GUNS-FOR-SLAVES:

THE 18TH CENTURY BRITISH SLAVE TRADE IN AFRICA*

WARREN C. WHATLEY
DEPARTMENT OF ECONOMICS AND CAAS
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48103
WWHATLEY@UMICH.EDU

DRAFT: APRIL 15, 2008

ABSTRACT

The transatlantic slave trade was a triangular trade that touched Europe, Africa and the Americas, with profound and lasting effects on each. At the center of our understanding of each case stands the elasticity of supply of enslaved Africans. It helps explain the scale of early Atlantic trade, the transition from indenture servitude to slavery in the Americas, and 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 techniques 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 to be an unlimited supply of African slaves, and what in Africa became underdevelopment.

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 dynamic Atlantic trade that fueled the 18th century economic take-off in Europe. (Inikori, 2002; Acemoglu, Robinson and Johnson, 2005). American economies that had a history of slavery today 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 have lower GDP per capita today 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 responses of African economies to the New World demand for its people – what I call the enslaved African export supply function – is a critical variable in understanding all of these cases. 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. For example, economic historians working on the American side of the Atlantic invoke an elastic African supply function to explain the transition from indenture servitude to African slavery after the 1680s. 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 try 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. A few estimates of supply elasticity exist, but these are average time-series correlations

---

[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).

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 generate a very elasticity supply function. Between 1650 and 1750 the number of enslaved Africans leaving Africa tripled without an 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, wars, population growth, declining productivity, or improved efficiencies in the organization of capture and marketing.

In this paper I econometrically identify and estimate enslaved African export supply functions hoping to address these issues and hoping to integrate the economic histories of African and American economies. Data from the 18th century British Triangular Trade allow me to identify and estimate a variety of these functions. Prices and quantities are taken from transactions between British and African slave traders operating on the coast of Africa between 1699 and 1807. Demand-side information on American sugar production, sugar prices and European wars help me identify and estimate the supply-side relationships in these transactions.

The resulting estimates 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. Not because of improvements in transportation technology. Not because of population growth. Not because of famine or drought. The primary determinant of the number of captives coming out of West Africa in the 18th century was the amount of gunpowder going in. This result is large, significant and robust across a variety of

specifications, samples and robustness checks. Instrumental variables estimation shows that more gunpowder did indeed produced more captives. This is 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 much of today's underdevelopment in Africa is tied to the persisting negative effects of the slave trade (Nunn, 2007, 2008).

The first part of this paper reviews three distinct conceptions of the slave supply process in Africa. The second part describes the data used to estimate the enslaved African export supply functions. The third part discusses some econometric issues. The fourth part presents coefficient estimates and the fifth part concludes and summarizes.

I. THE POLITICAL ECONOMY OF SLAVE CAPTURE AND EXPORT

In the literature one finds 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 primarily on variations over time.

The first conception is the political warfare model which argues that most Africans entering the transatlantic slave trade 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 conception, most enslaved Africans exported to the Americas were captives of wars who were exported rather than killed. Captives are sometimes called "joint-products of war," sometimes "stolen goods," but always the products of activities unrelated to American demand, with zero or very low opportunity cost in the African context.

The political warfare model is depicted in Figure 1. Supply is insensitive to price and exogenously determined by local political factors. Price allocates this politically generated

supply among competing European ships docked off of the coast of Africa at any point in time.

This model is very inflexible, especially the implication that the price offered by Europeans had no influence on the number of captives showing up on the coast. All slave raiders raided for gain and with a keen eye on costs and prices. Wars were often fought for economic gain and surplus extraction in the form of taxes, tolls, rents and tribute. It is hard to imagine a ruling class not seeing the export value of war captives. Asante, for example, extracted slaves as tribute from northern territories and sold them to Europeans (Wilks, 1975, pp. 66-68, 165-177). One does not have to assume that nations went to war if the price was right, but the existence of an export market for captives facilitated surplus extraction. Rather than tax captives or put them to work they could simply be sold.

No doubt some 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 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 violence of the slave trade era was fundamentally caused by the transatlantic slave trade and the associated trade in firearms.

The political warfare model also overlooks the role of domestic labor demand. There were many domestic uses for slave labor in Africa, especially by the 18th century. While slavery

in Africa was different from American slavery, it was nonetheless a form of labor extraction, especially for males. Slaves were used as porters, gold miners, goldsmiths, blacksmiths, plantation laborers and land clearers (Lovejoy, 200, pp. 112-139). Slaves were sometimes promoted to military and bureaucratic positions of leadership because their inferior social status removed them from political intrigue (Boubacar, 1998). These kinds of economic decisions were influenced by the export price of captives, albeit within limits. In 18th century West Africa, slaves could be bought easily, but once embedded in local kinship structures they became more difficult to sell. As Claude Meillassoux (1971) describes the situation,

> "…neither free commoners nor slaves born in captivity could be alienated… The only persons who could be sold were those snatched from their homes and families through capture. Communities could not sell their own members, nor their domestic slaves, nor breed slaves for sale. In these circumstances slaves were only produced through war or plunder (p. 54)."

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 the lives and resources lost during incursions, and the cost of transporting captives to the coast for export – which includes food, guards, shackles, tolls, taxes and other costs. Over time, capture and marketing activities became specialized, with coastal states emerging to extract rents of location from the trade as it 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 an average of 400%.

The second conception of the African supply process takes into account these concerns and explicitly considers opportunity costs and competing demands for captives. This is the export supply model best formulated by LeVeen (1975). The export and the domestic labor markets are linked through the export slave price. Even if capture activities were politically motivated and insensitive to price, exports would not be. Captors had to decide between domestic sale and export, and this decision was influenced by the export price of captives

relative to their domestic productivity. Captives in excess of domestic demand were exported.

These relationships are depicted in Figure 2. This particular depiction assumes that capture is still insensitive to price, but it need not be, especially for raiders. My point is to show how consideration of domestic labor productivity makes export quantities more responsive to price. Lower export prices increase domestic demand and reduce the number of captives available for export. Higher export prices cover higher costs of capture and transport, allowing the catchment zone to move further inland.[2] A decline in the profitability of employing labor domestically (for example, a decline in the profitability of gold mining) will reduce domestic demand for labor and shift out the export supply function.

The third conception is guns-for-slaves. It is often viewed as a cycle. Guns are purchased 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
> 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. Lastly, 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,

---

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

361-64).[3]

II. 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 trade is typically thought of as 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 then 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 account books are cleared and the cycle begun anew. This trade was a fixture of colonial mercantile trade -- a system fully developed by the 18th century. The goal was specialized production within the empire and a tax on trade for the benefit of the motherland. Each European nation administered its own mercantile system and each had to defend its territory and trade against the encroachment of others.

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 computerized the African ledgers as the Anglo-African Trade Statistics. The 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

---

[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

shipped to the Americas not to Britain. My data on slave exports come from the Revised Transatlantic Slave Trade Database.[5] For the past 10 years David Eltis and his colleagues have collected information on more than 34,000 transatlantic slaver voyages which account for over 13 million enslaved Africans leaving Africa (See Eltis, et al, 1999). They claim almost complete coverage for the 18th century British trade.

Below I briefly discuss how I construct the variables I use to identify and estimate the enslaved African export supply functions.

SLAVE_Q. The quantity variable is the annual quantities 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 the slave purchases found in the Transatlantic Slave Trade Database with the net export figures found in the Anglo-African Trade Statistics. I can then calculate the average annual price of the British slave purchases on the coast of Africa (see below).

British slave purchases are graphed in Figure 4, along with numbers for other nations. The 18th century slave trade exploded, 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 an annual time series of average slave prices. The series is

---

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.

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 the average real prices that British merchants paid for enslaved Africans on the coast of Africa between 1699 and 1807.[6] 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.[7] The trend follows very closely the trend in the Eltis price series for enslaved Africans newly arrived in the Americas.[8] The American prices are higher than the African coastal prices, reflecting the cost of the Middle Passage.

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 exports 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

---

[5] 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).

[6] 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.

[7] 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.

[8] 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)

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 entire 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.

GOLD_P. This variable is the annual real value of gold in the City of London. It is used as a proxy for the value of labor employed in the regions of Africa that produced gold. As early as the 12th century West Africa was a major supplier of gold to the Mediterranean and European worlds. In the 1440s, when Portuguese caravels set sail down the coast of West Africa they sailed in search of gold not slaves. West Africa remained a major world supplier of gold until the early 18th century when large reserves were discovered in Brazil. During the 18th and 19th centuries England held the largest stocks of gold in the world and became the underwriter of the international gold standard. The real value of gold in London is a good proxy for the purchasing power of the gold mined in West Africa. I use the mint price of gold in London, divided by either the consumer price index for London or the earnings index for London.[9] I try a variety of these measures, all with similar results. The real value of gold in London declined sharply in the middle of the 18th century. This should have depressed the value of labor in the regions of Africa producing gold.

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.

---

[9] All data are available at MeasuringWorth.com. Also see, Lawrence H. Officer, "What Were the U.K. Earnings Rate and Consumer Price Index Then?" Economic History Services, September 2005, URL : http://eh.net/hmit/ukearncpi/. Please read our Note on Data Revisions;

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.

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 (1803-1815). 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. I also add a dummy for the years following the Haitian Revolution (post-1791) thinking that this event might have permanently altered the expected profitability and future viability of the transatlantic slave trade.

MILITARY. These are 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).

All of the covariates are graphed in Figure 6. The series that stands out is gunpowder. There is lots of variation in the other time series as well.

II. ECONOMETRIC MODEL

The appropriate econometric model is a simple simultaneous equation system of supply and demand. I want to estimate the supply function for slave exports. Exports equal the total number of people captured minus those retained for domestic purposes,

$$Q_{Et} = Q_{ct} - Q_{dt}.$$

Q is the equilibrium observed quantities. Subscript t denote the year, E stands for export, c for capture and d for domestic. The number of people captured and the number of people retained domestically are functions of the slave price (P), some covariates (X) and unobservables (μ).

$$Q_{ct} = \alpha_p P_t + \alpha_c X_{ct} + \mu_{ct},$$

$$Q_{dt} = \beta_p P_t + \beta_d X_{dt} + \mu_{dt}.$$

The numbers exported equal

$$Q_{Et} = (\alpha_p - \beta_p)P_t + \alpha_c X_{ct} - \beta_d X_{dt} + (\mu_{ct} - \mu_{dt})$$

$$= \alpha_E P_t + \alpha_c X_{ct} - \beta_d X_{dt} + \mu_{Et}.$$

I have supply-side information on Q_E, P, GUNPOWDER and GOLD_P. To generate unbiased estimates of observed shifters I must make sure they are not correlated with unobserved shifters. The main concern is the absence of data on population density because population density could trend with GUNSPOWDER. Gunpowder helps capture people but it also kills and injures people. Guns also cause people to flee or defend themselves. If GUNPOWDER reduces population density, and if we do not control for this, then the estimated coefficient on GUNPOWDER will be biased downward.[10]

The number of enslaved Africans demanded in the Americas at time t is a function of the price of enslaved Africans (P_t), observable covariates (X_{Dt}) and unobservables μ_{Dt}.

---

[10] $E(\hat{\alpha}_2) = \dfrac{\partial Slaves}{\partial Guns} + \dfrac{\partial Slaves}{\partial Pop}\dfrac{\partial Pop}{\partial Guns}$. The second term is the bias and it is negative.

$$Q_{Dt} = \phi_p P_t + \phi_D X_{Dt} + \mu_{Dt}.$$

Sugar is the crop that drives American demand for enslaved Africans, although small amounts of demand come from mining in South America, and tobacco and cotton in the United States. I have good information on British sugar production (SUGAR_Q) and British sugar prices (SUGAR_P). The important technological changes in ocean shipping occurred after our period, in the 19th century. The technology of growing and processing sugar cane was worked out long before the 18th century.

GUNPOWDER is treated as an input into the slave production process, so the input is lagged one period to allow time for production to take place. Given my data, my capture function is

$$Q_{ct} = \alpha_1 SLAVE\_P_t + \alpha_2 GUNPOWDER_{t-1} + \mu_{ct}.$$

And my domestic labor demand function is,

$$Q_{dt} = \beta_1 SLAVE\_P_t + \beta_2 GOLD\_P_t + \mu_{dt}.$$

The simultaneous equation system is:

$$Q_{Et} = (\alpha_1 - \beta_1) SLAVE\_P_t - \beta_2 GOLD\_P_t + \alpha_2 GUNPOWDER_{t-1} + (\mu_{ct} - \mu_{dt})$$

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

I want to estimate the coefficients of the export supply function. The estimation strategy is to first estimate the export supply function using simple OLS as the baseline. Since the price of slaves is endogenous I move to two-stage estimation. I later incorporate instrumental variables for sugar price because sugar prices in any given year could be influenced by the prices or quantities of newly enslaved Africans. I also incorporate instrumental variables for gunpowder to identify the causal relationship between gunpowder

imports and slave exports.[11]

VI. REGRESSION ESTIMATES

Table 1 reports means for the entire British slave trade. Table 2 reports the estimated coefficients for the corresponding enslaved African export supply functions. The dependent variable is SLAVE_Q.

The estimated coefficient on the price of enslaved Africans is unstable and insignificant. The coefficient becomes insignificantly positive when I add to the equation the price of gold. When I control for wars the coefficient becomes insignificantly negative. The estimated coefficient on the price of gold is always negative, as expected, but it is seldom significant. Gold was produced in only a few select regions of West Africa, so we should not expect the price of gold to be a good proxy for the value of domestic labor in Africa generally. I find no evidence in these equations of an elastic export supply curve for enslaved Africans.

The robust estimate is the coefficient on GUNPOWDER. It is large, stable and highly significant across all specifications. The importation of an additional 100 pounds of gunpowder this year brought approximately two additional enslaved Africans to the coast next year. 50 pounds of gunpowder for an additional captive seems like a lot of gunpowder, suggesting a lot more carnage in the slave production process than previously thought. Since we do not have information on population density, it is likely that the coefficient on GUNPOWDER is biased downward. Still, this is strong support for the guns-for-slaves hypothesis.

---

[11] 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.

The guns-for-slaves hypothesis is about a cycle, and correlation does not imply causality. 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 responding to a demand for it. Thornton (1998) wants to argue this:

> "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 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 in the guns-for-slaves cycle I estimate gunpowder imports with instrumental variables that are correlated with gunpowder imports but uncorrelated with capture processes in Africa. British military expenditures serve this purpose well. The results are reported in the last column of Table 2. The coefficient on gunpowder is still 2.16 with a t-statistic of 5.05. More European gunpowder caused more Africans to be enslaved.

The political economy of this causal relationship between gunpowder and capture remains to be modeled and investigated empirically. Arms sales and arms distribution may have been an explicit policy of the British government. British forts on the coast of Africa may have systematically and strategically distributed arms in an effort to influence political developments, or divide and conquer African states, or arm strategic allies (Boubacar, 1998). Competition among European powers for enslaved Africans encouraged this kind of strategic behavior. One intriguing possibility is that credit in the form of gunpowder and guns may have tied repeat slave buyers and sellers in a principal-agent type relationship. Alternatively, close business relationships may have emerged between slavers and arms manufacturers in England. In any case, pushing guns and gunpowder was the most effective way to produce enslaved Africans for American plantations and mines. This is why colonial planters thought there existed an unlimited supply of African slaves at their disposal.

Table 3 reports summary statistics for the British slave trade in the Gold Coast region of Africa. The Gold Coast is in present-day Ghana. This is the site of the largest West African gold fields and where the GOLD_P variable has the best change of performing well as a proxy for domestic labor demand. Table 4 reports the estimated coefficients for the enslaved African export supply functions for the Gold Coast. The dependent variable is SLAVE_Q from the Gold Coast.

First note that the R-squares are lower for the Gold Coast than for all of Africa. This is because the SLAVE_P and GUNPOWDER variables are for the entire British trade whereas SLAVE_Q is only for the Gold Coast. Still, we expect variations in overall British slave prices to be correlated with variations in Gold Coast slave prices. The same applies to GUNPOWDER. Like for all of Africa, these regressions show no evidence of a price-elastic enslaved African export supply function.[12]

---

[12] In fact, it appears that controlling for the value of domestic labor increases the negative significance of slave prices. This is consistent with an inelastic demand for African luxury imports being paid for with slave exports. See Khan (2002). It is also consistent with the influence of a backward bending supply curve as regions lock-in to the slave trade and depopulate before moving on to other catchment zones. See Thomas and

Second, lagged GUNPOWDER imports are still correlated with slave exports. The coefficient is one-tenth the size of the coefficient for all of Africa because the Gold Coast accounts for approximately one-tenth of annual British slave purchases. The guns-for-slave relationship holds in the Gold Coast as well.

Third, the coefficient on the real value of gold is negative and significant. The decline in the value of gold in the middle of the 18th century reduced the value of domestic labor in the Gold Coast region and encouraged the region to export a larger share of its captives. This is support for the view that African and American labor markets were linked.[13] The five-fold increase in slave prices in the second half of the 18th century must have chocked-off a great deal of production in West African economies.[14]

V.   CONCLUSION

A guns-for-slaves cycle appropriately characterizes the 18th century British slave trade in Africa. Gunpowder was a powerful determinant of the number of Africans entering the Middle Passage in the 18th century. This result is robust across a variety of econometric specifications. The size of the estimated coefficient suggests that large numbers of Africans were killed and injured in the process.

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 is no peace until a new geo-political equilibrium is established. As Gemeryy and Hogendorn (1974) concluded over 30 years

---

Bean (1974, p. 910).

[13] Similar regressions run for the Senegambia region show a similar pattern. Senegambia did not produce as much gold in the 18th century. It did produce lots of gum arabic. Seven observations on gum arabic prices reveal a sharp price increase after 1750. The inclusion of a time trend after 1750 yields a negative coefficient on time.

[14] Gold Coast gold exports reversed to gold imports after mid century. See Johnson (1966) .

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)."

A second important finding is the competitive link between African and American labor markets. The export price for slaves tells us something about the relative profitability of domestic labor employed in Africa, especially slave labor. The tragedy is that the link was enforced by slavers. The five-fold increase in export prices in the second half of the 18th century shut down productive industries far into the interior of Africa, as it helped do for gold in the Gold Coast and similar productive activities in other places. None but slavers could buy enough protection because nothing else paid nearly as well.[15] As slave prices rose and as firearm technology improved nothing but distance could protect the innocent. The 18th century was a time of revolutionary upheaval in West Africa, the legacy of which we are only beginning to understand.

---

[15] 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. Summary Statistics: British African Slave Trade, 1699-1807

Variable	Obs	Mean	Std. Dev.	Min	Max
Slaves (number)	108	25978.71	11171.71	6232.978	56518.51
Sugar Quantity (000 cwt)	105	1,314,993	841,325	258,230	4,297,079
Sugar Price (shillings per cwt)	107	1.85	0.58	0.85	3.55
Real Price of Slaves (in 1699 pounds sterling)	106	11.16	7.17	1.47	33.23
Real Price of Gold (index)	108	0.156	0.0283	0.079	0.198
Gunpowder (lbs.)	106	503,376	456,385	28,961	840,533

Table 2. Regressions for All of Africa

(DEP. VAR: QUANTITY OF SLAVES EMBARKED IN AFRICA)

	OLS	OLS	2SLS	2SLS IV sugar_p, War dummies	2SLS IV sugar_p War dummies, IV gunpowder
SLAVE_P (pounds sterling)	-6.58	7.08	324.44	-836.55*	-369.11
	(0.03)	(0.04)	(1.17)	(1.97)	(0.93)
GUNPOWDER (per 100 lbs)	1.71**	1.72**	1.27**	2.03**	2.16**
	(5.58)	(5.59)	(3.19)	(5.29)	(5.05)
GOLD_P (index)		-1447.68	-1811.4	-4137.49*	-1123
		(0.66)	(0.81)	(2.35)	(0.68)
CONSTANT	17739.51**	17418.92**	16110.02**	44792.47**	24667.53*
	(11.96)	(11.63)	(9.03)	(3.85)	(2.29)
Adj. R-square	0.4687	0.4742	0.4709	0.473	0.4879
Observations	106	106	104	104	97

  Absolute value of t-statistics in parentheses
 * significant at 5% level; ** significant at 1% level

Table 3. Summary Statistics: British Gold Coast Slave Trade, 1699-1807

Variable	Obs	Mean	Std. Dev.	Min	Max
Slaves (number)	105	3151.58	1745.04	220	8540.74
Sugar Quantity (000 cwt)	105	1314993	841325.6	258230	4297079
Sugar Price (shillings per cwt)	107	1.85	0.58	0.85	3.55
Real Price of Slaves (in 1699 pounds sterling)	106	11.16	7.17	1.47	33.23
Price of Gold (index)	108	0.156	0.0283	0.079	0.198
Gunpowder (valued at 1699 prices)	106	503,376	456,385	28,961	840,533

Table 4. Regression Results for the Gold Coast

DEP. VAR: SLAVES EMBARKED IN AFRICA

|	OLS	OLS	2SLS Full Model	2SLS Full Model	2SLS IV on Gunpowder	2SLS IV on Gunpowder
SLAVE_P (pounds sterling)	-2.64	-4.64	-4.59	-13.48**	-7.74	-9.95
	(1.07)	(1.87)	(1.09)	(2.79)	(1.05)	(1.58)
GUNPOWDER (per 100 lbs)	.242**	.140*	.250**	.150*	.330**	.184*
	(5.69)	(2.59)	(5.11)	(2.57)	(3.99)	(2.05)
GOLD_P (index)		-664.0**		-908.0**		-792.0**
		(2.93)		(3.48)		(2.74)
CONSTANT	3001.9**	6832.2**	3175.7**	8815.6**	3203.3**	7806.4**
	(9.85)	(5.11)	(8.39)	(5.35)	(6.85)	(4.71)
Adj. R-square	.2346	.2873	.2091	.2209	.2626	.3354
Observations	106	106	104	104	97	97

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level
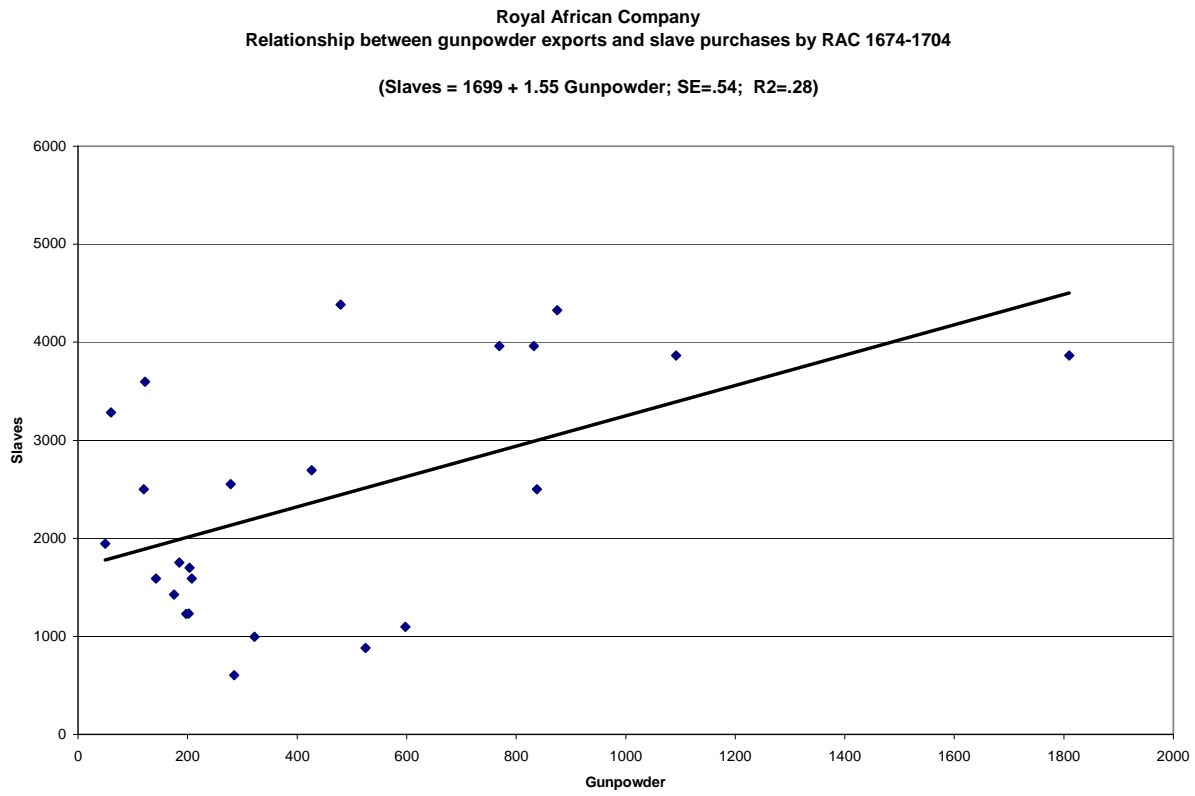
Figure 1. The Political Warfare Model

Political Warfare Model of Slave Supply
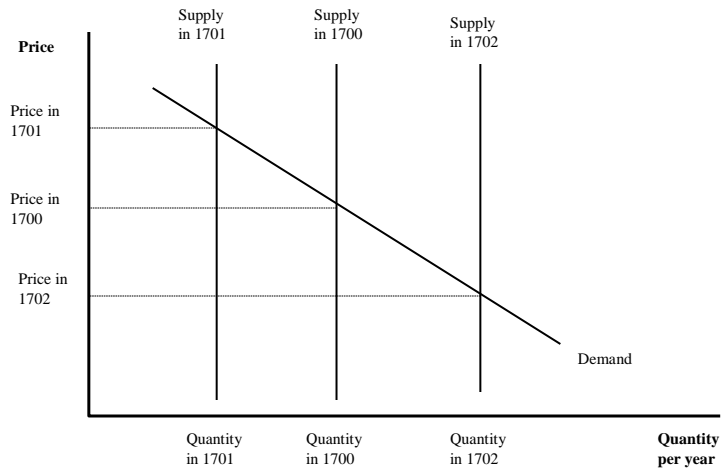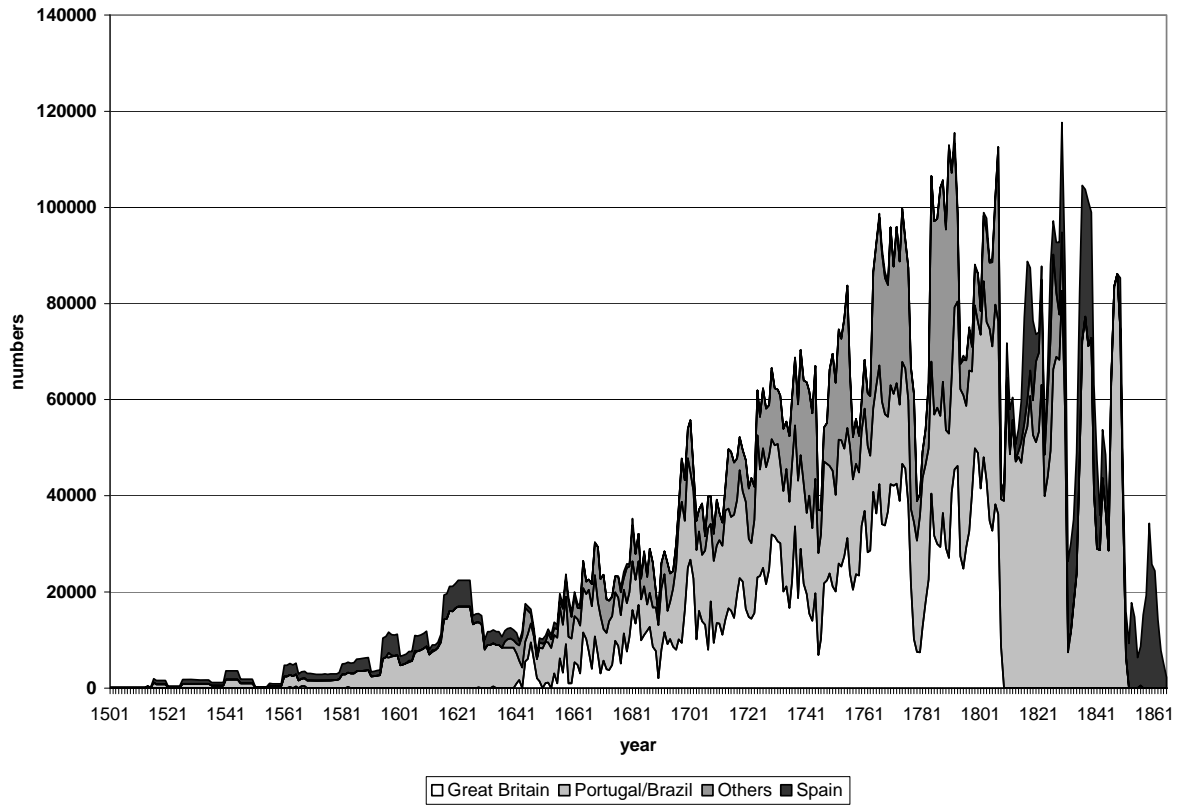

Figure 2. The Export Supply Model
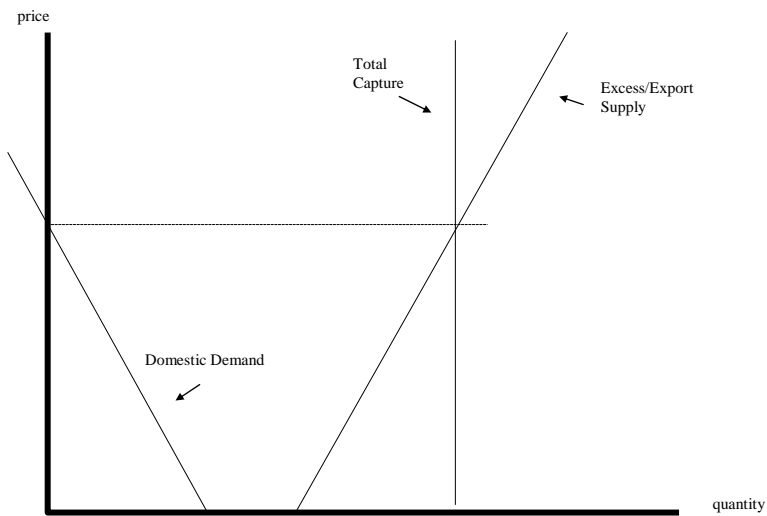
Figure 3. Royal African Company: relationship between gunpowder and slaves

Royal African Company
Relationship between gunpowder exports and slave purchases by RAC 1674-1704

(Slaves = 1699 + 1.55 Gunpowder; SE=.54; R2=.28)

Figure 4. Transatlantic Slave Trade by National Carrier

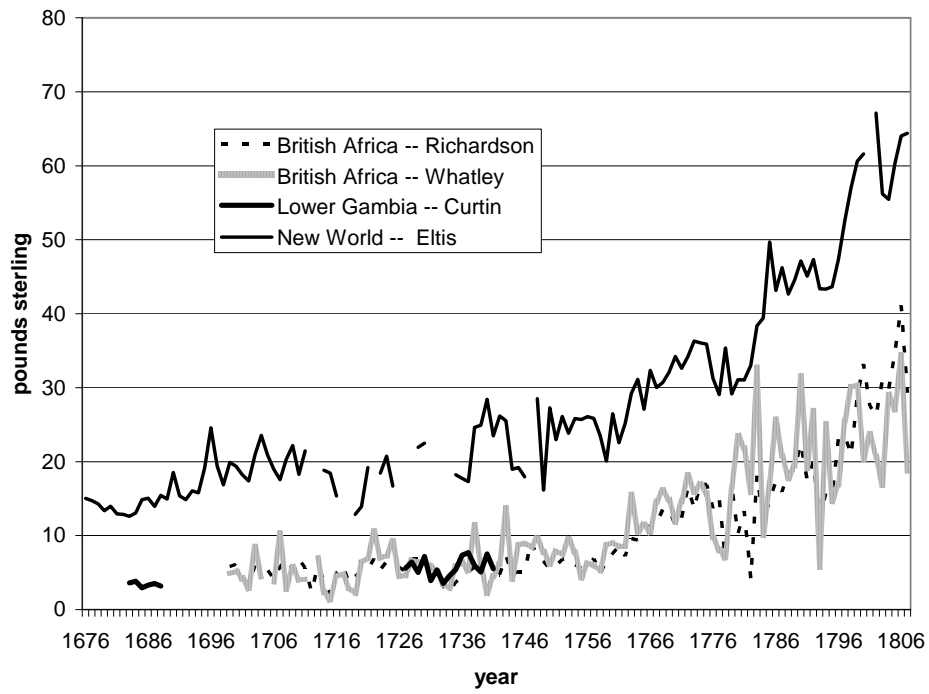**Figure 5. Prices of Enslaved Africans on the West Coast of Africa**

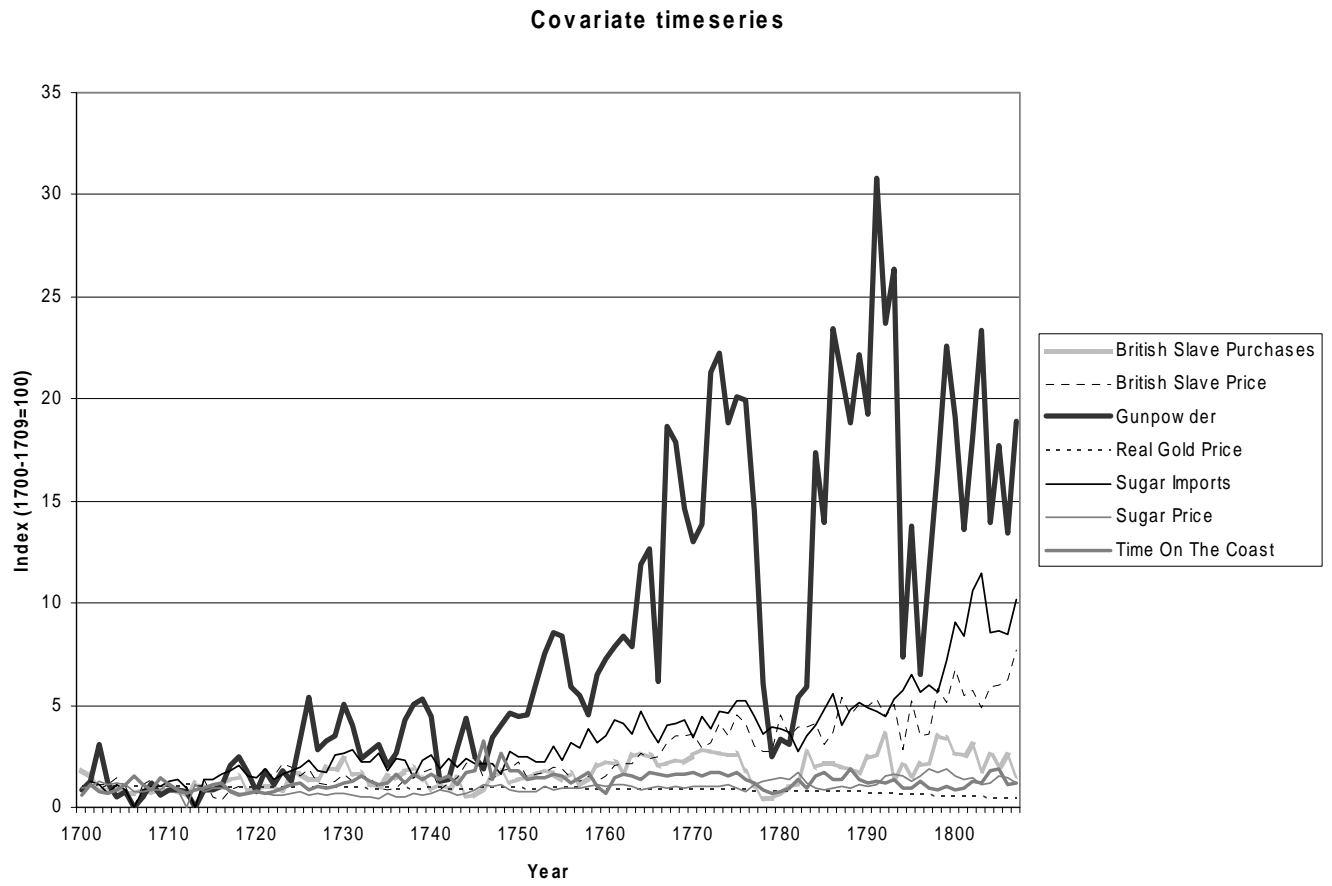**Figure 6. Covariate Time Series**

Covariate time series

REFERENCES

Acemoglu, Daron, Simon Johnson, and James Robinson. "The Rise of Europe: Atlantic Trade, Institutional Change, and Economic Growth." *The American Economic Review* 95, no. 3 (2005): 34.

Atack, Jeremy, and Peter Passell. *A New Economic View of American History*. 2 ed. new York: W. W. Norton, 1994.

Boubacar, Barry. *Senegambia and the Atlantic Slave Trade*. Translated by Ayi Kwei Armah. Cambridge: Cambridge University Press, 1998.

Curtin, Philip D. *Economic Change in Precolonial Africa : Senegambia in the Era of the Slave Trade*. 2 vols. Madison: University of Wisconsin Press, 1975.

Darity, William, Jr. "A General Equilibrium Model of the Eighteenth Century Atlantic Slave Trade." *Research in Economic History* 7 (1982): 287-326.

Davidson, Basil. *Africa in History*. London, 1968.

———. *Black Mother*. Boston, 1961.

Davies, K. G. *The Royal African Company*. New York: Octagon Books, 1975.

De Barros, Philip Lynton "The Effects of the Slave Trade on the Basser Ironworking Society, Togo." In *West Africa During the Atlantic Slave Trade*, edited by Christopher R. Decorse, 59-80. London: leicester University Press, 2001.

Deerr, Noel. *The History of Sugar*. Vol. 2. London: Chapman and Hall LTD., 1950.

Eltis, David, and David Richardson. "Prices of African Slaves Newly Arrived in the Americas, 1673-1865: New Evidence on Long-Run Trends and Regional Differentials." In *Slavery in the Development of the Americas*, edited by David Eltis, Frank D. Lewis and Kenneth L. Sockoloff, 181- 218. Cambridge: Cambridge University Press, 2004.

Engerman, Stanley L., Eugene D. Genovese, and Alan H. Adamson. *Race and Slavery in the Western Hemisphere; Quantitative Studies*. Princeton,: Princeton University Press, 1975.

Engerman, Stanley L., and Kenneth Lee Sokoloff. *Factor Endowments, Inequality, and Paths of Development among New World Economies*. Cambridge, MA.: National Bureau of Economic Research, 2002.

Evans, E. W. , and David Richardson. "Hunting for Rents: The Economics of Slaving in Pre-Colonial Africa." *The Economic History Review* 48, no. 4 (1995): 665-686.

Galenson, David W. "Economic Aspects of the Growth of Slavery in the Seventeenth Century Chesapeake." In *Slavery and the Rise of the Atlantic System*, edited by Barbara Solow, 265-292. Cambridge: Cambridge University Press, 1991.

Galenson, David W. . *White Servitude in Colonial America*. Cambridge: Cambridge University Press, 1981.

Gemery, H. A. , and J. S. Hogendorn. "Elasticity of Slave Labor Supply and the Development of Slave Economies in the Caribbean : the Seventeenth Century Experience." In *Comparative Perspectives on Slavery in New World Plantation Societies*, edited by V. Rubin and T. Tuden. New York, 1977.

Gemery, H. A. , and Jan Hogendorn. "Evidence on English/African Terms of Trade and 18th Century." *Explorations in Economic History* 27 (1990): 157- 177.

Gemery, Henry A. , and Jan S. Hogendorn. "The Atlantic Slave Trade: A Tentative Economic Model." *The Journal of African History* 15, no. To (1974): 223- 246.

Inikori, J. E. *Africans and the Industrial Revolution in England : A Study in International Trade and Economic Development*. Cambridge: Cambridge University Press, 2002.

———. "The Import of Firearms into West Africa 1750-1807: A Quantitative Analysis." *The Journal of African History* 18, no. 3 (1977): 339-368.

Johnson, Marion. "The Ounce in 18th Century West African Trade." *The Journal of African History* 7, no. 2 (1966): 197- 214.

Kea, R. A. "Firearms and Warfare on the Gold and Slave Coasts from the Sixteenth to the Nineteenth Centuries." *The Journal of African History* 21, no. 2 (1971): 185-213.

Khan, Wasiq Nawaz "Labor Productivity and Transportation Costs in Africa and the Americas During the Transatlantic Slave Trade: An Empirical Verification of Stephano Fenoaltea's Model " PhD, American University, 2002.

Klein, Herbert. *The Atlantic Slave Trade*. Cambridge: Cambridge University Press, 2007.

LeVeen, E. Phillip "The African Slave Supply Response." *African studies review* 18, no. 1 (1975): 9-28.

Lovejoy, Paul E. *Transformations in Slavery : A History of Slavery in Africa*. 2nd ed, *African Studies Series ; 36*. Cambridge, UK ; New York: Cambridge University Press, 2000.

Marion Johnson, J. Thomas lindblad, and Robert Ross. *Anglo-African Trade in the Eighteenth Century: English Statistics on African Trade, 1699-1808*. Leiden: Centre for the History of European Expansion, 1990.

Meillassoux, Claude, ed. *The Development of Indigenous Markets in West Africa*. Oxford: Oxford University Press, 1971.

Mitchell, B. R. . *British Historical Statistics*. Cambridge: Cambridge University Press, 1988.

Nunn, Nathan. "Historical Legacies: A Model Linking Africa's Past to Its Current Underdevelopment." *Journal of Development Economics* 83, no. 1 (2007): 157-175.

———. "The Long Term Effects of Africa's Slave Trades." *Quarterly Journal of Economics* 123, no. 1 (2008): 139-176.

———. "Slavery, Inequality, and Economic Development in the Americas: An Examination of the Engerman-Sokoloff Hypothesis." In *Institutions and Economic Performance*, edited by E. Helpman. Cambridge: Harvard University Press, 2008.

Price, Jacob M. "Credit in the Slave Trade and Plantation Economies." In *Slavery and the Rise of the Atlantic System*, edited by Barbara Solow, 265-292. Cambridge: Cambridge University Press, 1991.

Richards, W. A. "The Import of Firearms into West Africa in the Eighteenth Century." *The Journal of African History* 21, no. 1 (1980): 43-59.

Richardson, David. "Prices of Slaves in West and West Central Africa: Towards an Annual Series, 1698-1807." *Bulletin of Economic Research* 43, no. 1 (1991): 21- 56.

Rodney, Walter. *How Europe Underdeveloped Africa*. London,: Bogle-L'Ouverture Publications, 1972.

Schumpeter, Elizabeth. *English Overseas Trade Statistics, 1697-1808*. London: Oxford University Press, 1960.

Sokoloff, Stanly Engerman and Kenneth L. "Factor Endowments, Institutions and Differential Paths of Growth among New World Economies: A View from Economic Historians of the United States." In *How Latin America Fell Behind*, edited by Stephen Haber. Stanford: Stanford University Press, 1997.

Solow, Barbara L., and Stanley L. Engerman. *British Capitalism and Caribbean Slavery : The Legacy of Eric Williams*, *Studies in Interdisciplinary History.* Cambridge [Cambridgeshire] ; New York: Cambridge University Press, 1987.

Thomas, Robert Paul , and Richard Nelson Bean. "The Fishers of Men: The Profits of the Slave Trade." *The Journal of Economic History* 34, no. 4 (1974): 885-914.

Thornton, John. *Africa and Africans in the Making of the Atlantic World, 1400- 1800.* Cambridge: Cambridge University press, 1998.

White, Gavin. "Firearms in Africa." *The Journal of African History* 12, no. 2 (1971): 173-184.

Wilks, Ivor. *Asante in the Nineteenth Century : The Structure and Evolution of a Political Order*, *African Studies Series. 13*. London ; New York: Cambridge University Press, 1975.

———. "Wangara, Akan and Portuguese in the 15th and 16th Centuries, Ii: The Struggle for Trade." *The Journal of African History* 23, no. 4 (1982): 463- 472.

Williams, Eric. *Capitalism and Slavery*. Chapel Hill: University of North Carolina Press, 1944.