GUNS-FOR-SLAVES:

THE 18TH CENTURY BRITISH SLAVE TRADE IN AFRICA*

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ABSTRACT

The transatlantic slave trade was a triangular trade that touched Europe, Africa and the Americas. The elasticity of supply of enslaved Africans is at the center of our understanding of each of these episodes. It helps explain the structure and scale of early Atlantic trade; it is at the center of explanations of the transition from indenture servitude to slavery in the Americas; and it helps estimate the depth of the social upheaval in Africa. In this paper I estimate the first enslaved African export supply functions. Data come from the 18th century British Triangular Trade. Econometric specifications are informed by three conceptions of the supply process: indigenous warfare, economic incentives and guns-for-slaves. Two-stage least squares and instrumental variables estimation produce strong support for the guns-for-slaves conception. Rather than being a stable price-elastic supply function, as assumed by scholars working on both sides of the Atlantic, guns and gunpowder shifted out the supply function in a systematic way, producing what appeared to American planters as an unlimited supply of African slaves, and what in Africa became underdevelopment.

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INTRODUCTION

Evidence is mounting that the transatlantic slave trade had profound, lasting and unequal affects on the Atlantic economies it touched. Slave-based commerce spawned the Atlantic trade that fueled the 18th century economic take-off in Europe. (Inikori, 2002; Acemoglu, Robinson and Johnson, 2005). Today, American economies with a history of slavery have more inequality and lower GDP per capita (Sokoloff and Engerman, 1997; Engerman and Sokoloff, 2002; Nunn, forthcoming, 2008). And African economies that exported more slaves per square mile in the past now have lower GDP per capita as well (Nunn, 2008). The provocative theses advanced by Eric Williams in Capitalism and Slavery (1944) and Walter Rodney in How Europe Underdeveloped Africa (1972) are more alive today than ever.

The responsiveness of African economies and states to the New World demand for its people – what I call the enslaved African export supply function – is a central variable in our understanding of each of these episodes. It helps explain the volume of the slave trade, the location and extent of slavery in the Americas, and the impact of the slave trade on African economies and societies. For example, economic historians working on the American side of the Atlantic invoke an elastic supply function to explain the transition from indenture servitude to African slavery in the Americas. The popular exposition is found in the influential textbook by Atack and Passell, A New Economic View of American History (1994, pp. 40-51):

> "The higher the American wage, the greater the number of indentured servants willing to commit…. If the wage rises to W^2 -- the cost of

> securing and importing slaves -- then slave labor will be import. The supply of slave labor is perfectly elastic at any rate above the cost of importation -- that is, from the slavers' perspective, there was a limitless supply of potential slaves in Africa, theirs for the taking, subject only to the costs of transportation…. (O)nce the wage rate rises to W^2, all the new labor is supplied by slaves (p. 48)."[1]

On the African side of the Atlantic, economic historians have tried to explain why so many enslaved Africans were available at such low prices. Thomas and Bean (1974) conceptualize the supply process as a common-resource fishery, where over-exploitation of the "resource" is the typical result.

> "In the African fishery of men there were no property rights in the slave until a human being had been captured. There were a large number of fishermen (depending on circumstances the "fisherman" might be a lone kidnapper or an army). There was also free entry into the fishery… (p. 909).

Gemery and Hogendorn (1974) model the supply process as a "vent-for-surplus," where improved technologies of capture and marketing allowed New World demand to reach surplus populations in the interior of Africa.

> [T]he 'natural resources' of the trade, the unfortunate blacks living in smaller tribal communities, were numerous and unprotected. In short, it is suggested that the rapid growth of the overseas trade in slaves awaited only the great increase in demand that contact with Europe and the Americas would bring (p. 236)."

Yet when one looks at the literature one finds almost no empirical evidence for any of this.

[1] Galenson's (1981, 1991) telling is more-nuanced and historical, but the underlying economic logic is the same. Also see Solow and Engerman, (1987, pp. 15, 73).

A few estimates of supply elasticity exist, but these are average time-series correlations between quantity and price over long periods of time, and each identifies the supply function by *assuming* it is stable over time. These estimates range from 35 (Gemery and Hogendorn, 1977) to approximately one (Curtin, 1975, ch. 4; LeVeen, 1975). By this method, the data in Figures 4 and 5 can generate a very elasticity supply function. Between 1700 and 1750 the number of enslaved Africans leaving Africa tripled, but without any appreciable increase in price.

This was the historical experience that led New World planters to believe supplies of African slaves were unlimited, but the experience is also consistent with a constantly shifting supply function. The distinction is important, especially for an evaluation of the impact of the slave trade on African economies. A stable and elastic supply function implies that the structure of African societies encouraged the capture and export of many more people for a little more money. A shifting supply function points to an exogenous source of supply growth -- like famine, military escalation, population growth, declining productivity in Africa, or improved efficiencies in the technology and organization of slave capture and marketing.

In this paper I econometrically identify and estimate several enslaved African export supply functions that allow me to address these issues. My hope is to also integrate the histories of African, European and American economies. I use data from the 18th century British Triangular Trade. Prices and quantities are gotten from transactions between British and African slave traders operating on the coast of Africa between 1699 and 1807. I identify the supply-side relationships in these transactions by controlling for demand shifters like British exports to Africa, American sugar production, European sugar prices and European wars.

These data do not support the view that the enslaved African export supply function was stable and price elastic. Instead, I find that the supply function shifted out over time in a systematic way, primarily because British gunpowder exports to Africa had a multiplier effect. Gunpowder was not only exchanged for slaves; it was also used to capture slaves. This result is large, significant and robust across a variety of specifications and robustness

checks. This constitutes strong support for the guns-for-slaves hypothesis advanced by scholars like Basil Davidson (1961, pp. 242; 1968, 193, 69-70), Joseph Inikori (1977) and Gemery and Hogendorn (1974). It is also consistent with the view that today's relative underdevelopment of Africa is tied to the persisting negative effects of the slave trade (Nunn, 2007, 2008; Rodney, 1982).

The first part of this paper reviews three distinct conceptions of the slave supply process in Africa. The second part describes the data I use. The third part estimates the structure of the 18th century British slave trade. The fourth part concludes and summarizes.

I. THE POLITICAL ECONOMY OF SLAVE CAPTURE AND EXPORT

One can find in the literature at least three distinct conceptions of the slave supply process in Africa. Each conception is probably an accurate depiction of some events in some places at some times. The empirical question is the relative importance of each in explaining the magnitudes and variations in slave exports across time and place. This study focuses on variations over time.

The first conception is the political warfare model which argues that most African slaves were by-products of indigenous political struggles unrelated to the transatlantic slave trade (Curtin, 1975; Engerman and Genovese, 1975; Thornton 1998, ch. 4; Klein, 2007, pp. 66-73). According to this view, one should think of enslaved Africans as captives of wars who were exported rather than killed. They are sometimes called "joint-products of war," sometimes called "stolen goods," but always thought of as the products of activities unrelated to the American demand for slave labor, and always as people with zero or very low opportunity cost in African economies.

The political warfare model is depicted in Figure 1. Supply is insensitive to price and exogenously determined by local political factors. Price allocates a politically generated supply among competing European ships docked off of the coast at any point in time.

This conception is extremely inflexible, especially the implication that European slave prices had no influence on the number of captives showing up on the coast. Slave raiders (aggressors interested in people but not land) raided for profit. Even wars of territorial conflict and expansion (aggressors interested in people and land) were often fought for economic gain and surplus extraction (taxes, tolls, rents and tribute). It is hard to imagine a ruling class overlooking the export value of captives. Asante required slaves as tribute from its northern territories which it then sold to Europeans (Wilks, 1975, pp. 66-68, 165-177).

African wars would have been fought had there been no export market for captives, but some authors come close to arguing that the many wars of the slave trade era reflect the normal course of events in Africa. In the 10th printing of his popular book The Atlantic Slave Trade (2007), Herbert S. Klein concludes his discussion of this with the following summary:

> "It is generally agreed by most scholars that only one or two of the major civil or interstate wars in the late eighteenth century and early nineteenth century may have been influenced by this demand for slaves, but that the rest can be best explained by the usual problems of succession in highly centralized regimes, migration of people for purposes of conquest of new resources, or conflicts for control of territories and economies (p. 72)."

I believe this view is no longer tenable. The evidence presented in this paper shows clearly that much of the war and raiding for slaves was caused fundamentally by the transatlantic slave trade and the associated trade in firearms and gunpowder. In fact, it is hard for me to imagine slave raiding emerging autonomously as an organizing socio-economic institution within the African context.

Economic considerations also apply to capture and transport activities. When wars and raids were carried out with an eye to sell captives, private costs could be substantial. These include lives and resources lost during incursions and the cost of transporting captives to the coast (food, guards, shackles, tolls, taxes, etc). Over time, capture and marketing activities

became specialized regionally, with coastal states emerging to extract rents of location as the trade passed through to the coast (Richardson, 1995). Khan (2002, p. 56) collects estimates of these costs and finds that coastal prices exceeded interior prices by as much as 400%.

The second conception of the African supply process incorporates these economic calculations and explicitly considers the opportunity costs and competing demands for captives within Africa. An example is the export supply model formulated by LeVeen (1975). In this model the export and domestic labor markets are linked through the export slave price. Raiders had to decide between domestic and international sale, and this decision was influenced by the export price of captives relative to domestic values. Captives in excess of domestic demand were exported. Even if capture activities were insensitive to price, exports would not be.

These relationships are depicted in Figure 2. This particular depiction assumes that capture is still insensitive to price but it need not be. My point is to show how considerations of domestic economies make export quantities more responsive to price. A lower export price increases African employment and reduces the number of captives available for export. A higher export price covers higher capture and transport costs, and allows the catchment zone to move further inland.[2] A decline in the profitability of employing labor domestically reduces the African demand for labor and shifts out the enslaved African export supply function. These ideas also inform the models formulate by Darity (1982) and Nunn (2007).

The third conception is guns-for-slaves. It is often viewed as a cycle. Africans purchase guns from Europeans to capture people who are sold to Europeans for more guns to capture more people, ad infinitum. Inikori (1977) finds direct evidence of guns-for-slaves in the transactions of traders on the west coast of Africa:

> "These imports were due very largely to the strong preference for firearms by slave sellers and gatherers. The preference of ivory sellers

[2] See Curtin (1975, Vol. I, pp. 156-168); Lovejoy (2000, pp. 49-52); Thomas and Bean (1974, p. 910).

> for guns came a distant second to that of slave sellers. Sellers of other commodities, particularly foodstuffs, do not seem to have had any stronger demand for firearms (p. 361)."

Kea (1971) shows how the large-scale importation of firearms into the Gold Coast and Slave Coast regions of West Africa revolutionized military strategy and pulled those regions into the orbit of the transatlantic slave trade in a big way. Figure 3 graphs the relationship between gunpowder sales and slave purchases found in the records of the Royal African Company -- a royal monopoly in the Anglo-African trade for the second half of the 17th century. These data show a positive and statistically significant relationship between gunpowder sales and slave purchases between 1674 and 1704 (Davies, 1975, pp. 350-57, 361-64).[3]

II. THE DATA

I want to assess these conceptions empirically using data that have broad geographic and temporal coverage. The best data come from the British Triangular Trade. The Triangular Trade is a stylized depiction of colonial trade but it is an easy way to understand the sources of the data I use.[4] The Triangular Trade is typically thought of as a trade commencing in Europe with the exportation of manufactured goods to Africa – primarily textiles, iron, rum, manufactured goods and cowrie shell money. On the coast of Africa these goods are exchanged for human captives who are transported to the Americas and put to work in mines and on sugar, tobacco and cotton plantations. Plantation staples and precious metals are then exported to Europe, where the account books are cleared and the cycle begun anew. This trade was a fixture of colonial mercantilism -- a system fully developed by the 18th century. The goal was to specialize production within the empire and tax the trade for the benefit of the motherland. Each European nation administered its own mercantile system

[3] Also see Richards (1980). For examples of authors critical of this view, see White (1971) and Thornton (1998, pp. 121-25).

[4] For a formal model of the Triangular Trade and how it may have impacted the relative prosperities on Europe, Africa and the Americas, see Darity (1982). Also see Price (1991) for a revealing discussion of the financial and credit relationships of the triangular slave trade and how they may have contributed to

and each had to defend its territory and trade from the encroachment of others.[5]

Taxes on mercantile trade were sources of government revenue and the British were heroic in their efforts to track imports and exports. The British Customs Office made every effort to record the flow of all trade goods into and out of Britain. The original ledgers are housed in the British National Archives. Marion Johnson (1990) has computer-coded the African ledgers and published them as the Anglo-African Trade Statistics. These data record the annual values of British exports to Africa and the annual values of African exports to Britain for most years between 1699 and 1807. The trade is valued at 1699 prices, so these are real values over time.

African slaves are not included in the Anglo-African trade statistics because slaves were shipped to the Americas not to Britain. My data on slave exports come from the Revised Transatlantic Slave Trade Database.[6] For the past 10 years David Eltis and his colleagues have been collecting information on more than 34,000 transatlantic slaver voyages, accounting for over 13 million enslaved people leaving Africa. They claim almost complete coverage for the 18th century British trade (See Eltis, et al, 1999).

Below I briefly discuss how I construct the variables I use to estimate the enslaved African export supply functions. Estimates of British demand fall out of this exercise.

SLAVE_Q. The quantity variable is the annual number of enslaved Africans leaving Africa on British ships. These are constructed from the Revised Transatlantic Slave Trade Database. The year assigned to each ship is the year the ship left Britain, not Africa. This allows me to match slave purchases found in the Transatlantic Slave Trade Database with the British net export that purchased those slaves that I find in the Anglo-African Trade Statistics. I can then calculate the average annual price of the British slaves purchased on

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underdevelopment in the Americas. These depictions of the triangular trade do not include the direct trade between Brazil and Africa that ran directly between the two.

[5] See Greif (1994) for an analysis of the late medieval origins of this model of economic expansion.

[6] I thank David Eltis for making available to me the revised version of the Transatlantic Slave Trade Database. For a description of the original database, see David Eltis, Stephen D. Behrendt, David Richardson and Herbert S. Klein (1999).

the coast of Africa (see below).

British slave purchases are graphed in Figure 4, along with numbers for other nations. The slave trade exploded in the 18th century, growing from 20,000 per year to almost 120,000 per year. The British trade was largely confined to the 18th century when it may have been the largest slave trade in the world. The British trade was abolished in 1807 after which the Portuguese, Brazilian and Spanish trades expanding to pick up the slack. The 18th century British trade mimics the trade of other nations, with rapid growth over the century and recessions in the 1740s and 1770s. These recessions were not confined to the British trade but were related to military conflicts like the Seven Years War and the American War for Independence which disrupted Atlantic trade generally.

SLAVE_P. I use the Anglo-Africa Trade Statistics and the Revised Transatlantic Slave Trade Database to construct a time series of average annual slave prices. The series is constructed by dividing the real value of British net exports to Africa by the number of slaves those net exports purchased. The result is a time series of average real prices that British merchants paid for enslaved Africans on the coast of Africa between 1699 and 1807.[7] These prices are graphed in Figure 5, along with other comparable price series. The series tracks rather closely the price series constructed by Richardson (1991) who uses a similar method and similar data. The series also tracks closely the prices compiled by Philip Curtin for the lower Gambia, but only when he uses similar account books in a similar manner.[8] The trend follows very closely the trend in the Eltis price series for enslaved Africans newly arrived in the Americas.[9] The American prices are higher than the African coastal prices and reflect the cost of the Middle Passage.

[7] See Richardson (1991) for a discussion of biases in the Anglo-African Trade Statistics. Customs records underestimate British exports to Africa. Ships took on additional goods at non-British ports and at Channel Island and the Isle of Man. And between 1713 and 1730 many ships outbound for Madeira eventually sailed to Africa. These biases are likely to be offset by the fact that the Customs Office did not record imports of gold from Africa. No official record of gold imports exists and no attempt has been made to correct this bias. British gold imports from Africa virtually stopped sometime in the middle of the 18th century. Also see Gemery, Hogendorn and Johnson (1990) for a similar use of these data.

[8] These are prices from invoice books listing the goods exchanged for series or lots of slaves in the lower Gambia, without any corrections for loading or transportation costs, which Curtin did for some of his other price calculations. These prices are from Curtin (1975), Vol. II, Table A8.1, pp. 48-49.

These are real prices. The costs of goods sold are always valued at 1699 prices. The average real price for slaves on the coast of Africa sat at approximately five pounds sterling from the third quarter of the 17th century to the middle of the 18th century. At mid-century prices begin to rise sharply. By the end of the century they average between 25 and 30 pounds sterling -- a five-fold real increase in 50 years.

GUNPOWDER. The annual real values for British gunpowder exported to Africa are also taken from the Anglo-African Trade Statistics compiled by Johnson (1991). Like the rest of this series, gunpowder is valued at 1699 prices. I translate the gunpowder series into physical pounds of gunpowder by dividing through by the 1699 price for gunpowder. Inikori (1977) reports annual data on the quantity of gunpowder exported from Britain to Africa between 1750 and 1807. Dividing the real value of GUNPOWDER found in the Anglo-African data by the pounds of GUNPOWDER reported by Inikori yields a price of .03375 pounds sterling per pound of gunpowder for every year between 1750 and 1807. I take this to be the 1699 price of gunpowder used in the British Customs Office. The Anglo-African gunpowder series is then divided by .03375 to get the quantity of gunpowder (measured in physical pounds) exported from England to Africa for the years between 1699 and 1807. The estimated coefficient on GUNPOWDER can now be read as the number of enslaved Africans exported per pound of gunpowder imported.

*SUGAR_Q***.** The scale of sugar production is measured by annual British sugar imports, taken from the trade statistics reported in Schumpeter (1960) and Deerr (1950). The scale of sugar production is a proxy for replacement demand -- demand for newly enslaved Africans to replace losses in the stocks of slaves on British sugar plantations.

*SUGAR_P***.** These are the annual retail prices paid for sugar in London and Amsterdam, taken from Deerr (1950, pp. 530, 531). They are converted to real prices using the deflators for London.

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[9] I thank David Eltis for making these data available to me. These prices are constructed from new world price quotes on slave shipments recorded in the Transatlantic Slave Trade Database. See Eltis (2004)

RAINFALL. These are annual variations in rainfall measured by annual tree ring data. These data are used to measure exogenous sources of variation in the price of sugar. I use data from Mexico and Louisiana. I also use the Palmer Drought Severity Index.

WARS. To control for the affect of European wars on the effective demand for African captives I construct dummy variables for the Seven Years War (1756-63), the American Revolution (1775-83) and the Napoleonic Wars (1792-1815). I also construct a dummy variable to capture the affects of British access to the Asiento (the Spanish slave trade). Between 1713 and 1733 Britain had a monopoly on the Spanish slave trade. After 1789 the Asiento was thrown open to all takers.

MILITARY. These are total annual British net public expenditures on the Army, the Navy and ordnances. These are used as exogenous sources of variation in British gunpowder exports to Africa. They will serve as instrumental variables for GUNPOWDER imports. The data are taken from Mitchell (1988, page 578-580).

Table 1 reports sample means for these time series. Figure 6 displays some demand-side covariates and Figure 7 displays some supply-side covariates. On the demand side, it looks like slave exports were unable to respond fast enough to increasing sugar production and that this drove up slave price after 1750. On the supply-side, note the striking positive correlation between gunpowder imports and slave exports. Also note the striking inverse correlation between British gunpowder exports to Africa and British military expenditures. British military expenditures will serve as an instrumental variable for British gunpowder exports to Africa.

Table 2 reports the results of Dickey-Fuller tests for unit roots in the time series. Unit root processes violate the stationarity condition and require appropriate transformation of variables before least-square estimation techniques are applicable. A statistically significant coefficient on the lagged endogenous variable is strong evidence that the time series is not unit root. I find unit roots for SLAVE_P and SUGAR_Q only. SLAVE_P follows a

random walk with drift, suggesting that adaptive expectation is an appropriate specification of price expectations on both sides of the market. I use this fact latter in the paper.

III. THE STRUCTURE OF THE TRANSATLANTIC SLAVE TRADE

I begin by estimating a simple linear simultaneous equation system of supply and demand using 3-stage least squares. All variables are cotemporaneous. Supply sifters are gunpowder and time. Demand shifters are sugar price, sugar quantity, wars and time.

$$SLAVE\_Q_t = \beta_1 SLAVE\_P_t - \beta_2 GUNPOWDER_t + \beta_3 TIME + \mu_{St}$$

$$SLAVE\_Q_t = \phi_1 SLAVE\_P_t + \phi_2 SUGAR\_Q_t + \phi_3 SUGAR\_P_t + \phi_3 WAR + \phi_4 TIME + \mu_{Dt}$$

Results are reported in table 3.[10] We are most interested in the estimated coefficients in the supply equations. The coefficient on supply price is positive and significant in the first specification but it becomes smaller and less-significant as I step through the analysis. The coefficient on gunpowder is large and significant in every regression. In fact, it gets larger and more significant under instrumental variables estimation. According to these point estimates an additional 100 pounds of British gunpowder secures an additional 2-3 enslaved Africans. [11]

This relationship between gun-and-slaves is taken to be a supply side relationship. More gunpowder increased the number of slaves showing up on the coast at any prices. The suggestion is that more guns increased the capture rate in the interior, per unit of time and

[10] I also use a strategy where I set supply equal to demand and solve for the equilibrium price. I then estimate price as a function of the exogenous covariates and estimate the supply curve using these estimated first-stage prices. This approach allows me to estimate price in the first stage using two different first stage specifications, each designed to correct for autocorrelation in errors over time. The first specification includes all of the exogenous covariates plus lagged values of the endogenous variables. The second specification is a one period ARIMA model. Neither correction changes the results in any appreciable way.

[11] To generate unbiased estimates of gunpowder's impact on slave exports I must make sure gunpowder is not correlated with unobserved shifters in the error term. My main concern is the absence of data on population density because population density could trend with gunpowder. Gunpowder helps capture people but it also kills and injures people. Guns also cause people to flee or defend themselves. If gunpowder reduces

per unit of resources invested in slaving. Columns 2 and 3 are falsification tests on this conception. I substitute British cottons for British gunpowder as a check to see if the gun-for-slaves relationship I estimate is a supply-side relationship. British cottons were a substantial share of Anglo-African trade throughout this period. One would expect British cottons to be correlated with the British demand for slaves but not with African supply. Gun-for-slaves passes this falsification test. Exports of British cotton do not have a significant impact on the supply of slaves, and the gunpowder coefficient remains virtually unaltered when British cottons are included in the regression alongside gunpowder.

It could be the case that most of the wars and raids in Africa during this period were local in origin, with the supply of gunpowder simply responding to a demand for it. Thornton (1998) takes this position:

> "As historians learn more about warfare in Africa in this period, and as they probe more deeply into the political and social structures of African states, they realize that warfare needs to be explained in terms of the internal dynamics of the state or state system. As such dynamics are understood, the role of Europeans in causing war (as opposed to benefiting from it, either as vehicles to sell arms or buy slaves) begins to diminish (p. 123)."

On the other hand, the sale of gunpowder could have produced wars and raids that otherwise would not have happened, or it could have increased the efficiency of capture by destabilizing the regional balance of power and increasing the number of captives per clash. This is the view taken by Gemery and Hogendorn (1974) when they discuss the technical and institutional changes that brought new "surplus" populations into the orbit of the transatlantic slave trade.

> "The major manifestations of technical change which accompanied these entrepreneurial developments and in part made them possible

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population density, and if we do not control for this, then the estimated coefficient on gunpowder will be

was the rapid increase in the use of firearms by armies and raiding bands that captured the slaves in the first place, and by the middlemen who brought them to the coast (p. 241)."

To address the question of causality I estimate gunpowder imports with instrumental variables that are correlated with gunpowder imports but uncorrelated with capture. British military expenditures serve this purpose well.[12] The results are reported in column 4 of Table 3. Under instrumental variables estimated guns-for-slaves actually increases from 1.9 to 2.8 slaves per 100 pounds of gunpowder. The t-statistic increases as well. The fifth column differences the variables to guarantee stationarity. The estimated coefficient on gunpowder is unaltered. More British gunpowder caused more Africans slaves to be exported.

The next step is to investigate this guns-for-slaves relationship more closely. I first investigate guns-for-slaves in exchange. Inikori found evidence of this among coastal traders. I can test this directly. Let I(t) denote British imports in year t. Let P(t) denote slave price and S(t) the number of slaves carried away on British ships. Note that I calculate slave prices by dividing net British imports in Africa by the number of slaves carried away on British ships.

$$P_t = \frac{I_t}{S_t^s}, \text{ so } S_t = \frac{I_t}{P_t^s}.$$

British imports are valued at 1699 prices. I decompose imports into gunpowder and all other goods, $I_t = P_{1699}^g Q_t^g + P_{1699}^o Q_t^o$. This is the British cost of the British goods sold in Africa. On the coast of Africa these goods are exchanged for slaves, but not at British prices. The trick on the British side was to guess right and arrive on the coast with the correct assortment and

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biased downward. $E(\hat{\alpha}_2) = \frac{\partial Slaves}{\partial Guns} + \frac{\partial Slaves}{\partial Pop}\frac{\partial Pop}{\partial Guns}$. The second term is the bias and it is negative.

[12] The elasticity of gunpowder exports with respect to British military expenditures is -.88, with a t-statistic of -5.44. When Britain was at war shipment of gunpowder to Africa declined significantly. This equation also includes all of the other exogenous variables in the supply and demand system. The R-square is .818.

quantity of goods to satisfy African preferences. British slavers became very adept at amassing the appropriate cargo.[13] Once there, the British goods were exchanged for slaves at prices that reflected African demand preferences as well as British costs:

$$S_t = \frac{I_t}{P_t^s} = \left(\frac{\pi_t^g}{P_t^s}\right) P_{1699}^g Q_t^g + \left(\frac{\pi_t^o}{P_t^s}\right) P_{1699}^o Q_t^o ,$$

where $\left(\frac{\pi_t^i}{P_t^s}\right)$ is the exchange rate of pounds sterling for slaves when the good in question is good *i*.

I estimate the following equation: $S_t = \alpha_1 Gunpowderimports + \alpha_2 Otherimports + e_t$, where

$\frac{1}{\alpha_i} = \left(\frac{P^s}{\pi^g}\right)$ is the average marginal cost price of a slave in terms of gunpowder for the period 1699-1807, measured in pounds sterling.[14]

These estimates are reported in Table 4. The top panel reports the estimated coefficients. All estimates are significant at the 99 percent confidence level. The coefficient on gunpowder is ten times the coefficient on the composite of other goods. Differencing the variables does not alter this result.

The bottom panel of Table 4 reports the implied marginal cost prices of slaves. On the margin, 3.5 to 4.5 pounds sterling worth of gunpowder could buy a slave, but it took approximately 40 pounds sterling worth of other goods to buy a slave. At these relative marginal prices one wonders why more gunpowder was not shipped to Africa. This is even more intriguing when one notes that the data used to estimate these prices overstates the amount of gunpowder exchanged for slaves. I have assumes in these equations that all of the British gunpowder sent to Africa was exchanged for slaves which is clearly not the case. Further investigation of this phenomenon is beyond the scope of this paper, but the

[13] Eltis (200) reports that the Royal African Company purchased 92 percent of their intended or expected number of slaves, and this in a period of generally rising slave prices (pp. 295-297). Also see Metcalf (1987a, 1987b) .

implication is that gunpowder exports to Africa were rationed in some way. The inverse correlation between gunpowder exports and British military expenditures is another interesting clue.

Next I investigate guns-for-slaves in capture. This is a great controversy in African history. We need more than a correlation in exchange to establish guns-for-slaves as a phenomenon that impacted the path of development of African economies. Guns could have been used for a variety of purposes having nothing to do with slave capture, although the evidence presented here and by Inikori makes this highly unlikely. Still, examples of other uses include ceremonies and hunting. Protection is another use for guns, but protection was closely related to the heightened anxieties caused by slave raiding, so it is not independent of slaving per se.

Guns-for-slaves in capture would suggest that a fundamental cause of African slaving lay outside of Africa. Not that the British would be implicated and African slavers exonerated. The dynamic was too complex to allow such a blanket judgment. My goal is to reveal the structure of the slave trade so as to understand its impact on the path of development of African economies. Guns-for-slaves in capture identifies one possible exogenous shock.

For this paper, this issue boils down to whether or not gunpowder increased the capture rate. Did it increase the violence, or did it just respond to it? If gunpowder increased the capture rate then guns-for-slaves may have altered the long-term path of development in Africa. Potential alterations include reduced levels of social and economic cooperation and trust, alterations in the logic of state-building, and transformations in the relationship between people and the land (Rodney 1982, chapter 2).

To investigate guns-for-slaves in capture I move from the simple linear specification to one that incorporates historical context and implicit constraints in the data. First, the data are logged to account for the multiplicative relationship between slave price and quantity.

[14] These are analogous to the "ounce prices" discussed by Marion Johnson (1966) in her classic article on the subject.

Second, in accordance with our finding that price followed a random walk, I set slave price by adaptive expectations ($P_t = P_{t-1} + e_t$). On both side of the market the best ex ante prediction of price is last year's price. Third, I allow for guns-for-slaves in interior exchanges as well as coastal exchanges. The share of gunpowder in last years imports should influence the number of slaves brought to the coast in exchange for those British imports. And finally, I lag gunpowder imports two years back to isolate guns-for-slaves in capture from guns-for-slaves in exchange. Last year's gunpowder may have been *traded* for this year's slaves but the gunpowder landed two years ago was already in the hands of those who *captured* this year's slaves.[15]

Results are reported in Table 5. The estimated coefficient on lagged gunpowder is large and significant in each regression. Again, the estimate of supply price elasticity is positive and significant in the first equation but becomes smaller and less significant as I move through the analysis. The log form of the demand equation performs better than the linear form, generating large, negative and statistically significant price elasticities in every regression. These elasticities range from -.85 to -1.0.

In the first supply equation, which does not include lagged gunpowder, the point estimate for price elasticity is approximately 1. Column (2) adds lagged gunpowder. The price elasticity declines to .71 and the affect of lagged gunpowder is large and significant. A doubling of British gunpowder exports increased British slave shipments two-years later by 19.3 percent. Columns (3) and (4) report falsification tests. As before, British cottons do not perform well and the estimated coefficient on lagged gunpowder is unaltered when British cottons are included. Column (5) report IV estimation and column (6) differences the variables. Instrumental variables increase the coefficient on lagged gunpowder and differencing does not alter this result. This is strong support for guns-for-slave in capture.

IV. CONCLUSION

[15] The average circuit of British capital was approximately one year. I can only guess at the length of time it took British gunpowder to reach slaves raiders. Certainly within 1-2 years the wave of exchanges of guns-for-

Guns-for-slaves is an appropriate characterization of the 18th century British slave trade in Africa. Gunpowder shipments were a powerful determinant of the number of Africans entering the Middle Passage. This result is robust across a variety of econometric specifications.

At a regional level, one can think of the guns-for-slaves cycle as a prisoners' dilemma type arms race. Once firearms spread to a new region there was no peace until a new geo-political equilibrium was established. As Gemeryy and Hogendorn (1974) concluded over 30 years ago, the name of the game becomes "raid or be raided,"

> "States playing no role in the slave trade, and therefore not receiving muskets in payment for slaves, found themselves on the losing side of an arms race. Their dilemma: without firearms defense was precarious. To get muskets, there must be something to export. The only item in great demand was slaves. Thus, it is not surprising that slave trading spread rapidly, especially in the eighteenth century when flintlock replaced the cumbersome matchlock (p. 242)."

This empirical exercise has shown me that guns-for-slaves must be understood within the context of the transatlantic slave trade, for it is within this context that we can begin to see its long-term impact. Without a slave trade, British gun shipments to Africa might have influenced African development but primarily through its impact on military technology. Well-endowed economies would have probably seized the technology first and use it to conquer weaker economies and societies. In fact, the result could have been larger and stronger African states, in some respects a positive force for economic development.

The existence of an external demand for Africa's people changes all of this. The most obvious affect is to reduce the incentive to make war for territorial expansion (where aggressors are interested in people and land) and to increase the incentive to raid (where

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slave should have completed. The only remaining affect should be guns-for-slaves in capture.

aggressors are interested in people only). In the slave trade era states have less incentive to expand territorially because an external market for captives offers non-agricultural opportunities to gain from war. States prefer instead to establish tributary relationship with others who supply them with slaves, or at least to maintain an insider-outsider relationship with potential pools of captives. Increases in the returns from raiding also increase the cost of protecting citizens, which further reduces the incentive to expand territorially. It also tends to shut down industries that cannot afford protection.

The five-fold increase in slave prices in the second half of the 18th century must have driven this logic well into the interior of Africa. None but slavers could buy enough protection because nothing else paid nearly as well.[16] Guns and gunpowder increased aggression, but the slave trade channeled the affects towards raiding and away from state-building. As slave prices rose and as firearm technology improved nothing but distance could protect the innocent. The 18th and 19th centuries were times of revolutionary upheaval in Africa, the legacy of which we are only beginning to understand.

[16] For models that imply a decline in production and an increased emphasis on slave raiding, see Darity (1982) and Nunn (2007). de Barros (2001) uses archeological evidence to describes how the coming of slave raiders shut down the Bassar ironworking society of Togo. Wilks (1982) discusses how the Asante sacked the prosperous industrial-trade city of Begho in the 1760s.

Table 1

Arithmetic Sample Means					
Variable	units	Obs	Mean	95% Confidence Interval	
African slave exports	number	109	25,937.40	23,824.62	28,050.18
British slave price	pounds sterling	107	11.32	9.91	12.73
Lbs. of Britih gunpowder exports	pounds	107	504,493.90	417,401.00	591,586.70
European sugar price	shillings per cwt	108	1.95	1.86	2.04
British sugar imports	pounds	106	1,336,939.00	1,169,915.00	1,503,963.00
Total net British exports to Africa	pounds sterling	107	345,235.10	281,569.90	408,900.20
Net exports minus gunpowder	pounds sterling	107	328,208.40	267,120.60	389,296.20
British cottons exports	pounds sterling	107	73,465.66	53,966.93	92,964.40
Gunpowder exports	pounds sterling	107	17,026.67	14,087.28	19,966.05
British military expenditures	thousand pounds sterling	102	12,311.00	10,367.20	14,256.20

Table 2. Dickey-Fuller Tests for Unit Root

Dickey Fuller Test for Unit Root				
Y(t) = (1-ρ)*Y(t-1) + β*time + e(t)				
Trend				
Variable	est. of (1-ρ)	t statistic	est. of β	t statistic
gunpowder	-0.3827	-4.78	145.03	3.61
net exports	-0.4446	-5.39	3,852.72	4.30
slave price	-0.3968	-4.93	0.09	4.65
slaves	-0.3943	-5.01	84.51	3.01
net exports minus gunpowder	-0.4431	-5.38	3,670.50	4.28
sugar price	-0.2635	-3.81	0.00	-0.62
sugar quantity	-0.1799	-2.95	5,177.90	3.06
British cottons	-0.4584	-5.44	1,223.80	4.44
Drift				
Variable	est. of (1-ρ)	t statistic	est. of β	t statistic
gunpowder	-0.1553	-2.98	2,873.60	2.39
net exports	-0.1650	-3.01	62,872.90	2.39
slave price	-0.0678	-1.61	0.99	1.76
slaves	-0.2461	-3.86	6,407.50	3.56
net exports minus gunpowder	-0.1671	-3.03	60,506.70	2.39
sugar price	-0.2592	-3.77	0.49	3.55
sugar quantity	-0.0183	-0.57	53,488.60	1.06
British cottons	-0.1748	-2.92	15,546.00	2.11

For "trend," the critical t-statistic for 99% confidence that $\rho \neq 1$ is -4.039. For 95% confidence it is -3.449. For 'Drift," the critical t-statistic for 99% confidence is -2.362. For 95% confidence it is -1.659.

Table 3

Simple Linear Specification of the 18th Century Transatlantic Slave Trade											
Dependent Variable = Slave_Q(t)											
		1		2		3		4		5	
Independent Variables		Linear	t-stats	False 1	t-stat	False 2	t-stat	IV Gun	t-stat	Diff and IV	t-stat
	Supply										
Slave_P(t)		771.5232	2.69	1089.253	2.14	515.4604	1.31	-16.1868	-0.05	75.92225	0.18
Lbs. of gunpowder(t)		0.01868	6.71			0.019048	7.08	0.028338	7.9	0.029118	5.4
British cottons				0.026965	1.25	0.007541	0.45				
Time		-164.015	-2.85	-84.2023	-1.09	-133.746	-2.27	-123.815	-2.3	-14.5896	-0.16
Constant		17123.74	11.65	16601.12	7.36	17616.93	10.27	18679.58	12.08	-159.395	-0.07
"R-square"		0.601		0.3693		0.6402		0.6421		0.3876	
F stat		59.85		27.99		48.77		65.84		10.52	
N		105		105		105		98		93	
	Demand										
Slave_P(t)		-6097.49	-1.01	-3285.08	-2.75	-3604.42	-2.9	-3651.52	-2.84	-1052.13	-0.43
Net exports(t)		0.106663	1.47	0.073198	4.97	0.076997	5.01	0.081207	4.72	0.011283	0.39
Sugar_P(t)		-1646.7	-0.57	-1557.67	-1.06	-1567.78	-0.98	-933.979	-0.58	1949.349	0.54
Sugar_Q(t)		0.00277	0.44	0.001033	0.39	0.00123	0.43	-0.00025	-0.08	0.007062	1.17
Time		481.4645	1.01	263.6442	2.58	288.3774	2.69	284.7298	2.47	138.3977	0.53
Napoleonic Wars		1283.412	0.11	-3070.38	-0.76	-2576.01	-0.59	-3795.48	-0.93	-55234.5	-4.42
Asiento		-657.885	-0.21	-236.563	-0.15	-284.404	-0.17	-260.52	-0.16	5545.223	0.58
American Revolution		12007.96	0.62	3355.455	0.75	4337.937	0.91	5129.015	1.05	-10576.1	-1.32
Seven Years War		-9017.04	-0.59	-2195.13	-0.59	-2969.75	-0.75	-2399.68	-0.63	9388.883	1.18
Constant		31353.16	2.18	25772.17	5.51	26405.89	5.22	26097.35	5.42	393.6383	0.09
"R-square"		0.1293		0.7745		0.7305		0.7505		0.2298	
F stat		9.72		37.95		31.98		32.34		3.17	
N		105		105		105		98		93	

Table 4.
Estimates of the marginal cost price of slaves
(Dep var = slave export)

	series are not differenced		series are differenced	
All net imports	.0339** (11.77)		.0326** (13.07)	
Gunpowder imports		.2808** (3.51)		.2326** (2.75)
Other net imports		.0249** (6.21)		.0257** (6.73)
Time	-36.65 (1.17)	-72.59* (2.26)		
Estimated marginal cost price of slaves in pounds sterling:				
All net imports	29.50		30.67	
Gunpowder imports		3.56		4.30
Other imports		40.16		38.91
N	107	107	104	107
Adj R-squared	.772	.790	.626	.646

Regressions include dummies for the Napoleonic Wars, the American Revolutionary War, the Seven Years War and the Spanish Asiento. T-statistics are listed below the coefficient estimates. * denotes significance at the 95% confidence level. ** denotes significance at the 99% confidence level.

Table 5

The Structure of the 18th Century Transatlantic Slave Trade												
Dependent Variable = ln [Slave_Q(t)]												
	1		2		3		4		5		6	
Independent Variables		t-stats		t-stats	False 1	t-stat	False 2	t-stat	IV on Guns	t-stat	Diff and IV	t-stat
	Supply											
ln [Slave_P(t-1)]	1.034	2.590	0.710	1.910	0.653	1.860	0.454	1.350	0.496	1.290	0.435	0.780
ln [Percent Gunpowder(t-1)]	0.338	1.980	0.183	1.110	0.240	1.630	0.106	0.720	0.042	0.240	-0.074	-0.490
ln [lbs. Gunpowder(t-2)]			0.193	2.210			0.210	2.430	0.548	3.740	0.638	2.450
ln [British Cottons(t-2)]					0.034	1.030	0.007	0.200				
Time	-0.012	-1.530	-0.012	-1.710	-0.007	-1.030	-0.008	-1.230	-0.019	-2.470	0.001	0.320
Constant	7.941	11.940	6.448	7.310	8.315	15.680	6.620	7.730	3.028	2.080	-0.069	-0.610
"R-square"	-0.020		0.194		0.179		0.295		0.109		-0.915	
F stat	11.640		11.860		9.970		10.360		12.060		-36.270	
N	103.000		101.000		101.000		101.000		96.000		93.000	
	Demand											
ln [Slave_P(t-1)]	-0.994	-3.100	-0.873	-3.200	-0.842	-3.620	-0.847	-3.620	-0.981	-2.940	7.187	0.180
ln [Net Exports(t)]	0.755	8.350	0.752	9.310	0.745	10.140	0.747	10.120	0.778	8.020	-0.117	-0.060
ln [Sugar_P(t-1)]	0.116	0.770	0.094	0.700	0.092	0.700	0.093	0.700	0.113	0.700	0.616	0.140
ln [Sugar_Q(t-1)]	0.334	1.800	0.329	1.940	0.325	1.970	0.326	1.970	0.329	1.730	-2.163	-0.190
Time	0.002	0.310	0.000	-0.090	-0.001	-0.180	-0.001	-0.160	0.001	0.190	0.008	0.110
Napoleonic Wars	-0.153	-1.120	-0.134	-1.090	-0.136	-1.130	-0.136	-1.120	-0.139	-0.950	-1.694	-0.300
Asiento	0.046	0.590	0.013	0.190	0.014	0.210	0.014	0.210	0.012	0.160	-1.580	-0.160
American Revolution	-0.159	-1.120	-0.171	-1.360	-0.177	-1.490	-0.176	-1.470	-0.148	-1.040	-1.645	-0.240
Seven Years War	-0.186	-1.160	-0.141	-1.000	-0.131	-1.000	-0.132	-1.010	-0.177	-1.070	1.676	0.190
constant	-1.779	-0.710	-1.831	-0.800	-1.748	-0.790	-1.761	-0.790	-1.999	-0.760	0.895	0.050
"R2"	0.680		0.750		0.762		0.760		0.693		-36.270	
F stat	28.190		35.250		37.180		36.930		27.170		0.060	
N	103.000		101.000		101.000		101.000		96.000		93.000	

Figure 1. The Political Warfare Model

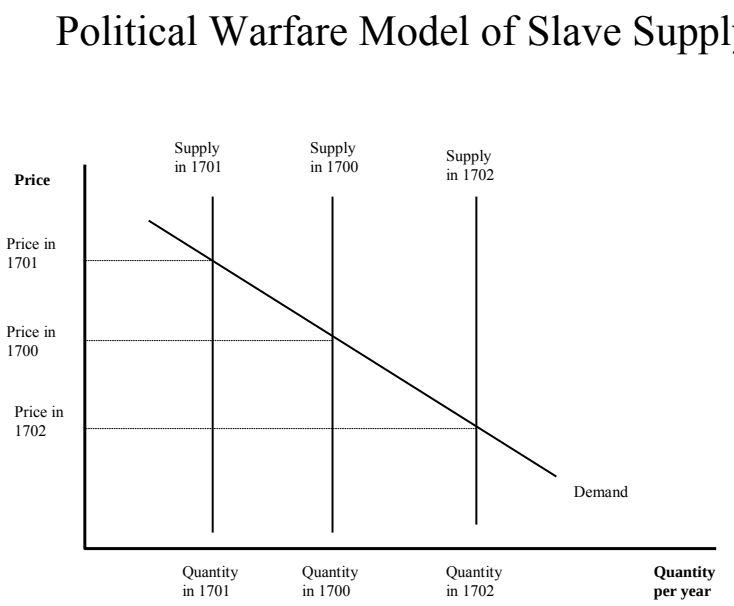


Figure 2. The Export Supply Model

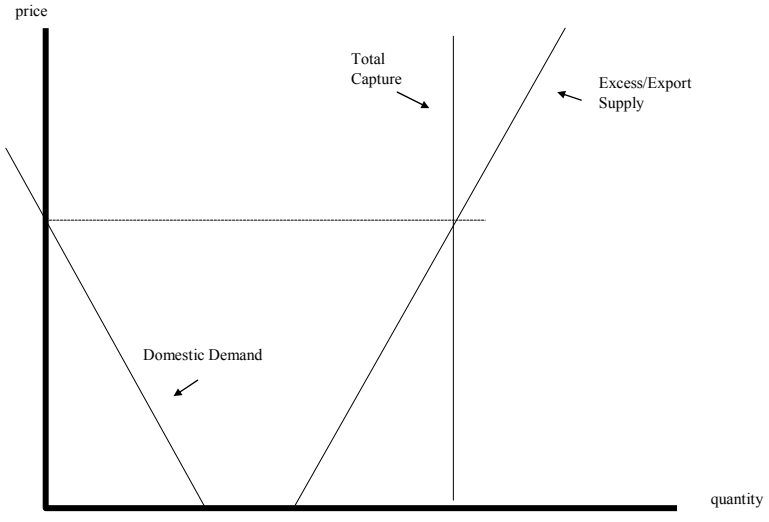


Figure 3. Royal African Company: relationship between gunpowder and slaves

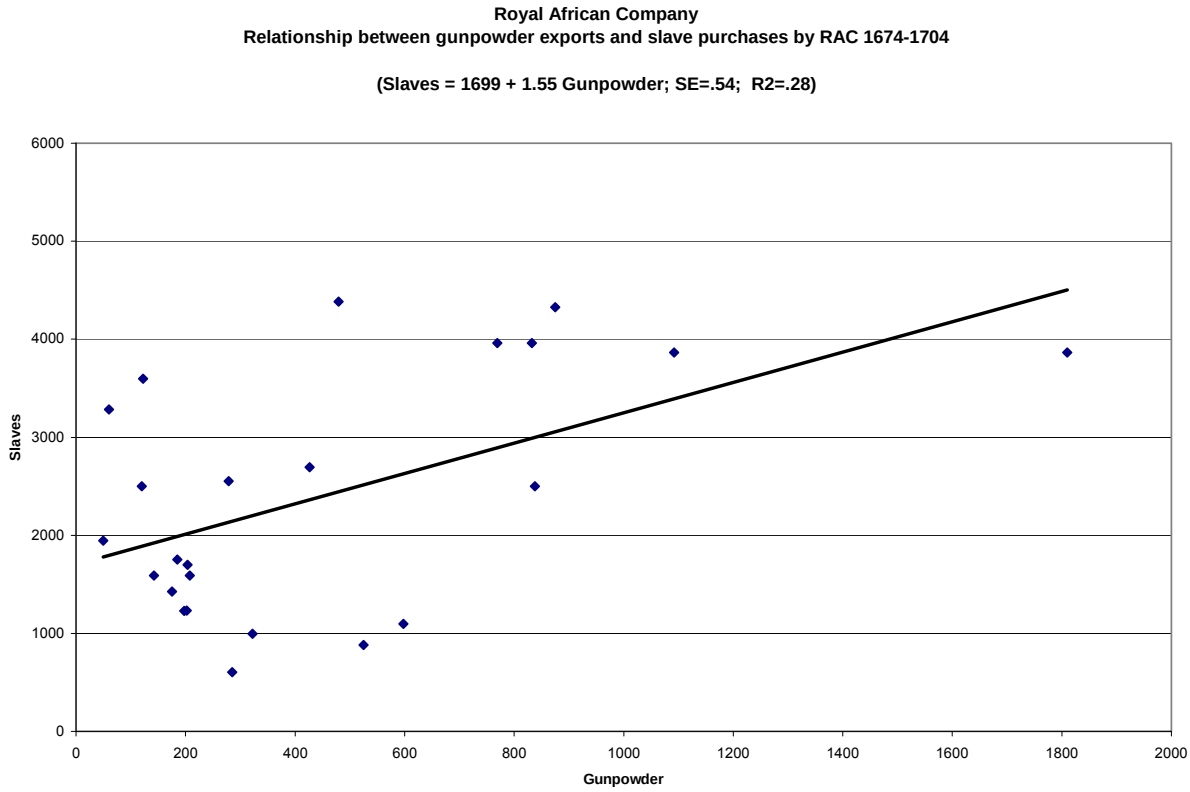


Figure 4. Transatlantic Slave Trade by National Carrier

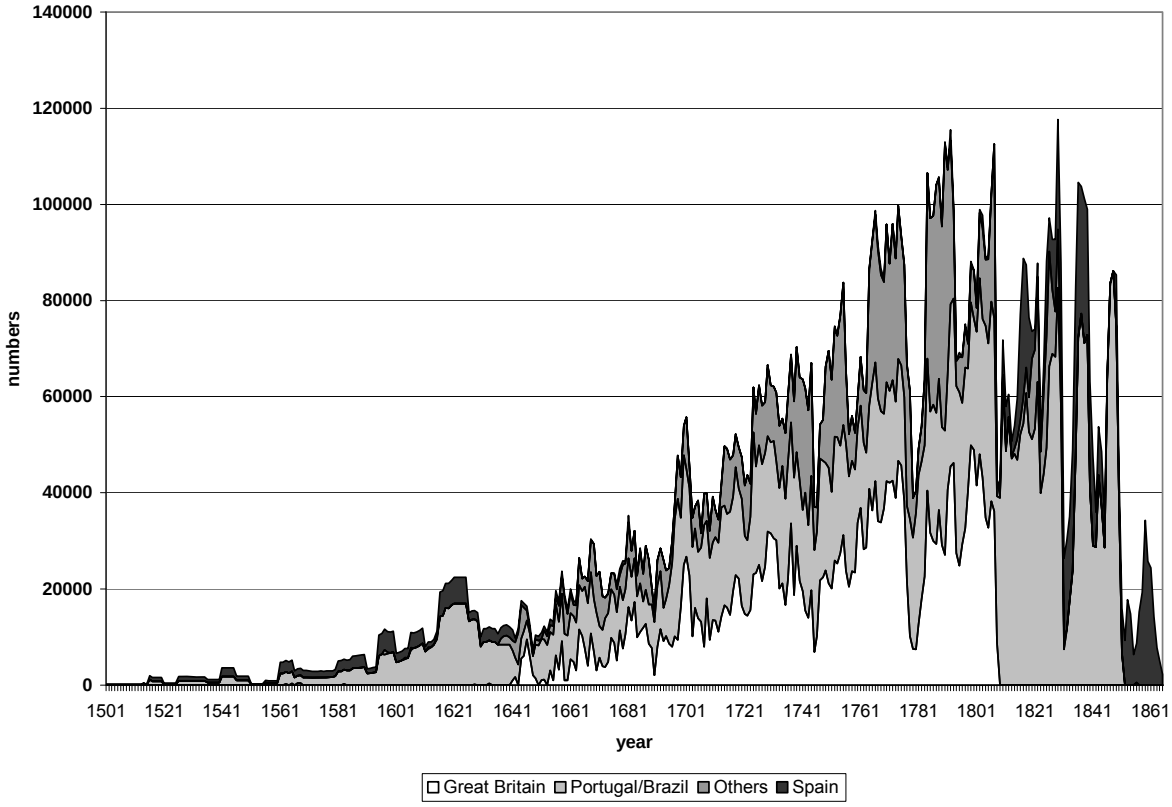


Figure 5. Prices of Enslaved Africans on the West Coast of Africa

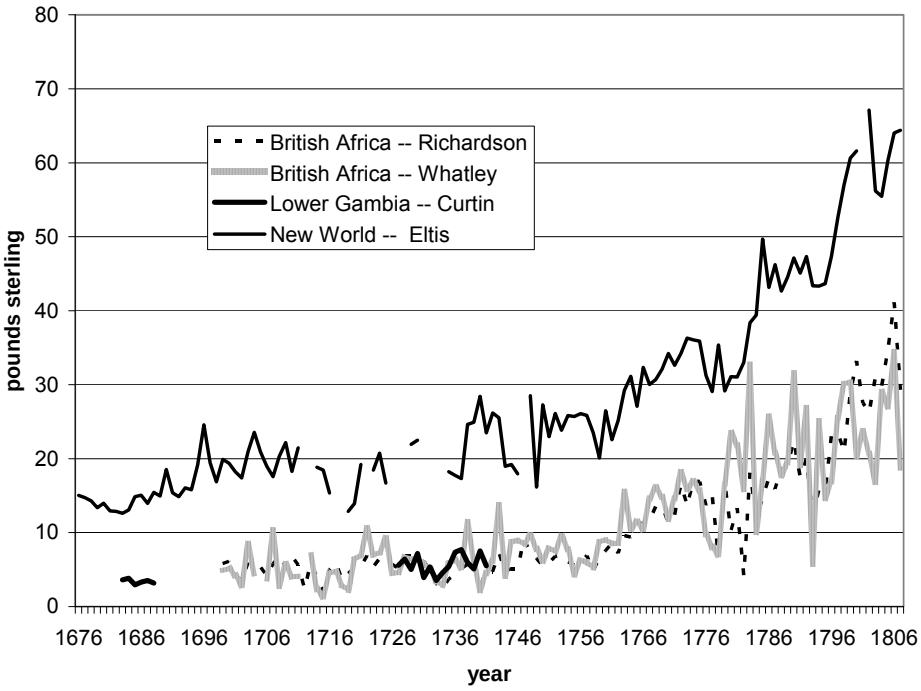


Figure 6. Demand-Side Covariates

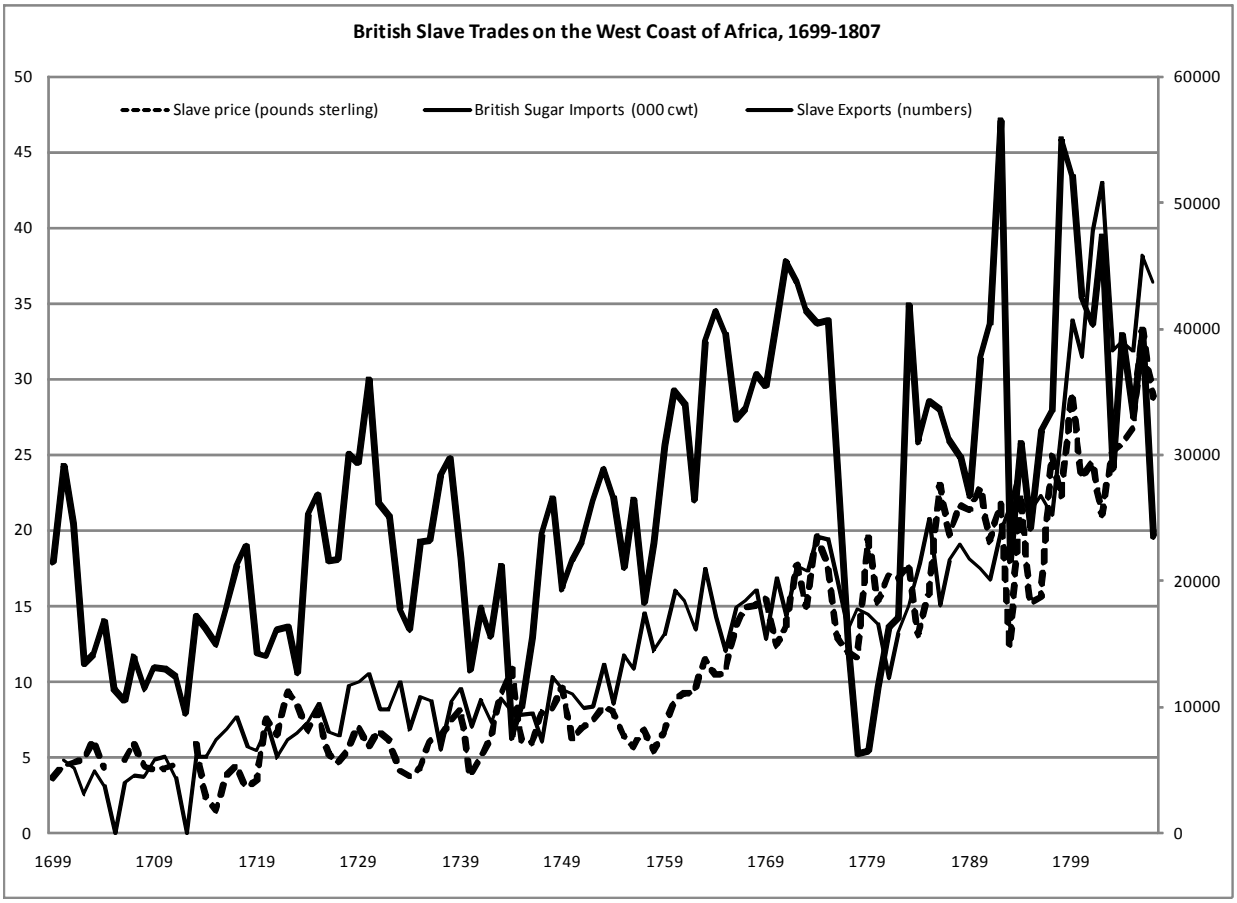
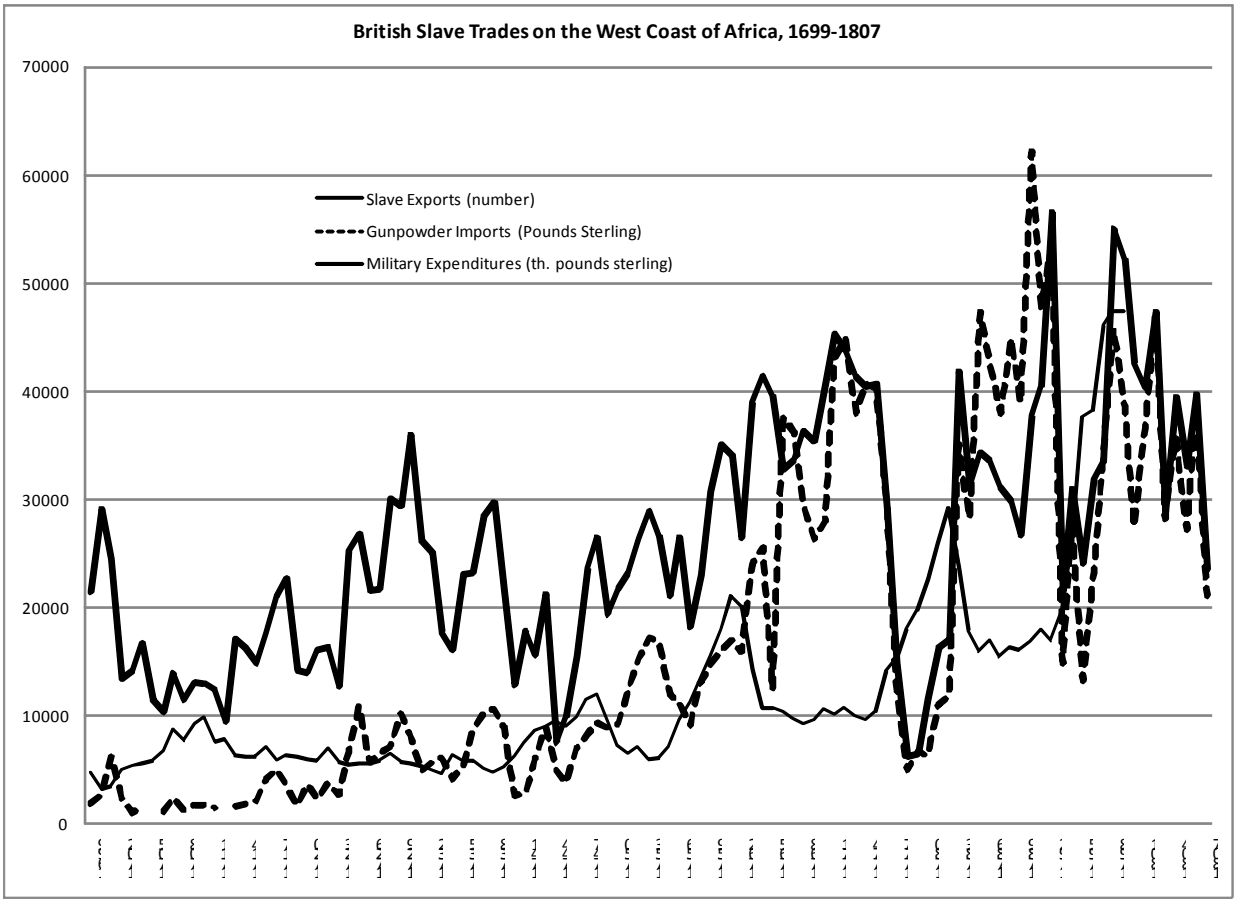


Figure 7. Supply- Side Covariates



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