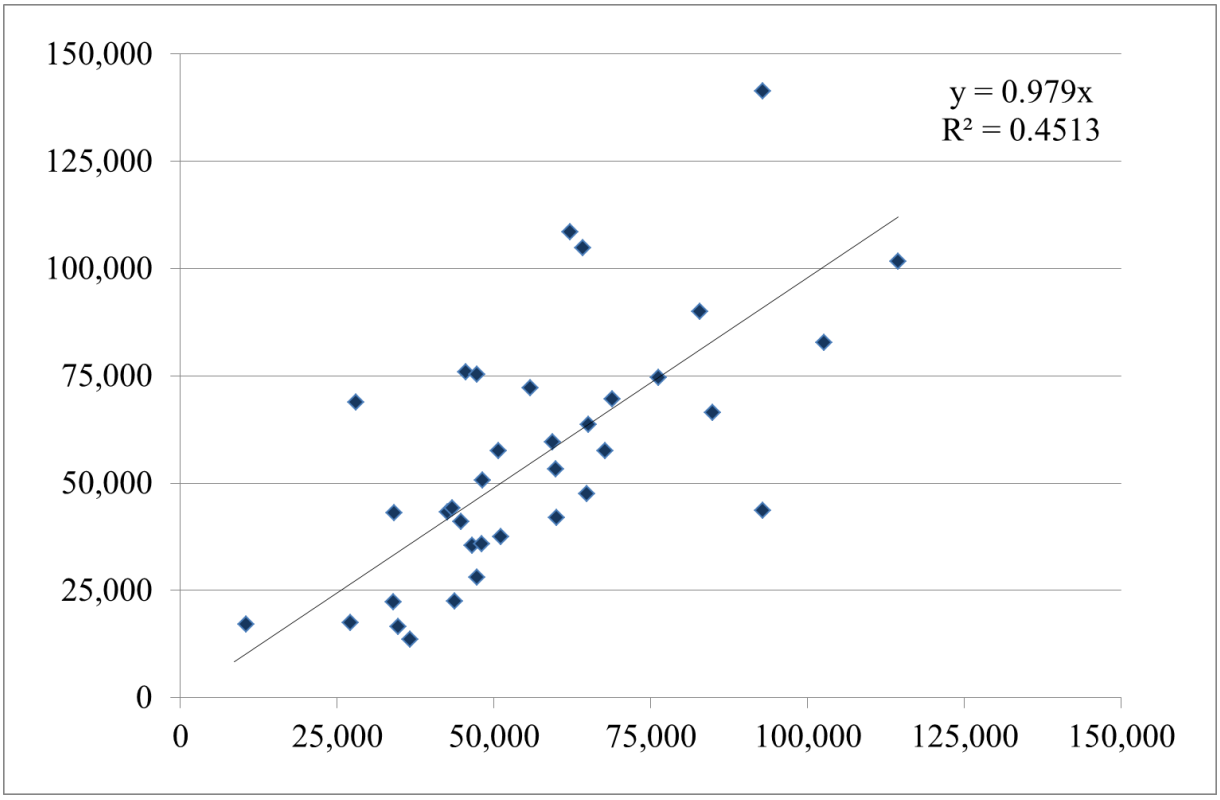
4) We estimate the total number of day-rations required by multiplying the total number of slaves embarked from the TSTD with the average number of days the median slave spent on board. We don't adjust our estimate of required day-rations for slave mortality during the voyage as captain's would probably have provisioned on the basis of a best-case scenario (i.e. negligible mortality). We do include a security margin as slavers were well aware of the unpredictability of their voyages (insecure slave supplies, adverse weather conditions, diseases, food rot, privateers and so on). More details are given under step 5.

5) We account for region and era-specific voyage duration. To estimate the average number of days the median slave spent on board, it mattered in which period the voyage was conducted (e.g. 1680s or 1800s), and to which particular region the ship headed for purchasing slaves. Embarkation times depended on the relative concentration of slave supplies. Moreover, the middle passage took longer from some regions than from others. Shorter *expected* voyage lengths would have translated in lower provisions, ceteris paribus. To account for this type of variation we derived 20-year interval means and standard deviations of the actual time spent at the coast (TAC) and the middle passage (MP) for the seven major West African slave trading regions: Senegambia, Sierra Leone, Windward Coast, Gold Coast, Bight of Benin, Bight of Biafra and West-Central Africa. All the data on voyage length were taken from the TSTD and are presented in Appendix Table 3.

We then applied two assumptions which put our estimate of required food provisions a bit on the conservative side. First, we assume a linear slave intake ratio. That is, a slave vessel taking in 300 slaves in 100 days at the African coast, has a linear intake rate of 3 slaves per day. In practice, slave intakes tended to be non-linear, as slaves were purchased in larger quantities towards the end of the TAC (Hogerzeil and Richardson 2007). Second, we assume that the provisioning strategies were based on the average number of days of the MP plus one standard deviation, which offers a considerable security margin, often exceeding 30% of actual voyage length. The assumed expected number of days for which slave rations were required are presented for each voyage separately in Appendix Table 1 (column 15a and 15b).

6) We put our estimation procedure to the test using the fact that for 36 cases we can actually compare the estimated number of required day-rations to the actual observed provisions taken on board. Figure 1 shows a scatter plot where the x-axis presents our benchmarks and the y-axis the observed no. of day-rations. The figure shows that our approach is a viable one. There does not seem to be a systematic under- or overestimation of required day-rations as the slope of the regression line ($y = 0.98x$) is close to unity. Moreover, there is a clear correlation, such that ships carrying more slaves for longer periods of time - leading to a higher provisioning requirement estimate at the x-axis - did indeed carry more supplies of food in reality. A similar test for protein requirement indicates that the far majority of ships took much more than the 40 grams per day per person which we envisioned, especially in the form of beans and peas, but this is less relevant given the fact that calories posed the obvious constraint to storage space, not proteins. With this test in mind, we are confident that our analysis is not systematically biased towards a particular conclusion on the relative importance of African or non-African provisions.

Figure 1: Scatter plot comparing our estimated number of day-rations (horizontal-axis) versus the actual observed number of day-rations (vertical-axis)



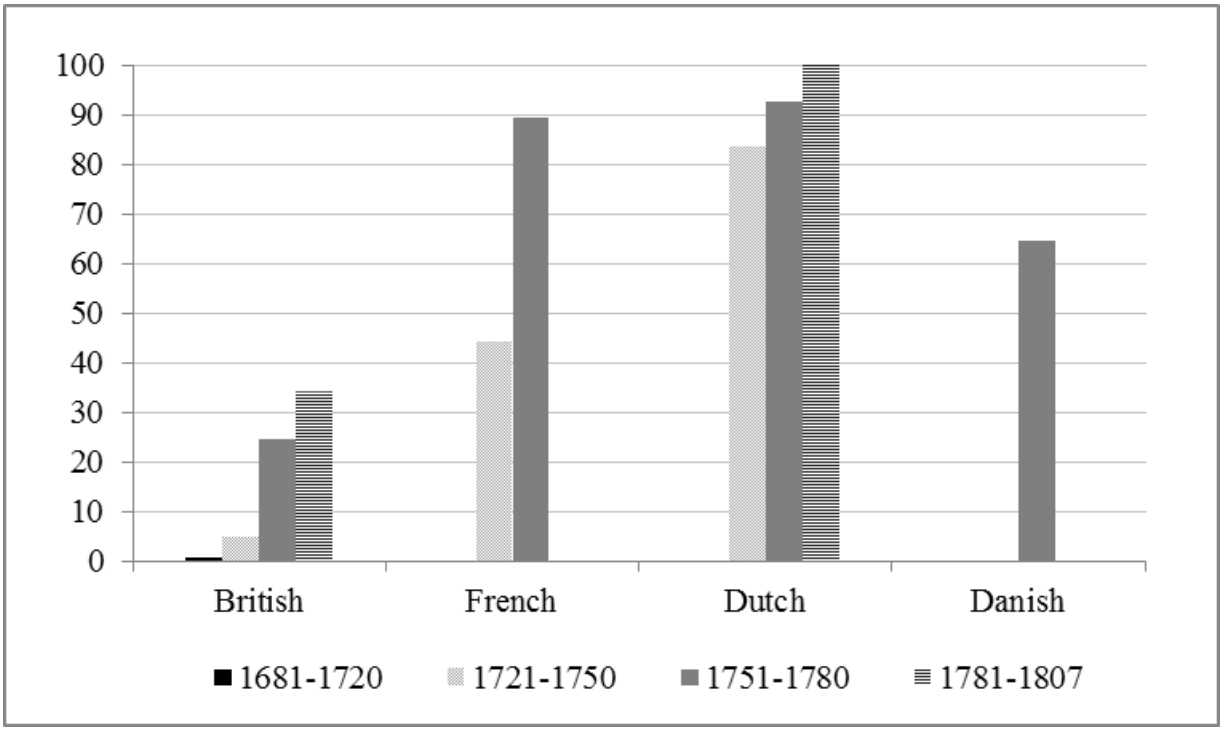
Source: See Appendix Table 1.

Note: we removed two outliers from the overall sample, namely the MCC voyages of XXX in 17XX and of XXX in 17XX. These ships carried exceptional quantities of food from Europe, much more than recorded for any other ship. Although we have been unable to figure out exactly why these ships were over-provisioned, we speculate that they have sold part of their food to other slave ships or trading forts before heading across the Atlantic. The amounts of calories they carried were sufficient to make a double journey.

4. Provisioning strategies in the long 18th century: main results

This section explores the varying provisioning strategies of British, French, Dutch and Danish slavers over the course of the 18th century and also looks into varying provisioning patterns by African region of embarkation. Our sample consists of 164 voyages, unless otherwise indicated. Figure 2 shows the percentage share of required Kcal supplied by European provisions sub-divided in four periods, two in the chartered companies era (1681-1720 and 1721-1750) and two in the private trade era (1751-1780 and 1781-1807). The data are also sub-divided by nationality of the slaver. The primary conclusion that can be drawn from these results is that we should abandon the idea that European (or non-African) provisions played a marginal role in the Atlantic slave trade. French, Dutch and Danish ships took in over half of the required Kcal in Europe. For British slavers the picture is different, as they tended to rely much more on African-sourced provisions.

Figure 2: Percentage share of total required Kcal supplied by European provisions, voyages by nationality, 1681-1807



Source: See text and Appendix Table 1, available at www.aehnetwork.org

Why have previous studies overlooked the role of European provisions? The most probable explanation is that the literature has mainly focussed on British slave ship records of the RAC, which are known to be more complete and accessible than most other sources. Indeed, one may easily conclude from written instructions on slave provisioning by the South Sea Company (the successor to the RAC), that it was a largely African affair,

"*The following account of a proportion of provisions for 100 Negroes to be taken in at Guinea: 80 chests corn at 5 ackeys per chest is 400 ackys. 4 bushells of salt at 1 acky per bushel is 4 ackeys. 20 gallons Palm Oil at 8 tack's per gallon is 13 ackeys 4 tacks. 50 ch Malagetta at ackeys per is 4 ackeys. The above is according to the present usage of the Royal Africa company*." [15]

But as Figure 2 shows, also British slave ships changed their provisioning strategies, especially after the end of the chartered companies era. Indeed, the overall share of European provisions increased in the course of the 18th century among slavers of Dutch, French and British nationality, but is especially notable among British slavers. This is important for the analysis of the slave-trade induced demand effect on West African commercial agriculture, because Britain was the single largest slave trading nation in the century leading up to the abolition of 1807. Whereas in the 1680s and 1690s European provisions constituted a

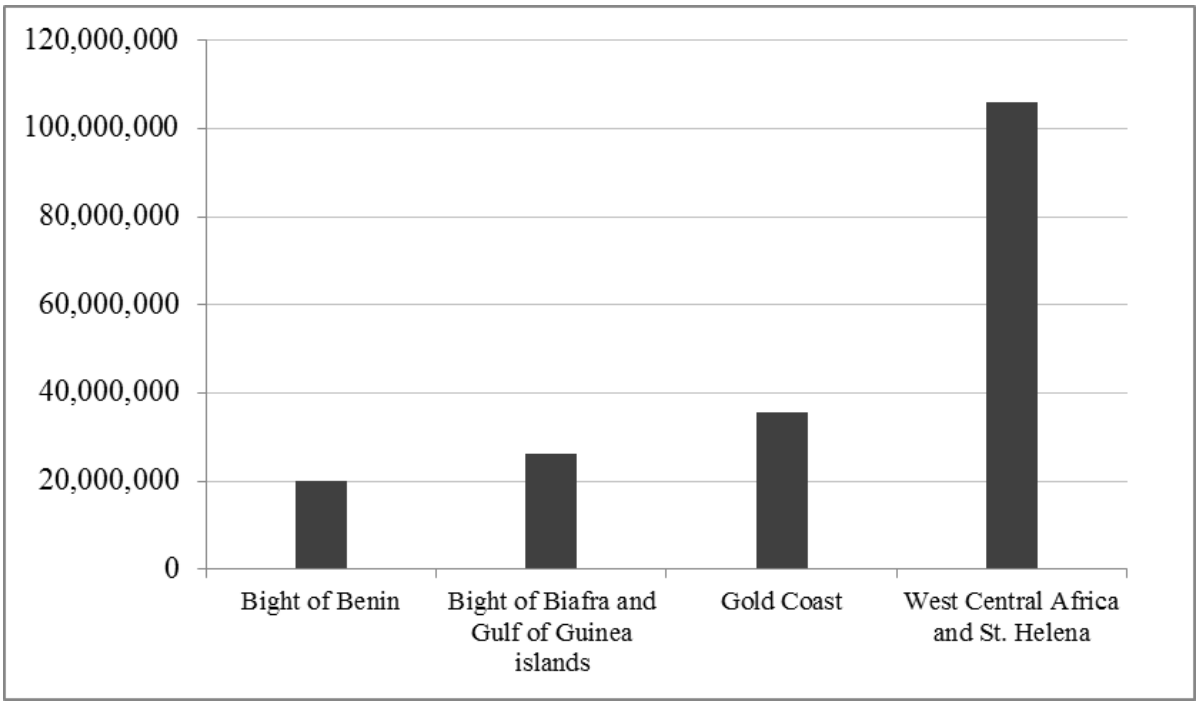
[15] The South Sea Company: minutes of the Court of Directors 1713 (Donnan 1965) p 157

negligible share of about 1 or 2 percent of total requirements, this share rose to an average of 34 percent during the heydays of the trade in 1781-1807. Behrendt (2001) notes that English slaving merchants mainly bought beans, peas and salted fish from domestic sources, but also imported Carolina rice and Irish salt beef / pork (pp. 179 – 180).

The variation in provisioning strategies depended not only, and perhaps not even primarily, on the nationality of the slavers. Figure 3 details the average amounts of calories piled up from European ports for ships heading off to the four major regions of embarkation in the 18th century, i.e. the Bight of Benin, Bight of Biafra, the Gold Coast and WCA. Ships sailing to WCA took, on average, about three times the amount of calories from Europe, and this difference cannot be explained by greater voyage length, since the average time the median slave spent on board was not significantly longer than for the other three regions (see Appendix Table 3).

Apparently, access to local food markets was much more complicated in WCA than in the other three areas. This figure offers a first clue as to why British slave ships have relied on African provisions to a greater extent than Dutch or French slave ships: British slavers were not as active in WCA[16]. However, for Portuguese and Brazilian slavers WCA was the main trading region. WCA played a considerable role in the 18th century expansion of the Atlantic trade, as roughly one-third of all slaves between 1681 and 1807 were taken from the coast of Angola and the Congo (TSTD). The lion-share of these slavers departed from a handful of Brazilian ports such as Salvador (Bahia), Recife (Pernambuco) and Rio de Janeiro, while a relatively small share came from Lisbon (TSTD).

Figure 3: Average no. of European Kcal taken to different regions of embarkation, 1681-1807



Source: See text and Appendix Table 1, available at www.aehnetwork.org

[16] During the long 18th century, British slavers took only 13% of their slaves from WCA compared to 42% for the Dutch and 46% for the French (TSTD).

In our smaller subset of French slave ships the distinction is also very clear. The three ships we observe sailing on WCA from the 1760s to the 1780s sourced on average 99% of the required calories from Europe, while three ships sailing to Benin took c. 49% from Europe. And even Dutch slavers, who tended to pile up most of their food stocks at the port of departure anyway, still tended to take more supplies on board when sailing to WCA, than when they were heading for other regions. John Adams (1822), a slave captain during the 1790s, wrote that "…on the coast of Angola, the natives have no superfluity of provisions to sell, in consequence of which, vessels frequenting it are compelled to bring with them from Europe, sufficient food to feed the negroes while accumulating on board the ships, and during the passage to the West Indies." (p. 54) [17]. Newson (2007, p. 85) has argued that the availability of food was lower because of the relatively dry climate and the high expenses involved in transporting food provisions from the more fertile interior down to the Angolan coast. There are also stories about Brazilian slavers taking on insufficient provisions, rather than paying the inflated prices charged during the regular periods of drought (Miller 1979). Carney and Rosomoff (2011) quote a Portuguese governor of Angola who ordered that all ships coming from Brazil should carry sufficient manioc flour to feed their slaves during the return voyage. The study by Rinchon (1964) of the voyages of a French captain also discusses the problems of insufficient provisions along the Angolan coast:

"*Les negres de la cote d'Angole ne cultivent absolument que ce qui est necessaire et vivent la plus grande partie d.u temps de poissons ; c'est ce qui fait qu'il n 'est pas possible aux navires d'y refaire leurs vivres ; il faut que ceux que l'on porte d'Europe servent pour tout le voyage ; cette necessite doit done faire prendre les plus grandes precautions pour s'en pourvoir suffisamment dans le principe, et avoir un tres grand soin de les conserver*." (p. 264)

But apart from WCA, the other regions of embarkation offered varying access to food markets as well, and none of the major embarkation regions could guarantee sufficient quantities of staple food at all times of the year. Whereas the Gold Coast was known as one of the slave trading regions where commercial agriculture developed in support of the trade (Shumway 2013, Savage 2014) our sources indicate that the Bight of Benin provided no significant foodstuff to slave ships beyond fresh provisions while ships were loading. To overcome this problem, RAC ships were instructed to take on rice along the Windward coast or corn at the Gold Coast, before heading to ports such as Whydah or Jakin on the 'slave coast' of Benin. This pattern seems to have continued into the free trade era, when similar provisioning strategies were followed by the Dutch slavers of the MCC. Why African farmers in Benin did not respond to growing opportunities for food sales remains somewhat puzzling. The area is attested in sources as being extremely fertile and was able to support complex,

[17] This evidence is corroborated by a British slave ship surgeon who stated that "....*the greater mortality I mentioned was from the Coast of Angola, which Country finds of Slaves provisions - we are therefore obliged to carry provisions partly from Europe and (when to be got) partly from the Windward Coast of Africa.*" John Knox (1789) *"Minutes of Evidence taken before a committee of the whole house To whom it was referred to consider the circumstances of the slave trade"* p. 93.

centralised states such as Dahomey and Oyo[18]. If environmental constraints cannot explain the lack of trade in food, a political explanation may be most probable. Did the war-economies of the Dahomey and Oyo states command that food surpluses had to be stored for domestic economic, political or military purposes?

It is not clear whether the partial post-1760 switch of British slavers from the Gold Coast and the Bight of Benin towards the Bight of Biafra had something to do with provisioning conditions in either region, but it is not implausible. Slaves from Biafra were lower valued by buyers in the New World (Klein 2010, Thomas 1999) as they were generally seen as more prone to sickness and disease. This is also borne out by analysis of mortality rates during the Middle Passage with slaves from the Biafra region dying at nearly twice the rate as those from other areas[19]. Lovejoy and Richardson (2004) have suggested that the preference for trading in Biafra was due to more sophisticated credit arrangements and faster embarkation times. In section 5 we suggest that ready and cheap access to yams in Biafra may also have been a factor.

5. Why did slave ship provisioning strategies vary?

Why did British and Dutch slavers adopt such different provisioning strategies and why did British traders reduce their reliance on African-sourced provisions after the demise of the RAC in the 1740s? We review five possible explanation, some of which we have already briefly touched upon above: 1) the size and organization of food markets in the region of embarkation versus the region of departure; 2) the relative costs of African versus non-African provisions; 3) the relative costs of provisions to slave purchasing prices; 4) slaves' dietary preferences; and 5) the technology available to conserve different types of food for journeys of several months.

We start with the fifth factor. The literature generally acknowledges that techniques to prepare and conserve food improved considerably during the 18th century, and fitted into a pattern of further 'professionalization' of the trade (Behrendt 2001). A telling example is the increasing use of limes to prevent scurvy, the working of which was not entirely understood but its effect was (Leuftink 1991). But knowledge on nutritional value and conservation techniques cannot explain the difference between the provisioning strategies of Dutch and British slavers in the early 18th century. It is very unlikely that the Dutch had a knowledge monopoly on food conservation techniques for a long period of time. Moreover, the French ships we observe also relied much more on European provisions already in the first half of the 18th century.

We face a similar problem with the dietary preferences of African slaves. Many sources indicate that European slavers were well aware of the advantages of feeding their captives with African-sourced staple foods. Instructions to and observations by ship's captains of all nations advise at least a portion of the food to have some local element even if it was

[18] See for example Atkins (1737) p. 112 or Phillips (1693) p. 215.

[19] For the period 1750 to 1808, when the Biafra region became a major point of embarkation the % of slaves dying during the middle passage were: Senegambia: 11%, Sierra Leone: 10%, Windward Coast 10%, Gold Coast 11%, Bight of Benin 10%, Bight of Biafra 17%, West Central Africa 9%

just a condiment such as palm-oil and malaguetta pepper[20]. This seems to have been primarily motivated by the belief that such provisions helped reduce sickness and mortality. It can of course not entirely be ruled out that British slavers were, on the whole, more sensitive to the dietary preferences of slaves than Dutch slavers, but the latter were clearly aware of the problem that slaves disliked the gruel of barley and beans that they served on board. In other words, it is more likely that the Dutch had other reasons that outweighed this perceived disadvantage of European provisions.

Is it possible that Dutch slavers from Middelburg or Amsterdam had better access to food provisions in their home ports than British slavers? Behrendt (2001) has argued that "During peak periods of the slave trade, English food supplies could not meet the requirements of all Guineamen. Merchants thus relied on African provisions, particularly during late summer and fall…." (p. 181). There is no doubt that as the slave trade grew it did carry substantial numbers of people. If one were to count the crew and slaves aboard ships out of Liverpool as additional mouths to be fed, then they would have added 5% to 7% to the total population of Lancashire in an era when the city was itself growing at an exponential rate (Wrigley 2007). However this seems quite unlikely too. Especially for ships sailing from England, whose capital was one of the most important commercial and naval hubs of Western Europe together with the Amsterdam. In case local food markets would have been insufficient, or prices too high, there was always an option for slave ships to stock up with foodstuffs in other European ports, as was common practice in the purchase of exchange commodities, such as textiles, guns, alcohol, tobacco, iron and copper rods[21]. Indeed, there is evidence that French slavers leaving from the port of Nantes first sailed northwards to the Dutch port of Rotterdam to take in provisions[22]. So even if British slavers departing from Liverpool and Bristol had difficulties in sourcing food from their immediate hinterlands, than it would still have been an option to call in at London or other European ports.

Therefore, it is much more likely that intra-African differences in the access to provisions, as well as the related relative costs of provisions, the risk of possible delays (waiting for food to be supplied) and the types of food that were available, hold the key to explaining the major contrasts in provisioning strategies. What do we know about relative

[20] In their instructions to captains, the directors of the West India Company recommended that all beans be flavoured with "….een weinig sap" and "…wat oly de palm" (quoted in Balai 2011 p250). Likewise the Royal Africa company stated that its ships were to purchase a proportion of corn, palm oil and mallagetta pepper (Donan II p 164=3). Later ships of the Middelburgse Commercie Companie regularly also regularly stocked up on palm oil and pepper, regardless of other provisions they bought (see online appendix). A recipe for soup served aboard French slaving vessels included locally bought corn, pepper and palm oil as well as beans or rice (Mandelblatt 2008 p412). Captain John Adams (1822) stated that "On every other part of Africa where slave-ships resort, the captains of these ships depend on the country supplying a certain portion of food adopted to the habits and constitution of the negroes they may obtain at them…". When his slaves started getting sick the slave captain and future abolitionist John Newton noted in this diary "…the season advancing fast and, I am afraid, sickness too; for we have almost every day one or more taken with a flux, of which a woman dyed tonight (no. 79). I imputed it to the English provision and have given them rice twice a day ever since I came here" 21st April (Bernard & Spurrell 1962).

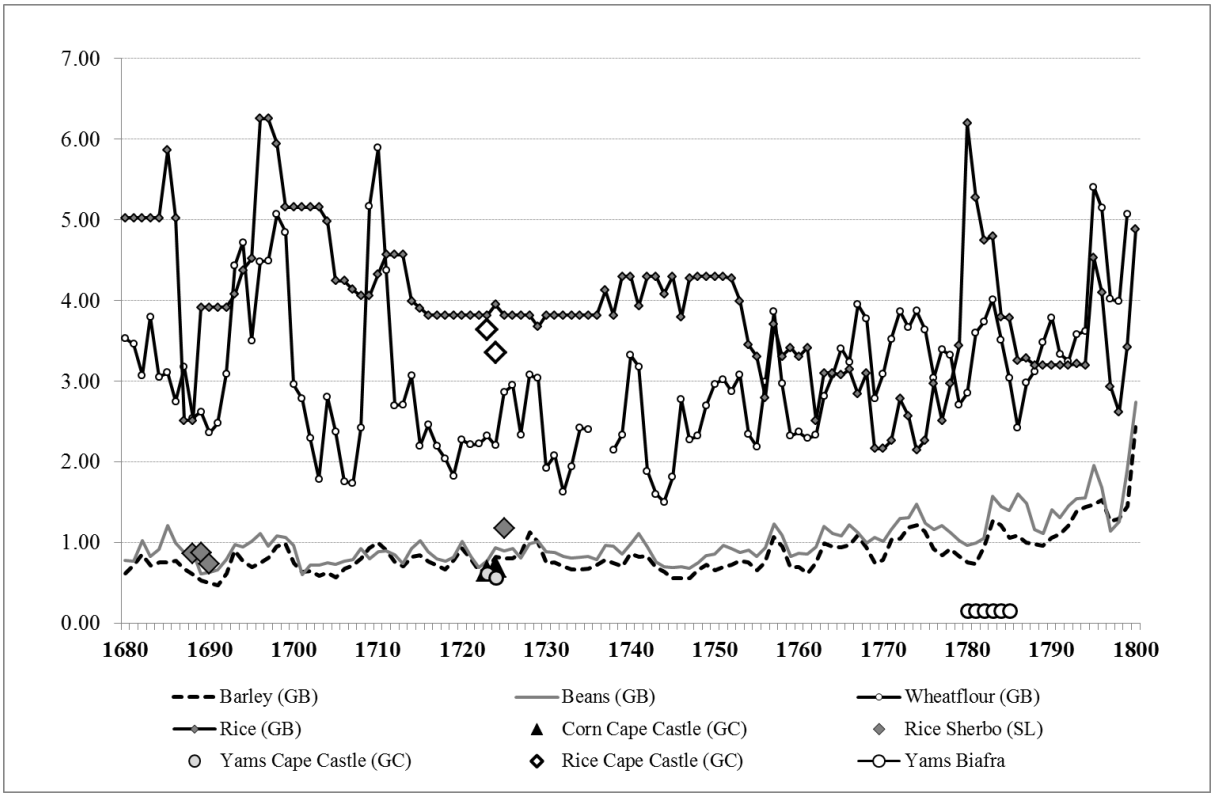
[21] Records from the accounts of forts along the coast of Africa show that they were importing trade goods from around the world, including Swedish iron, Indian textiles, Danish guns, Brazilian tobacco and Caribbean rum. TNA T70/928 – 930.

[22] Based on personal correspondence with Gerhard de Kok. We thank him for sharing this insight with us. Mandelblatt (2008) notes that while the majority of provisions on French ships were bought in France, they also purchased rice in London and Salt Beef from Ireland (p. 417).

food prices? Were African provisions cheaper than European provisions? Were the price differentials sufficiently large to matter? And what about the intra-African differences in food types and prices?

Figure 4 shows the scattered food price observations in West Africa we collected from the RAC accounts for a number of benchmark years between 1680 and 1730[23]. We compare these prices with British domestic price series for barley, beans, rice and wheatflour. We express the price of all foodstuffs in pence per 2,000 Kcal. The British annual price series are farm-gate prices from Clark (2004) to which we added a 30% mark-up to adjust for additional retail and transportation costs from the countryside to the belly of slave vessels in the harbours of Bristol and Liverpool. This 30% mark-up closes the gap between the farm-gate prices and the unit prices reported in the slave ship trading accounts we have studied. Finally, we have taken various observations from Behrendt et al. (2010) based on sources commenting on the cost of yams in the Biafra region in the 1780s.

Figure 4: Prices of food in Britain and West Africa in pence per 2,000 kcal



Source: Appendix Table 1
Notes: GB is Britain, GC is Gold Coast, SL is Sierra Leone

Our scattered West African food price observations suggest that, on the whole, it was a bit cheaper to buy African food provisions, especially corn and yams, but compared to the

[23] For the forts the data comes from Sherbo (Sierra Leone) and Cape Coast Castle (Gold Coast) for 1686, 1687 and 1688. These primarily show purchases of African products in local currencies which are converted into pound sterling. For ships we have taken information from ship accounts in the invoice books of the RAC which show both quantities and prices of European foodstuffs.

nutritional value that slavers could get from beans and barley, the margins that slavers could make weren't that impressive. The vast rice price differences between Sherbo and Cape Coast Castle show that it also mattered a lot where one bought food in West Africa. It is possible that the price of rice sold to slavers at Cape Castle followed British market prices. There only seems one major bargain available in West Africa, yams from Biafra, which were much cheaper than any other staple sourced from Britain or West Africa. But it should be noted that this cost advantage may only have emerged after mid-century, when the region became more important for the British trade.

If average price differences cannot have played a decisive role, what about price volatility? Slavers who relied mainly on African provisions had to cope with less secure supplies and risks of delays or price peaks which could only be mitigated by extending the number of provisioning stations. In this respect it is important to note that ritish ships could pile up food at various locations in Sierra Leone and the Gold Coast, before taking a leap to the Bight of Benin, where food markets remained underdeveloped. The Dutch had only one fort along this part of the coast (Elmina) compared to six owned by the British. With less dependable supplies along the coast it was a less risky strategy to stock up with greater quantities of foodstuffs before departure, even though this might not have given Dutch companies the best value for money. This is not to say that the MCC did buy no food in West Africa at all, they just bought much less of the main staples. Many ships we observed bought food in the region around modern day Cote d'Ivoire. Other captains, like Van Alstein, sailed to the islands of Fernando Po and São Tomé. But Dutch ship logs also reveal that there were very few places along the coast where one could get reliable supplies.

Even the British in the 1680s and 1690s, when the slave trade was at a fraction of what it was to become in the 18th century, and with the advantage of numerous forts which could buy food in advance of ship arrivals, already faced considerable problems in acquiring sufficient calories for the slave they bought. We analysed over 3,000 letters and notes collected by Robin Law (1997), giving deep insights into correspondence from and to RAC officials stationed in the forts along the Gold and Slave Coast in the last two decades of the 17th century. We used this collection of letters to quantify all references to problems with provisioning that led to delays or problems for the forts or ships. Figure 5 demonstrates that especially in the months February to July there were frequent references to food 'scarcity' as a cause of delays in provisioning. For example, in 1686 a Captain Woodfine 1686 stated that he is unable to move on Whydah until he has sufficient corn and there is none to be had except at inflated prices[24]. Likewise a Captain Jefferies in 1692 mentioned he is unable to move on to the Bight of Benin for want of sufficient corn[25]. Local forts, which were often suppliers of slaves as well as provisions, were equally affected by insecure food supplies. For example, the factor at Accra stated in 1681 that he was unable to buy more slaves as there was no corn to be had[26].

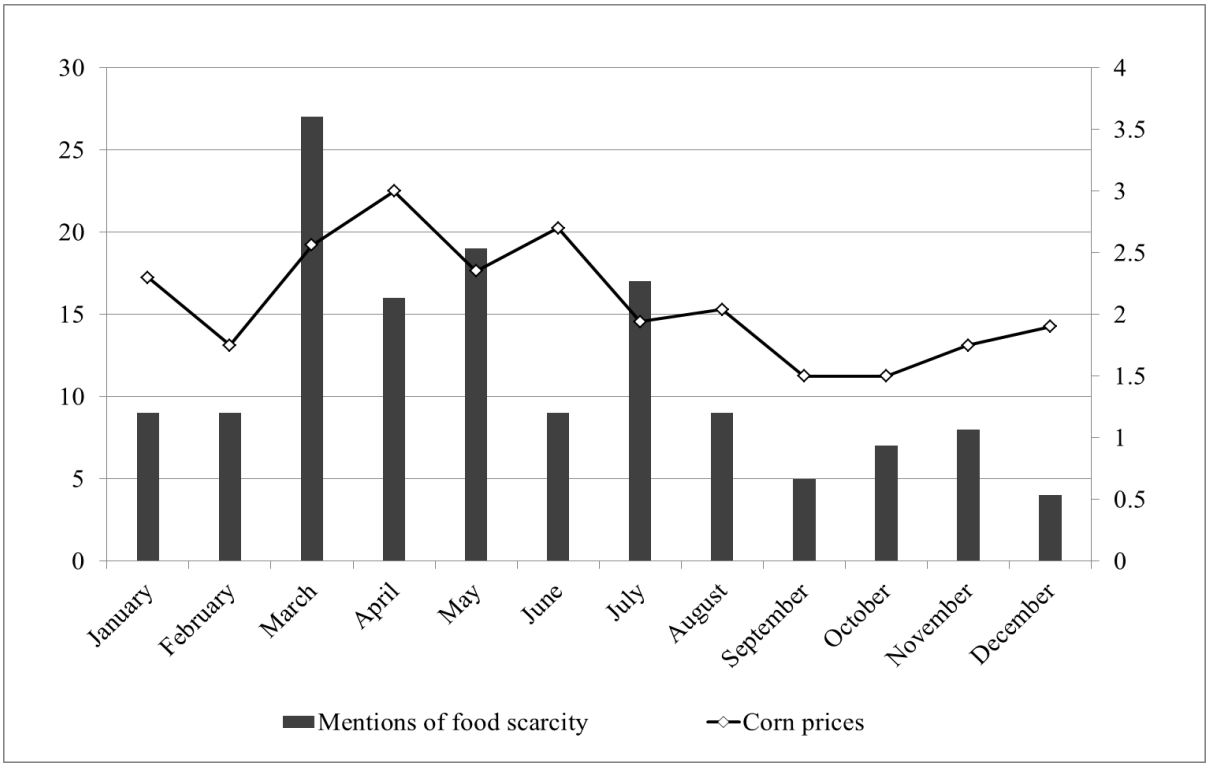
Indeed, unless captain's were able to time their arrival during the latter months of the year they could expect serious delays in their voyage, or higher prices for their provisions. Figure 6 shows that the average monthly prices of corn coincided with numerous mentions of

[24] May 16 1686 Ref 904 Law Book 2
[25] November 13 Ref 10 Law Book 3
[26] Octoer 25 1681 Ref 417 Law Book 1

scarcity. The reasons for failing supplies were not only related to the seasonality of harvests. Local wars and disputes as experienced by the Egya fort, near modern day Cape Coast in Ghana[27], could put a complete ban on food supplies reaching the coastal forts. And it was not only the Gold Coast or the Bight of Benin that experienced this problem. In Senegambia Searing (2003, p. 81) notes that food shortages caused by warfare or drought were often the biggest 'bottleneck' in the slave purchasing chain.

If slave captains were regularly confronted with shortages of foodstuffs, even when they had locally based buyers and during a period of relatively low slave embarkations in comparison with the latter 18th century, then private traders may have begun to pursue a different provisioning strategy. It is also possible, as we will suggest in section 6, that during the second half of the 18th century the relative price advantage of African foodstuffs deteriorated for two reasons. Firstly, a rapidly growing demand for provisions may have outpaced supply capacity and secondly, a rapid upward drift of slave export prices may have inflated African food prices in its wake.

Figure 5: Monthly no. of mentions of provisioning problems in RAC correspondence (left-hand axis) and average monthly corn prices in gold ackies, 1680 - 1699



Source: Own calculations based on the letters between British forts and slave ships compiled by Law (1997).
Note: Gold ackies were an African coastal currency unit worth c. 1 British shilling (12 pence).

[27] March 8 1687 Ref 647 Law Book 2

This may also have been one of the motives for British merchants to shift part of their trade towards the Biafra region, despite the higher instances of disease induced mortality and the perceived low quality of the slaves procured there. The yam harvest was only once a year which certainly increased pressures on captains to time their voyages more accurately, but it squared with the widely held belief among traders that slaves were more likely to prosper if fed with local foodstuffs (Behrendt 2001)[28]. Moreover, once obtained, yams can be stored for long periods of time and the densely populated regions around the major slaving ports were able to significantly increase production during this period to meet the increased demand (Northrup 1978, Latham 1973). Large supplies of yams at low prices may thus have reduced the time spent on the coast and eventually raised cost efficiency, despite higher slave mortality rates during the Middle Passage[29].

Finally, it appears that the shift from British slavers towards European provisions accelerated during the final decades before the abolition. The British slave vessels sailing off to the Gold Coast in the 1790s and 1800s (4 obs.), took over 80% of total provisions from their home ports. It may indicate that all Atlantic merchant shipping during this period were significantly more vulnerable due to the heightened and prolonged periods of war, including lots of naval attacks. This may have led to a greater aversion to risk unforeseen waiting times at the African coast.

6. The development of relative slave provisioning prices

This section is devoted to the question how the price of slave provisions developed relative to the price of slave purchases at the African coast. We make use of the fact that European-sourced provisions were, on average, more expensive than African-sourced provisions, but also less volatile, to estimate an upper-benchmark of relative provisioning prices across the 18th century. We calculate the price of 225 daily slave rations consisting of 350 grams of barley, 100 grams of horse-beans, 100 grams of rice and 0,01 litre of palm oil. This ration offers slightly over 2,000 Kcal and about 80 grams of protein. The 225 day-rations are consistent with Eltis' assumption that slaves spend, on average 4.5 months waiting at or near the coast and 3 months on board of the slave ship. We take annual price-series of barley, beans and rice from Clark (2004) with a 30% mark-up. Lacking price-series for palm-oil we add a fixed price based on an average per gallon price obtained from African price data in our sample.

To check the trend in British provisioning prices over the 18th century, we also constructed a time series for barley, beans and rice on Dutch markets collected by Posthumus (1946). The Dutch prices series has large gaps, but the index-trend shows that Dutch provision prices kept pace with British food price developments (see Appendix Table 4).

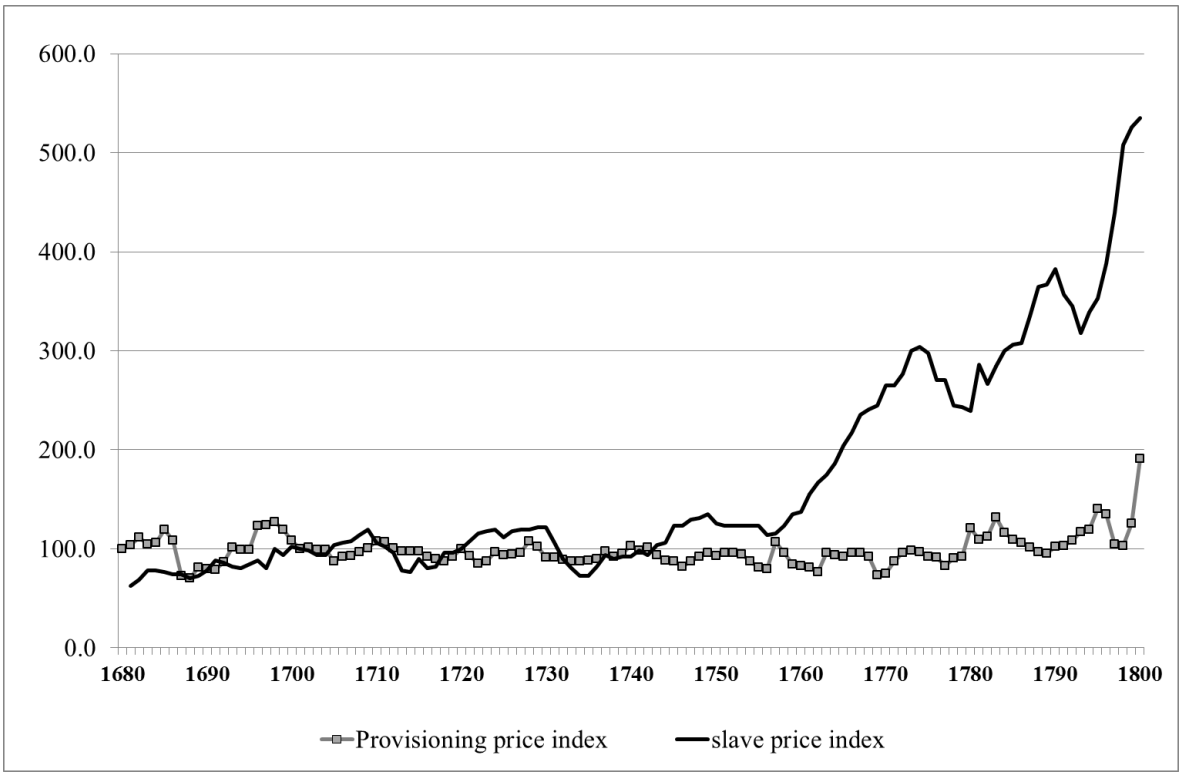
[28] Behrendt (2001) also quotes a merchant in 1806 stating that his ship should arrive between September and February/March because yams were "the favourite food of all the Eboe negroes" p184.

[29] By the 1780s ships going to Bight of Biafra spent less time loading slaves than at any other major region of slave embarkation (appendix 3). Lovejoy & Richardson (2004) note that faster loading times were one reason, along with other such as superior credit arrangements, why slave traders began to favour what was considered a 'horrid hole' with less desirable slaves and higher rates of mortality for both captives and crew p378 – 380. However they do not examine the role that better food supplies may have played.

Slave prices for the long 18th century are taken from the same source as Eltis (2013), for 1681-1700 the data are from Eltis (2000) and for 1701-1800 the data are from Richardson (1991), all in current prices.

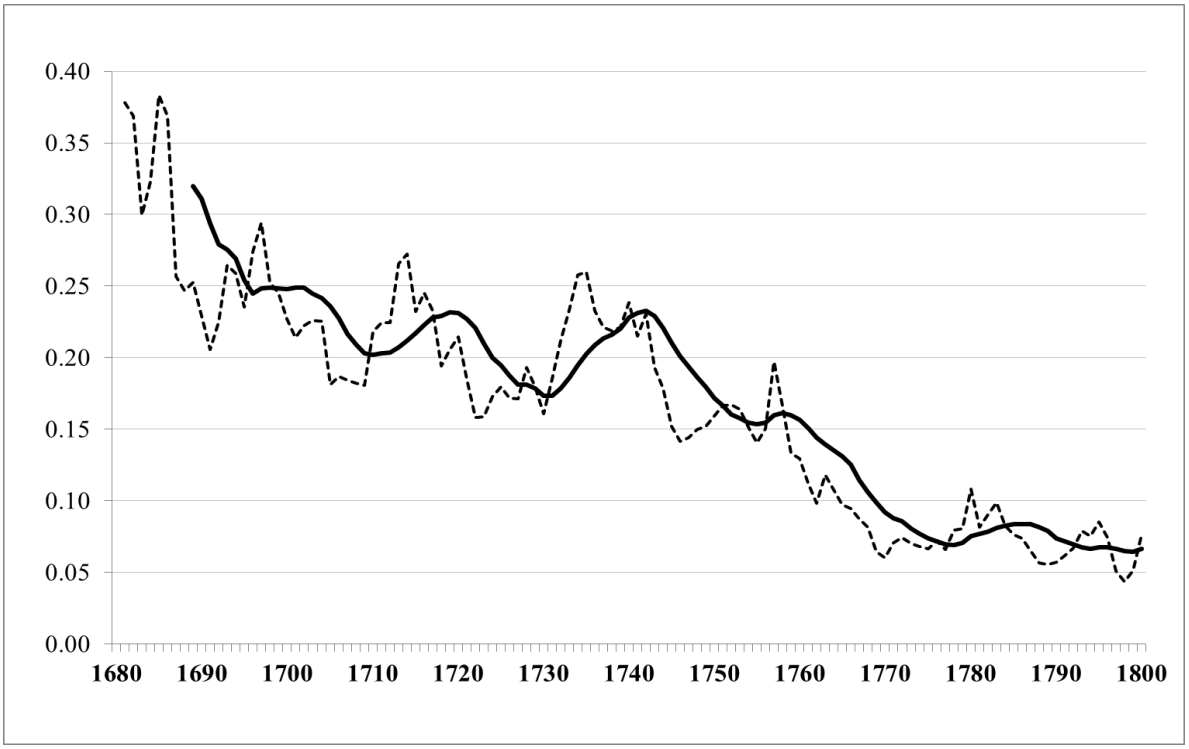
Figure 6a shows the index-series of slave purchasing prices and slave provisioning prices (1701 = 100). Figure 6b shows the slave provisioning prices (i.e. 200 day rations) as percentage share of the slave purchasing prices. Taken together these graphs reveal an important development in relative prices that further helps us understand our finding that European slave traders increased their reliance on European provisions over the course of the 18th century. In the mid-1750s the slave purchasing prices started to rise exponentially, from an index level of 114 in 1756, to a staggering 535 in 1800. Slave export prices experienced a temporary drop in the 1770s and 1790s, but they never fell back to pre-1750 levels. Provisioning prices remained far more stable over the long run. Although there is a clear upsurge from 1770 to 1800, most of the rise involved a price shock associated with the Napoleonic wars in the 1790s, when the index shut up from 103 in 1798 to 191 in 1800. But unlike the rise in slave prices, this was clearly not a structural trend-break.

Figure 6a: Index-series of slave purchasing prices (African coast) and slave provisioning prices (British staples), 1680-1800 (1701 = 100)



Source: Food price index based on Clark (2004); Slave price index based on Eltis (2000) and Richardson (1991).

Figure 6b: Slave provisioning price (225 day-rations) as percentage share of average slave purchasing price, 1680-1800 (10-year moving average in bold)



Source: see figure 6a.

The implication of these diverging price developments is, as figure 7b shows, that the relative costs of slave provisioning fell over the course of the 18th century, from about 20%-25% in the chartered companies era, to about 5-10% in the closing decades of the 18th century. This trend indicates that, in so far relative prices had played a role in determining where to buy provisions (Europe or West Africa), the impact of this choice on the overall profit margin of slave trading companies decreased. Since we have no accurate information on the long-term price trends of African food staples, it is impossible to assess the question whether European provisions had also become cheaper than African provisions in absolute terms, but it is highly likely that the relative gap narrowed, as African provisioning prices must at least to some extent have been affected by the price inflation of African slaves. Hence, European provisions became an ever more attractive alternative in slave ship provisioning strategies.

7. Did the Atlantic slave trade boost West African commercial agriculture?

It is now time to feed our results back into Eltis' calculations of the total value of African-sourced provisions. We take the total number of slaves embarked in the period 1681-1807 according to nationality of the slaver (flag of the ship) and insert our estimates of the share of non-African provisions in total provisioning requirements. For British slavers we assume 5%

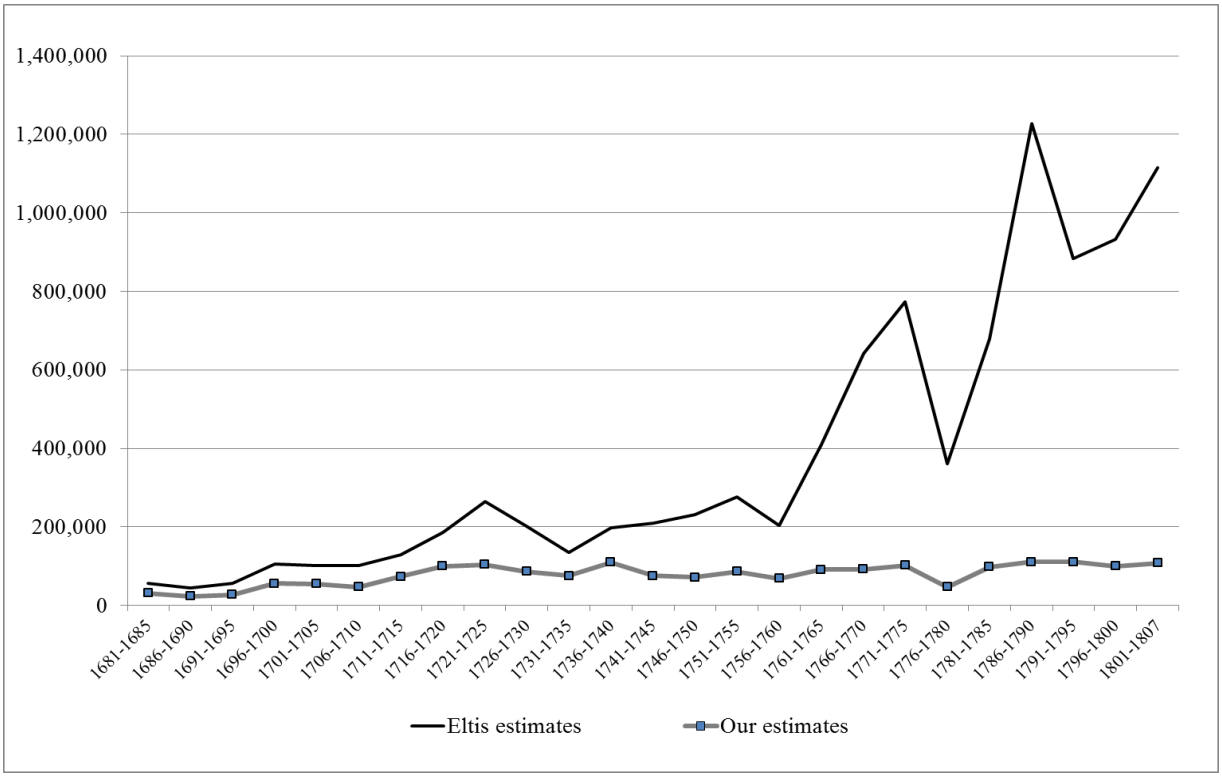
for 1680-1740 and a linear increase to 50% for 1740-1807. For US vessels we assume the same. For Dutch slavers we assume 80% for the WIC era up to 1740 and 90% for the MCC traders after 1740. For French vessels we assume 50% up to 1740 and 75% thereafter, and for Danish/Baltic ships we assume 50% before 1740 and 66% thereafter. For Portuguese/Brazilian slavers, who traded mainly at the WCA coast, we insert the rather conservative estimate that 50% of their provisions were sourced from the New World during the entire century. For Spanish/Uruguayan slavers we assume the same. For ships from other nations (a negligible proportion) we assume that 30% of provisions were taken in at the home port.

We then replace Eltis' assumption of a fixed 25% provisioning costs share of slave purchasing prices by the shares reported in Figure 6b. In so far African provisions continued to offer a cheaper alternative, these shares represent an upper-benchmark estimate of the relative provisioning prices. We maintain Eltis' assumptions for converting the value of exchange commodities f.o.b. to c.i.f. (multiplying f.o.b. series by 2) and also maintain the mark-up of 3% for the consumption of African provisions by slave ship crews.

Figure 7 compares our estimates of the overall slave-trade induced demand impulse on West African commercial agriculture to the estimates offered by Eltis for five year-intervals. The difference is vast. Contrary to Eltis provisional estimates we conclude that the order of magnitude of slave trade induced demand has been around £70,000 per year in the first half of the 18th century, to increase to c. £100,000 – £125,000 per year during the heydays of the slave trade in the 1780s to 1800s. Our estimates are a staggering 80% lower than Eltis' estimates for two principle reasons. First, the non-African share in slave provisions was significant and rose up to 50% at the end of the 18th century. Second, Eltis estimates were seriously inflated by taking a fixed 25% of rapidly rising slave purchasing prices after the mid-1750s.

Our alternative estimates also shed a different light on the commodity export boom of the 19th century. Compared to West African exports of staple foods the commercial transition did imply a substantial expansion of African international trade. We are not arguing that the rise of West African markets for slave ship provisions was unimportant in light of what was yet to come, but its importance was confined to a few key areas that supplied the lion-share of foodstuffs. In those areas in Senegambia, Sierra Leone, the Gold Coast and Biafra where the slave trade induced the development of coastal food markets, it may in fact have created the ideal stepping stone for the 19th century commercial transition. In those areas where markets for food provisions remained underdeveloped, i.e. WCA and Benin, the commercial transition did not gain steam, while it did in the Senegambia, the Gold Coast and Biafra. Indeed, the historical connections between both types of commercial development offer an intriguing subject for further investigation.

Figure 7: Our estimates of the average annual value of African-sourced provisions compared to Eltis estimates, 1681-1807, in constant British £ of 1700



Sources: Eltis 2013 and for our own estimates see text.

8. Conclusion

In this paper we have asked the question to what extent the increase of demand for food provisions by European slave ships may have boosted West African commercial agriculture in the long 18th century. Exploring the provisioning strategies of British, French, Dutch and Danish slave ships, we have shown that a considerable share of the calories and proteins required to maintain African slaves were supplied from Europe or the Americas. We have also shown that the relative costs of European-sourced slave provisions remained fairly stable, while slave purchasing prices quintupled between 1755 and 1807. Hence, the Atlantic slave trade played a smaller role in the development of West African commercial agriculture than previous studies have suggested and was definitely much smaller than the aggregate value of West African commodity exports in the mid-19th century.

Apart from the orders of magnitude, our analysis has also revealed two interesting patterns of variation in slave ship provisioning strategies. We have shown that British slavers relied to a much larger extent on African food markets than continental slavers. We have hypothesized that the main reason for this difference is that British slavers had more secure access to provisions, especially because a string of trading forts on the West African coast reduced the risk of failing supplies. We have also observed notable differences in the size of food exports between various West African regions of embarkation. While some structural differences may have been caused by different ecological conditions for the production of

food surpluses, it is also likely that political or institutional constraints have held back the development of coastal food markets, especially in the case of Benin. A deeper exploration of these patterns of variation contain promises of a deeper understanding of the economic impact of the slave trade as well as the long-term effects it had on the commercial transition of the 19th century.

Appendix Table 1: Pending

Appendix Table 2: Weights, measures and nutritional contents used in our study

Food type	Quantity Measure	Kg	Kcal / kg	Protein / kg
Barley	Lb (Br)	0.45	3500	82
Barly	Lb (Middleberg)	0.47	3500	82
Barley	Sack	60.00	3500	82
Barley	Litre	6.20	3500	82
Barley	Last (Muddle,Schepel)	2000.00	3500	82
Beef flesh	Hogshead (Hhd)	228.82	1150	220
Bread White	Hundred Weight (cwt)	50.85	3410	77
Cassava flour	Bushel	0.00	3440	16
Cassava flour	Alquiers	14.00	3440	16
Corn Ears/Cobs	Piece	0.00	2450	20
Fish, dried, salted	Lbs (Br)	0.45	2250	470
Kidney beans, dry	Quarter	12.71	3330	236
Kidney beans, dry	Bushel	0.00	3330	236
Kidney beans, dry	Ton	1016.96	3330	236
Kidney beans, dry	Sack	60.00	3330	236
Kidney beans, dry	Last (Muddle,Schepel)	2133.80	3330	236
Maize flour, whole	Lb (Br)	0.45	3530	93
Maize flour, whole	English Chest	101.70	3530	93
Maize flour, whole	Dutch Chest	104.83	3530	93
Maize flour, whole	Stekan	1.77	3530	93
Millet, bulrush	Stekan	1.77	3410	104
Millet, bulrush	Chest	104.83	3410	104
Palm oil	Litres	1.00	8840	0
Palm Oil	Gallon	3.50	8840	0
Palm Oil	Aume	0.00	8840	0
Palm Oil	Anker	0.00	8850	10
Pigeon peas, dry	Lb (Br)	0.45	3430	217
Rice Polished	Lb (Br)	0.45	3610	65
Rice Polished	Lb (Middleberg)	0.47	3610	65
Rice Polished	Alquiers	14.00	3610	65
Rice Polished	Barrels	81.72	3620	75
Wheat, whole	Hundred Weight (cwt)	50.85	3230	126
Wheat, whole	Hundred Weight (cwt)	50.85	3230	126
Yam	Piece	7.50	1180	15
Plantain	Piece	0.30	1350	12

Appendix Table 3: Average time spend on board of a slave vessel per region of embarkation, 1681-1807, 20-year time intervals

	Senegambia TAC				Senegambia MP				Senegambia Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*Sd*	*N*	*TAC + MP*
1680 - 1700	**91**	80	41	13	**42**	36	19	31	**133**
1701 - 1720	**60**	61	24	12	**47**	43	15	28	**106**
1721 - 1740	**132**	104	83	69	**52**	42	48	70	**184**
1741 - 1760	**116**	83	85	80	**47**	43	20	65	**163**
1761 - 1780	**90**	62	81	58	**53**	42	41	71	**143**
1781 - 1800	**79**	63	55	91	**45**	38	26	117	**124**
	Sierra Leone TAC				Sierra Leone MP				Sierra Leone Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*Sd*	*N*	*TAC + MP*
1680 - 1799	**160**	155	65	4	**56**	48	21	10	**216**
1701 - 1720	**49**	49	33	2	**65**	56	26	4	**114**
1721 - 1740	**137**	117	30	3	**56**	56	19	5	**193**
1741 - 1760	**186**	141	133	17	**60**	52	24	15	**246**
1760 - 1780	**244**	227	168	15	**55**	54	18	25	**298**
1781 - 1800	**192**	168	116	54	**44**	43	13	76	**235**
	Windward Coast TAC				Windward Coast MP				Windward Coast Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*S.D*	*N*	*TAC + MP*
1680 - 1700	**ND**	ND	ND	ND	**ND**	ND	ND	ND	**ND**
1701 - 1720	**29**	29	23	2	**60**	59	17	4	**88**
1721 - 1740	**55**	55	8	2	**80**	80	34	2	**135**
1741 - 1760	**172**	173	55	23	**70**	61	23	22	**242**
1761 - 1780	**232**	204	95	20	**74**	62	29	21	**306**
1781 - 1800	**211**	161	142	38	**52**	50	16	46	**263**

	Gold Coast TAC				Gold Coast MP				Gold Coast Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*S.D*	*N*	*TAC + MP*
1680 - 1700	**107**	95	76	8	**78**	73	22	15	**184**
1701 - 1720	**133**	87	154	63	**68**	63	20	119	**201**
1721 - 1740	**117**	105	85	110	**82**	75	30	90	**199**
1741 - 1760	**134**	120	91	86	**94**	85	56	104	**229**
1761 - 1780	**130**	111	76	156	**84**	77	33	151	**214**
1781 - 1800	**147**	124	109	204	**68**	63	27	240	**215**
	Bight of Benin TAC				Bight of Benin MP				Bight of Benin Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*S.D*	*N*	*TAC + MP*
1680 - 1700	**73**	53	61	41	**91**	87	26	70	**164**
1701 - 1720	**96**	85	85	137	**85**	76	39	175	**182**
1721 - 1740	**113**	99	58	184	**97**	94	31	196	**210**
1741 - 1760	**152**	137	74	120	**117**	112	37	126	**269**
1761 - 1780	**191**	177	88	168	**100**	99	32	149	**291**
1781 - 1800	**130**	117	72	96	**64**	52	32	244	**194**
	Bight of Biafra TAC				Bight of Biafra MP				Bight of Biafra Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*S.D*	*N*	*TAC + MP*
1680 - 1700	**ND**	ND	ND	ND	**93**	85	28	16	**ND**
1701 - 1720	**ND**	ND	ND	ND	**91**	83	32	23	**ND**
1721 - 1740	**72**	72	0	1	**127**	94	80	3	**199**
1741 - 1760	**118**	128	63	17	**86**	82	24	19	**203**
1761 - 1780	**155**	127	114	42	**78**	78	25	57	**234**
1781 - 1800	**103**	91	76	195	**66**	60	32	243	**169**

	West Central Africa TAC				West Central Africa MP				West Central Africa Total Mean
Decades	*Mean*	*Median*	*S.D*	*N*	*Mean*	*Median*	*S.D*	*N*	*TAC + MP*
1680 - 1700	**78**	56	58	5	**84**	83	35	6	**162**
1701 - 1720	**115**	137	55	17	**58**	59	17	17	**174**
1721 - 1740	**139**	131	82	103	**58**	51	25	81	**197**
1741 - 1760	**179**	152	109	240	**49**	49	16	85	**228**
1761 - 1780	**163**	156	90	401	**58**	56	25	259	**222**
1781 -1800	**139**	133	71	361	**53**	50	17	488	**192**

Appendix Table 4: Price index of staple food basket (barley, beans, rice) on English and Dutch markets, 1681-1800 (1701 = 100)

year	Britain	NL	year	Britain	NL	year	Britain	NL
1681	103.9		1721	93.1		1761	81.2	
1682	111.5		1722	85.4	75.2	1762	76.6	
1683	104.2		1723	87.4		1763	96.1	
1684	106.6		1724	96.7		1764	93.6	
1685	119.5		1725	93.9		1765	92.4	
1686	108.2	86.4	1726	94.3		1766	96.1	
1687	73.0		1727	95.8		1767	96.1	
1688	70.1	86.2	1728	108.1	85.1	1768	91.9	
1689	81.1	94.9	1729	101.9		1769	73.7	
1690	79.8		1730	91.3		1770	74.7	
1691	79.1		1731	91.6	73.0	1771	87.6	
1692	86.5	112.0	1732	89.4		1772	95.8	
1693	101.7		1733	87.6		1773	98.6	
1694	99.6		1734	87.5		1774	96.7	
1695	99.2		1735	88.1		1775	92.3	
1696	122.9		1736	89.5		1776	91.5	112.4
1697	123.9		1737	97.4		1777	83.1	104.0
1698	127.2		1738	92.1	83.2	1778	91.0	111.6
1699	119.1		1739	95.4	82.9	1779	91.8	133.0
1700	108.2		1740	102.8		1780	120.9	129.6
1701	100.0	100.0	1741	98.5		1781	109.5	137.8
1702	101.9		1742	101.5		1782	112.5	124.8
1703	99.3		1743	93.8		1783	131.6	
1704	99.1		1744	88.4		1784	116.0	139.2
1705	87.9	103.5	1745	87.9		1785	109.0	119.5
1706	92.5		1746	81.8		1786	105.9	
1707	92.9		1747	87.2		1787	101.4	122.3
1708	96.9		1748	92.1		1788	96.5	116.3
1709	100.9		1749	96.1		1789	95.3	114.8
1710	108.0		1750	93.3		1790	102.1	
1711	107.0		1751	96.2		1791	103.1	
1712	100.8		1752	96.4		1792	108.5	
1713	97.3		1753	94.6		1793	117.0	
1714	97.3		1754	87.5		1794	119.1	
1715	98.0		1755	81.0		1795	140.3	
1716	92.2		1756	80.0		1796	134.6	
1717	89.5		1757	106.6		1797	104.7	
1718	87.2	100.2	1758	96.0		1798	103.4	
1719	92.4		1759	84.1		1799	125.7	
1720	100.3		1760	83.1	104.1	1800	191.3	

Appendix Table 5: Eltis' estimates of the five-year average annual value of African-sourced provisions in the Atlantic slave trade, 1681-1807 (all estimates in constant British Pound sterling of 1700)

	Average annual value of slaves purchased (fob Europe/Americas)	Average annual value of African-sourced provisions (fob Europe/Americas)	Average annual value of African-sourced provisions (cif Africa)	Average annual value of African-sourced provisions for slave ship crews	Average annual value of African-sourced provisions (total)
	1	**2**	**3**	**4**	**5**
1681-1685	107,587	26,897	53,794	1,614	55,407
1686-1690	86,610	21,653	43,305	1,299	44,604
1691-1695	110,731	27,683	55,366	1,661	57,026
1696-1700	202,723	50,681	101,362	3,041	104,402
1701-1705	196,478	49,120	98,239	2,947	101,186
1706-1710	196,241	49,060	98,121	2,944	101,064
1711-1715	248,689	62,172	124,345	3,730	128,075
1716-1720	361,423	90,356	180,712	5,421	186,133
1721-1725	512,750	128,188	256,375	7,691	264,066
1726-1730	392,838	98,210	196,419	5,893	202,312
1731-1735	262,800	65,700	131,400	3,942	135,342
1736-1740	385,436	96,359	192,718	5,782	198,500
1741-1745	405,049	101,262	202,525	6,076	208,600
1746-1750	449,280	112,320	224,640	6,739	231,379
1751-1755	537,147	134,287	268,574	8,057	276,631
1756-1760	396,019	99,005	198,010	5,940	203,950
1761-1765	796,786	199,197	398,393	11,952	410,345
1766-1770	1,246,728	311,682	623,364	18,701	642,065
1771-1775	1,503,464	375,866	751,732	22,552	774,284
1776-1780	698,969	174,742	349,485	10,485	359,969
1781-1785	1,317,247	329,312	658,624	19,759	678,382
1786-1790	2,381,871	595,468	1,190,936	35,728	1,226,664
1791-1795	1,717,428	429,357	858,714	25,761	884,475
1796-1800	1,812,184	453,046	906,092	27,183	933,275
1801-1807	2,165,957	541,489	1,082,979	32,489	1,115,468
1681-1807	**762,158**	**186,494**	**372,989**	**11,190**	**384,179**

Source: Eltis (2013) Table 1.2, p. 39; Column 1 is taken from Table 1.1, p. 33.

Appendix Table 6: Our estimates of the five-year average annual value of African-sourced provisions in the Atlantic slave trade, 1681-1807 (all estimates in constant British Pound sterling of 1700)

	Average annual value of slaves purchased (fob Europe/Americas)	Average annual value of slave provisions (fob Europe/Americas)	Average annual value of African-sourced slave provisions (fob Europe/Americas)	Average annual value of African-sourced provisions (c.i.f) (OUR ESTIMATES)	Average annual value of African-sourced provisions (ELTIS)
	1	**2**	**3**	**4**	**5**
1681-1685	107,587	21,517	15,476	**31,416**	55,407
1686-1690	86,610	17,322	11,401	**23,144**	44,604
1691-1695	110,731	22,146	13,604	**27,615**	57,026
1696-1700	202,723	40,545	27,655	**56,139**	104,402
1701-1705	196,478	37,321	26,978	**54,766**	101,186
1706-1710	196,241	33,229	23,058	**46,808**	101,064
1711-1715	248,689	52,959	36,150	**73,385**	128,075
1716-1720	361,423	70,203	49,472	**100,427**	186,133
1721-1725	512,750	77,890	51,084	**103,701**	264,066
1726-1730	392,838	61,213	42,554	**86,385**	202,312
1731-1735	262,800	53,645	37,233	**75,584**	135,342
1736-1740	385,436	77,616	54,050	**109,722**	198,500
1741-1745	405,049	69,836	37,087	**75,287**	208,600
1746-1750	449,280	59,659	34,987	**71,025**	231,379
1751-1755	537,147	75,379	42,247	**85,762**	276,631
1756-1760	396,019	54,674	33,894	**68,806**	203,950
1761-1765	796,786	75,497	44,862	**91,069**	410,345
1766-1770	1,246,728	86,016	45,524	**92,413**	642,065
1771-1775	1,503,464	93,452	49,981	**101,462**	774,284
1776-1780	698,969	50,510	23,145	**46,984**	359,969
1781-1785	1,317,247	100,718	48,416	**98,284**	678,382
1786-1790	2,381,871	130,287	54,547	**110,730**	1,226,664
1791-1795	1,717,428	112,396	54,369	**110,370**	884,475
1796-1800	1,812,184	95,491	49,286	**100,051**	933,275
1801-1807	2,165,957	108,298	53,167	**107,929**	1,115,468
1681-1807	**762,158**	**69,383**	**39,223**	**79,622**	**421,430**

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