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THE GUN-SLAVE CYCLE IN THE 18TH CENTURY BRITISH SLAVE TRADE*

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ABSTRACT

What explains the rapid and sustained growth in the trans-Atlantic slave trade during the 18th century? This paper addresses this question by investigating the 18th century British slave trade. I combine data from the Transatlantic Slave Trade Database and the Anglo-African Trade Statistics to build a time-series of annual observations on the British slave trade that spans the period 1699-1807. I find evidence in these data of a gun-slave cycle in the first half of the 18th century that produced large number of slaves for export. In the second half of the century British slave traders dumped excess gunpowder on Africa when it was not needed for military purposes. There is also evidence that British merchant-capital financed the expansion of African slaving between 1750 and 1789. There is little evidence in these data that slave exports responded to changes in the international price of slaves. These results support the British abolitionists' claim that the international slave trade caused African wars rather than African wars causing the slave trade.

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“...it was not the war which was the cause of the Slave Trade, but the Slave Trade which was the cause of the war.”

Thomas Clarkson (1839, p. 167).

"Previous to my being in this employ, I entertained a belief that the kings and principal men [in Africa] breed Negroes for sale as we do cattle. All the information I could procure confirms me in the belief that to kidnapping, the trade owes its key support. "

Alexander Falconbridge (1788, p. 15).

1 INTRODUCTION

According to the *Transatlantic Slave Trade Database*, the trans-Atlantic slave trade carried more than 13 million enslaved Africans across the Atlantic and into the Americas. What social factors lay behind this enormous enslavement of people? For Thomas Clarkson, the intellectual leader of the British Abolition Movement, this question went to the heart of the matter – to the legitimacy or illegitimacy of the trade itself. According to the dominant Natural Rights philosophy of the time, if African slaves were captured in “justified” wars declared among African peoples, people caught in the “natural” struggles of nation building, then the victors in those wars had every right to enslave the vanquished, those whose lives they had just chosen to spare. On the other hand, if “it was the slave trade which was the cause of the war,” then neither the African captors, nor their British trading partners, nor the American planters who used the slaves, had any rights to the captives whatsoever.¹ Alexander Falconbridge’s admission, while less philosophical than Clarkson’s, is probably closer to the typical layman’s query: did African societies produce human slaves in their normal course of affairs, or did the international slave trade cause the enslavement?

Over 200 years later, this debate is still unresolved. Did the slave trade produce the wars or did the wars produce the slave trade? Prominent historians of Africa like Philip Curtin (1975), David Eltis (1987) and John Thornton (1998) argue that the slave trade had little impact on Africa and that the majority of the captives came from justified wars amongst African peoples,

¹ For a full elaboration of this critique, see Clarkson (1786), his award-winning Oxford essay that launched his career as a major figure in the British abolition movement. Also see Patterson (1982) who calls the process of enslavement “social death” regardless of justification.

wars that had little to do with the international demand for slaves. Other prominent historians of Africa like Walter Rodney (1972), Joseph Inikori (1982), Robin Law (1991) and Basil Davidson (1961) argued that the slave trade had significant political and economic effects on Africa; that the growth of African slave exports was in response to exogenous international demand and technology shocks like the American demand for African slaves and the introduction of the European gunpowder technology. Recently, economists have documented a variety of long-term negative consequences of the slave trade for African economies, including lower national incomes, greater gender inequality, and increased ethnic and political fragmentation,² implying that Clarkson was right, that the international demand for African slaves caused enough war and conflict to leave indelible marks on African economies.

Is this true? Econometric studies of the long-term effects of the slave trade continue to grow, but we still know very little about the forces behind the trade itself, or how, when and why African societies responded the way they did. The central goal of this paper is to fill this void. The case study is the 18th century British slave trade, and while the trans-Atlantic slave trade lasted for more than 400 years, Figure 1 shows that the major expansions occurred in the 18th century when the volume increased from approximately 20,000 to 100,000 per year. The British slave trade was the most-successful slave trade during this period, rising from small beginnings in the mid-17th century to become the largest in the world by 1807 (then Britain abolished the trade). Did African slavers capture more slaves in response to increases in the British demand for slaves or were large numbers of slaves available for export for reasons unrelated to British demand?

To address this question, I combine data from the *Transatlantic Slave Trade Database* and data from the *Anglo-African Trade Statistics* (1990) to build a time series of annual observations on the British slave trade that spans the period 1699-1807. I estimate a number of reduced-form relationships between British cargo shipments to Africa and British slave shipments out of Africa. I pay particular attention to the hypothesized gun-slave cycle – the idea that imported guns and gunpowder played a special role in facilitating and even encouraging slaving in

² Nunn (2008), Nunn and Wantchekin (2011), Obikili (2014), Whatley (2014), Whatley and Gillzeau (2011a, 2011b),

Africa. Did guns “grease” the slave trade, as 18th century British slave traders argued during the Seven Years War, or is the gun-slave cycle nothing more than abolitionist propaganda?

I find evidence in these data of a gun-slave cycle, but not a simplistic one for the entire 18th century. The British gun-slave cycle was confined to the first half of the 18th century when gunpowder secured additional slave exports like no other commodities could, and when these additional slaves, in turn, attracted additional gunpowder the next year. Then, sometime around mid-century, this gun-slave cycle gave way to a new pattern of Anglo-African trade, one where cargo shipments financed the expansions of slaving in the interior of Africa, and where excess British gunpowder was dumped on Africa when it was no longer needed to fight British wars. I show that these were successful trade strategies that allowed British traders to dominate the slave trade in their major ports of operation.

The second section of the paper documents general trends in the 18th century British slave trade, highlighting a break in the price-quantity relationship at mid-century. Section 3 describes the gun-slave cycle and its component parts. Section 4 derives the estimated equation and the identification strategy. Section 5 presents econometric results and section 6 concludes.

2 THE 18TH CENTURY BRITISH SLAVE TRADE

Figure 1 presents data on annual British purchases of African slaves, along with numbers for other nations.³ The British trade was largely confined to the 18th century, but it quickly became one of the largest in the world. The British trade mimics the trade of other nations, with rapid growth over the 18th century and sharp contractions in the 1740s, 1770s and 1790s that correspond to military conflicts like the American War for Independence and the Napoleonic Wars that disrupted Atlantic trade generally.

The British demand for slaves arrived on the coast of Africa as ships laden with cargo looking for slaves to buy. African destinations were largely determined before ships left Britain, with cargos carefully selected to meet the anticipated preferences of intended African consumers

³ All data on slave export quantities are taken from the Transatlantic Slave Trade Database at www.slavevoyages.org. Downloaded 5/7/2013.

(Metcalf, 1987a, 1987b; Eltis, 2000). The most popular items were textiles of various kinds, iron bars, firearms and other weapons, rum, cowrie shells and a vast array of manufactured goods.⁴ On the coast of African these commodities (call them *CARGO*) were traded for slaves (*SLAVES*) who had been captured by Africans in wars and raids in the interior. The average rate of exchange between British *CARGO* and African *SLAVES* is the average price that British slave traders paid for African slaves. $PRICE_t$ is the annual average price that British traders paid for slaves on the coast of Africa in year t.

$$PRICE_t \equiv \frac{CARGO_t}{SLAVES_t} \quad (1)$$

Available data allow me to construct a time series of $PRICE_t$ for the years 1699-1807. Annual estimates of $CARGO_t$ come from the *Anglo-African Trade Statistics* recorded in the British Customs Office at the time and later digitized by Marion Johnson, et al (1990).⁵ The *Anglo-African Trade Statistics* contain annual estimates of the *real* value of British *CARGO*.⁶ The British Customs Office set the value of traded cargo items at “official prices,” primarily 1699 prices that did not change over our sample period, so changes in *CARGO* measure changes in the quantities of items shipped to Africa, not changes in their prices. It is the appropriate measure for our purposes because we want to investigate the responses of African slave exporters to changes in the cargo items, and thus the real prices, they received.

Annual estimates of $SLAVES_t$ come from the *Transatlantic Slave Trade Database*. The variable $SLAVES_t$ measures the number of slaves boarding the same British ships that carried the

⁴ The *Anglo-African Trade Statistics* do not report trade by region, but several studies have analyzed trade books and ship’s ledgers that document the regional variation in African preferences. See Metcalf (1987) and Eltis (2000, p. 168) for a sample.

⁵ See Richardson (1991) for a discussion of countervailing biases in the Anglo-African Trade Statistics. On the one hand, Customs Office records underestimate British exports to Africa. Ships took on additional goods at non-British ports, at Channel Island and the Isle of Man; and between 1713 and 1730 many ships outbound for Madeira eventually sailed on to Africa. On the other hand, the Customs Office did not record imports of gold from Africa. No official British record of gold imports exists and no attempt has been made to correct for these biases. After careful assessment, Richardson concluded that the two biases probably cancelled each other out.

⁶ The *Anglo-African Trade Statistics* do not record British slave purchases because slaves were shipped to the Americas and never entered Britain. *CARGO* is calculated by taking total British commodity exports to Africa and subtracting total African exports to Britain. What is left is the real value of goods used to purchase the slaves shipped to the Americas.

$CARGO_t$ to Africa. For cut-offs, the British Customs Office used Christmas-to-Christmas for 1699-1771 and January 5-to-January 5 for 1772-1807 (Johnson, 1990, p. 13). If, for example, $CARGO_t$ measures the cargo leaving Britain in 1750, then $SLAVES_t$ measures the number of slaves leaving Africa on the ships that left Britain between Christmas 1749 and Christmas 1750.

The resulting $PRICE$ series (labeled Whatley) is graphed in Figure 2, along with other price series for comparison. My estimate of $PRICE$ closely tracks the annual price series constructed by David Richardson (1991) who uses a similar method and similar data, the difference being updates to the slave trade data since 1991. $PRICE$ also tracks the price series compiled by Philip Curtin (1975) for the lower Gambia, but only when he uses similar account books in a similar manner.⁷ $PRICE$ also tracks the price series for enslaved Africans newly arrived in the Americas.⁸ American prices are higher, reflecting the additional cost of the Middle Passage, but the trends are similar.

$PRICE$ sat at approximately £5 between the third-quarter of the 17th century and the middle of the 18th century. At mid-century $PRICE$ begins to rise sharply. By the end of the 18th century the average annual real $PRICE$ of slaves on the coast of Africa is between £25-30, a five-fold increase in 50 years.⁹ Existing estimates of the long-run price elasticity of slave exports tend to cluster around 1.0 (Curtin, 1975, ch. 4; LeVeen, 1975; Grubb and Stitt, 1994). These are simple correlations between slave exports and slave prices over long periods of time. By this method, the British data exhibits a long-run price elasticity of around 0.8 for the 18th century.¹⁰

One advantage of the annual data is that they allow us to study trends and changes in the price-

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 and Ricardson (2004) .

⁹ Gemery, Hogendorn and Johnson (1990) refer to this as improvements in African terms of trade, but it could also reflect increases in the cost of slave capture and transport to the coast. As time passed, African slavers had to venture further inland to capture slaves, and communities used a variety of means to defend themselves. See Diouf (2003) and Klein (2001) for numerous examples of defensive strategies, especially among decentralized societies, the primary victims of the slave trade.

¹⁰ British quantity increased by approximately 400 percent while price increased by approximately 500 percent.

quantity relationship over time.¹¹ Figure 3 places $PRICE_t$ and $SLAVES_t$ on the same graph, with five-year moving averages to highlight trends. If there was any perceptible relationship between the trends in price and quantity before mid-century it was an inverse relationship. According to identity (1) this implies that increases in $SLAVES_t$ were outstripping increases in $CARGO_t$ and driving down $PRICE_t$, as if supply shifts were dominating demand shifts. The second thing to notice is how this pattern changes sometime around mid-century. In a reversal that seems to occur in the 1750s, $PRICE_t$ and $SLAVES_t$ begin to trend together. According to identity (1), this implies that $CARGO_t$ is increasing faster than $SLAVES_t$, driving up $PRICE_t$ and $SLAVES_t$ together, as if demand shifts have come to dominate supply shifts.

OLS regressions confirm a break in the price-quantity relationship around mid-century. Table 1 reports OLS regressions of $SLAVES_t$ on $PRICE_t$. To isolate general market trends, the regressions control for wars and revolutions in the Atlantic theater that temporarily disrupted both the transatlantic slave trade and Atlantic trade generally ($WARS_t$).¹² The $WARS$ are the War of Spanish succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), and the Great French Wars (1793-1801 and 1803-1807). The dummy variables correspond to the dates of British involvement in these conflicts. See the appendix for a discussion. I also add a dummy variable for the years that Britain held the Spanish Asiento (1713-1743) and a dummy variable for the years following the Haitian Revolution (1791-1807).

Table 1 reports results for eleven sub-periods that step through the century. The first sub-period is for 1699-1709. Each subsequent sub-period adds a decade of observations. After 1799 only eight (8) additional years are added because the British slave trade was abolished in 1807.¹³ Standard errors are estimated Newey-West, which allows for autocorrelation in the error terms up to the specified lags reported in Table 1.

¹¹ Unfortunately, they do not allow us to identify and estimate the short-run supply curve because the $PRICE$ measure is derived from the quantity measure ($SLAVES$).

¹² The regressions do not control for $CARGO_t$. That would cause an identity crisis. See equation (1). Later, reduced-form equations will control for $CARGO_t$.

¹³ There are two missing years in the Anglo-African Trade Statistics, 1705 and 1712, which are missing from the archive records.

The first thing to notice in Table 1 is that *WARS* typically reduced the volume of slave exports, holding price constant. The exception is the Seven Years War.¹⁴ Second, in the first half of the century there is no statistical relationship between *PRICE* and *SLAVES*, yet *SLAVE* exports increased from an average of 16.6 thousand per year in 1699-1708 to 23.2 thousand per year in 1746-1755. Shifts in British demand were being matched by shifts in African supply. Third, a positive relationship between *PRICE* and *SLAVES* first appears in the samples that extend beyond the 1750s, as if shifts in demand have come to dominate shifts in supply after mid-century. Table 2 reports these same regressions in log-form so that we can read off elasticities. The same pattern emerges. A positive relationship between *PRICE* and *SLAVES* does not appear until after the 1750s. For the century as a whole, the estimated price elasticity of exports is 0.38.

Table 3 reports the results of tests for a break in the price-quantity relationship after 1756, the date the trend appears to change in Figure 2. A dummy variable, *G1756*, is constructed where $G1756 = 1$ if $year \geq 1756$, zero otherwise. $SLAVES_t$ is then regressed on $PRICE_t$, $G1756*PRICE_t$ and $WARS_t$. A statistically significant coefficient on $G1756*PRICE$ indicates a change in the price-quantity relationship after 1756. The regression is estimated on annual observations (the short-run), overlapping 3-year weighted moving averages (the intermediate run) and overlapping 5-year weighted moving averages (the long-run). The estimated coefficients show a negative and statistically insignificant price-quantity relationship before 1756, but a positive and statistically significant price-quantity relationship after 1756. The estimated price elasticity for 1756-1807 is 0.13, considerably lower than the estimated 0.38 for the entire century, primarily because slave exports increased between 1699 and 1756 without an appreciable increase in price.

So far the data show that slave exports in the first half of the 18th century increased without price inducements. In the second half of the century slave export increased without much price inducement. At first glance, these regressions would appear to support the view that “African

¹⁴ West (1991) shows how British slave merchants were influential enough during the Seven Years War to successfully petition Parliament for exemptions to the national prohibition against gunpowder exports. They argued that gunpowder “greased” the slave trade. The Seven Years War was partially about the possession of slave estates in the West Indies.

wars caused the slave trade” -- that exogenous increases in African conflicts increased the number of slaves available for export, and that international demand simply set the price at which these slaves would be sold on the international market. But what factors lay behind the increase in conflict among Africans, and were these factors independent of the international demand for slaves? The regressions thus far have not controlled for *CARGO* which measures British demand for slaves. It is possible that some of the items in *CARGO* also influenced the number of slaves available for export.

3 THE GUN-SLAVE CYCLE

The guns-slave cycle is a hypothesis that explicitly singles out firearms and other weapons as items in *CARGO* that not only exchanged for slaves on the demand-side (as part of *CARGO*) but also entered into the production of slaves on the supply-side. The gun-slave cycle has two component parts: guns-for-slaves and slaves-for-guns. Gun-for-slaves emphasizes the European origin of the guns (the slave trade caused the African wars). In 1730, the Dutch Director General at Elmina Castle described what he saw along the Gold Coast of Africa as guns-for-slaves:

“The great quantity of guns and gunpowder which the Europeans have brought have caused terrible wars between the Kings and Princes and Caboceers of these lands, who made their prisoners of war slaves; these slaves were immediately brought up by Europeans at steadily increasing prices,... (quoted in Richards, 1980, 46).”

On the other hand, slaves-for-guns locates its origins in the political and economic ambitions of Africans -- ambitions that involve slave exports as a by-product of nation-building (African wars cause the slave trade).¹⁵ The proclamation of Ose Bonsu, King of Asante, is often taken as evidence:

"I cannot make war to catch slaves in the Bush, like a thief. My

¹⁵ See Northrup (2002), pp. 90-98 for a critical review.

ancestors never did so. But if I fight a king, and kill him when he is insolent, then certainly I must have his gold, and his slaves, and the people are mine too (quoted in DuPuis, 1824, p. 163)."

Lastly, guns-for-slaves and slaves-for-guns are sometimes combined into a self-perpetuating gun-slave cycle that feeds on itself,¹⁶ like the one described by Gemery and Hogendorn (1974):

“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).”¹⁷

Historians have long documented dramatic increases in the number of firearms shipped to Africa in the late 17th and early 18th centuries, precisely when slave exports began to increase.¹⁸ Before then, the older matchlock musket proved ineffective in tropical climates and the Catholic Church prohibited their sale to non-Christians, although some muskets were distributed to Kings as gifts and others were captured by Africans in skirmishes with Europeans. The sale of large numbers of guns and gunpowder to Africans began with Protestant slave traders not bound by Catholic prohibitions.¹⁹ The Dutch were the first to sell large numbers, followed by the English as their participation in the slave trade grew. Fearful of losing their position in the trade, the Portuguese quickly followed suit. By the 1680s the more-efficient

¹⁶ What Acemoglu and Robinson (2012) call a “vicious cycle.”

¹⁷ The Dutch Director General at El Mina does not describe what he saw as a prisoners’ dilemma arms race, but his quote continues along similar lines: “The great quantity of guns and gunpowder which the Europeans have brought have caused terrible wars between the Kings and Princes and Caboceers of these lands, who made their prisoners of war slaves; these slaves were immediately brought up by Europeans at steadily increasing prices, *which in its turn, animates again and again these people to renew their hostilities, and their hope of big and easy profits makes them forget all labor, using all sorts of pretexts to attack each other or revive old disputes* (italics added and quoted in Richards, 1980, 46).”

¹⁸ See Curtin (1975, p. 320-25); Inikori (1977); and Richards (1980).

¹⁹ See Kea (1971) and Northrup (2002), especially pages 90 - 98.

flintlock began to replace the matchlock, and firearms became a staple outbound cargo on most slave ships destined for Africa. By the 1690s, the new gunpowder technology was influencing military formations and military strategies along the Lower Guinea Coast, precisely when slave exports from that region began to accelerate.²⁰

Thus began a period of sustained growth in both firearms shipments to Africa and slave exports from Africa. Between 1680 and 1685, the British Royal African Company shipped but 2,615 firearms per year to Africa. By the end of the 18th century, Inikori (1977) estimates that the British were shipping 150,000 to 200,000 guns per year and the total for all European nations was between 300,000 and 400,000 guns per year.

The aggregate correlation between firearm shipments and slave exports is not controversial. What is controversial is the claim that the two were systematically related on the supply side -- that the diffusion of the new gunpowder technology increased productivity in slaving and drove the expansion of slave exports. When one thinks of the violent process of enslaving people and marching them to the coast, one can imagine how firearms might give captors an advantage, but the advantage cannot be assumed. In Europe, the strategic advantage of the gunpowder technology was its ability to pierce armor, something that was seldom worn in and around the rainforests of Africa. There the advantage was the projectile's ability to cut through the thicket and overgrowth that often served as cover for troops and escapees (Thornton, 1999). Kea (1971) describes how the flintlock revolutionized military formations and strategies in the forests kingdoms of the Lower Guinea Coast. Thornton (1999) describes how the flintlock allowed Dahomey marksmen to cover wider gaps in infantry formations to slow the advance of Oyo cavalry from the north.²¹ On the other hand, a wounded captive was of little value, although no less valuable than a runaway, and firearms probably allowed slave traders to threaten captives more effectively. Firearms were also effective defensive weapons, especially behind walls (Thornton, 1999). They were also used extensively to hunt for ivory and food, and to defend against predatory animals and people (White, 1971).

²⁰ See Kea (1971), Thornton (1998), Daaku (1970) and Law (1991).

²¹ The "shock-and-awe" advantage was also a tactic learned early and often from encounters with Europeans. The early Portuguese traders were quick to display the power of their weaponry, and when British ships arrived on the coast of Africa to purchase slaves, they announced their arrival by firing rounds of canons (St. Clair, 2007, chapter 1).

The net advantage of firearms in the capture and transport of slaves is not a forgone conclusion. It must be established empirically. Eltis and Jennings (1988), for example, show that while firearms shipments to Africa increased tenfold between the 1680s and the 1780s (from 20,000 to 200,000 guns per year) they did not keep pace with the overall growth of *CARGO*, declining from 8.6% of the trade in the 1680s to 7.5% of trade in the 1780s. How then can we think of guns as driving the expansion of the slave trade in the 18th century?

The *Anglo-African Trade Statistics* document a similar decline in the importance of the gunpowder technology in *CARGO*. The *Anglo-Africa Trade Statistics* do not record guns separately,²² but they do contain a continuous time-series on gunpowder. For our purposes gunpowder may be a better measure than guns. There were so many kinds of guns that it would prove difficult to construct a reliable index. In addition, firearms are durable goods, so in order to convert trade flows into stocks available for slave production one would need estimates of depreciation rates, and ideally a different depreciation rate for each type of gun. And even if the stock of guns could be estimated, their effective capacity as weaponry was largely determined by the amount of gunpowder available to activate them.

Gunpowder, on the other hand, is a more homogeneous product and much easier to handle quantitatively. While there are different grades of gunpowder, a poor grade was always shipped to Africa to match the poor quality of the firearms shipped to Africa.²³ Gunpowder is measured in standardized pounds or barrels, which we could never do for guns. And gunpowder does not last nearly as long as guns, especially in the humid tropics. The analysis that follows assumes that the flow of gunpowder largely determines the productive capacity of the gunpowder technology.

Figure 4 displays the data on British gunpowder shipments found in the *Anglo-African Trade Statistics*. As a share of British *CARGO*, gunpowder increased steadily during the first half of

²² We still do not know why. Marion Johnson, the scholar who digitized the *Anglo-African Trade Statistics*, believed guns were recorded in the category “wrought iron (p. 9).” Inikori (1977, p. 347) finds in the *British Parliamentary Papers* data on the value of firearm shipment between 1796 and 1805, so the data exist for that period. Other than this, a time series on British firearms shipments to Africa does not seem to exist.

²³ See Inikori (1977), West (1991) and Richards (1980)

the 18th century, peaking at about 10 percent of imports in the 1760s but holding steady or declining thereafter. If we add available data on the value of firearms shipped between 1792 and 1805, as reported by Inikori (1977, p. 347), the share of weaponry in British *CARGO* increases by approximately ten percentage points. Adding knives and swords would increase the share more. A reasonable range for British weaponry exports to Africa in the late 18th century appears to be 15-25 percent of British *CARGO*. For the period 1758-1806, Richardson (1979, p. 312) estimates guns and gunpowder to be 25-33 percent of British cargo in the New Calabar and Windward Coast slave trades, and about 20 percent of British cargo in the Gambia and Bonny trades.

As high as these figures appear to be, the constant or declining share of gunpowder in *CARGO* after mid-century raises an important issue. If the gunpowder technology was driving the expansion of slave exports, then one would expect the share of gunpowder in *CARGO* to increase throughout the 18th century, along with increases in slave exports, but the share peaks around mid-century. This is the primary reason why Eltis and Jennings (1988) cautioned that "[t]hose claiming a major impact from arms will have to build their arguments on some basis other than just the volume of imports (954)."

I address this caution in two ways. First, the share of gunpowder in *CARGO* may not be the best measure for investigating the gun-slave cycle. The share of gunpowder in *CARGO* measures the importance of guns-for-slaves in exchange, not guns-for-slaves in production, and while the two are related they are not the same. The distinction is highlighted in Figure 5. A good summary measure of the importance of guns-for-slaves in exchange is the share of gunpowder in *CARGO*, or gunpowder per unit of *CARGO* exchanged for slaves. A good summary measure of the importance of guns-for-slaves in the production of slaves is gunpowder per *SLAVE* export. If gunpowder was used to capture slaves then a lot more of it was available per captive in the second half of the 18th century, even as gunpowder was declining as a share of *CARGO*. True, there was a lot more of everything else around too, as Eltis and Jennings point out, but the other items in *CARGO* were not used to capture slaves. This critical distinction between gunpowder and other items in *CARGO* allows me to use the other cargo items as *PLACEBO* products in falsification tests to see if the estimated guns-slave relationship is a supply-side or demand-side

relationship. All *CARGO* items, including gunpowder, exchanged for slaves on the demand-side, but only gunpowder and other weapons were used to produce slaves on the supply-side.²⁴

Second, rather than rely on levels to investigate the gun-slave relationship, I rely on *changes* in levels. Differencing the annual observations de-trends the data, which removes potential spurious correlation between covariates that may be trending together over time. Differencing the annual observations also transforms the data into a weakly-stationary time-series where the mean, variance and auto-covariance do not change over time. This allows the analysis to predict the impact of average changes in *CARGO* and *GUNPOWDER* on average changes in *SLAVES* within well-defined periods of time.²⁵

4 ESTIMATION EQUATION

As we saw in identity (1), our measures of price and quantity are not independent of each other, so the empirical approach is to equilibrate supply and demand and estimate the resulting reduced-form relationship between *SLAVES* and exogenous supply and demand covariates. The supply and demand equations are:

$$\begin{aligned} PRICE_t &= S(SLAVES_t, X_{st}) \\ PRICE_t &= D(SLAVES_t, X_{dt}), \end{aligned}$$

S denotes supply, *D* denotes demand and *X* is a vector of exogenous covariates.

Setting $D = S$ and solving for equilibrium *SLAVES*_{*t*} as a function of *X*_{*st*} and *X*_{*dt*} yields

$$SLAVES_t = H(X_{st}, X_{dt}).$$

Total differentiation yields

²⁴ Strictly speaking, some items in *CARGO* other than *GUNPOWDER* were also used to produce slaves, namely knives, firearms, shackles and chains, wherever these may be recorded. The placebo tests will help identify their locations.

²⁵ See Wooldridge (2013) chapter 11.

$$d(SLAVES_t) = \sum_i \frac{\partial H}{\partial x_{it}} dx_{it}.$$

The estimated equation is

$$\Delta(SLAVES_t) = \alpha + \sum_i \beta_i \Delta x_{it} + \varepsilon_t.$$

Δ denotes change between year t and year $t-1$, and β_i is the estimated reduced form relationship between $\Delta SLAVES_t$ and Δx_i . Available demand-side covariates are *CARGO* and *WARS*. The available supply-side covariate is *GUNPOWDER*.

WARS_t are exogenous to *SLAVES_t*, being primarily the result of hostilities among European mercantile powers over national sovereignty at home and colonial possessions in the Americas. We are interested in *GUNPOWDER* as the treatment variable. Was *GUNPOWDER_t* exogenous to *SLAVES_t*? Could *SLAVE* exports in year t influence the amount of *GUNPOWDER* shipped to Africa in year t ? The answer depends on the length of time it took for information about *SLAVES_t* to return to Britain and influence *GUNPOWDER_t*. Figure 5 plots the number of days it took the ships in the British sample to travel from Britain-to-Africa-to-America. The average duration approached 300 days. From here, the ventures had to sell their slaves in the Americas, restock provisions, secure a British-bound cargo of sugar and sail back to Britain. In Britain, they had to unload the American cargo, secure a new commission and crew, restock *GUNPOWDER* and set sail for Africa. In order for information about supply conditions on the coast of African in year t (*SLAVES_t*) to influence the amounts of gunpowder shipped to Africa in year t (*GUNPOWDER_t*), ventures had to complete the cycle from Britain to Africa to America to Britain and then outbound to Africa again within the calendar year t . This was the nature of the Triangular Trade. Because of ocean currents and prevailing winds, information in the northern hemisphere of the Atlantic Ocean tended to flow in a clockwise direction. Some of the first ships leaving in January might complete the triangle before the end of the calendar year, but the vast majority will not. The same applies to *CARGO_t*. Information learned from

$SLAVES_t$ could influence next year's $CARGO_{t+1}$ and $GUNPOWDER_{t+1}$, but it was unlikely to influence this year's $CARGO_t$ and $GUNPOWDER_t$.

I therefore estimate the following gun-for-slave equation:

$$\begin{aligned} \Delta SLAVES_t = & \alpha + \beta_1 \Delta GUNPOWDER_t + \beta_2 \Delta GUNPOWDER_{t-1} + \beta_3 \Delta CARGO_t \\ & + \beta_4 \Delta CARGO_{t-1} + \beta_5 \Delta WARS_t + \varepsilon_t \end{aligned} \quad (2)$$

The value of gunpowder is a component of $CARGO$ and controls for guns-for-slaves in exchange, acting here like any other commodity in $CARGO$. $CARGO$ is measured in hundreds of pounds sterling (£00). The variable $GUNPOWDER$ is measured in hundreds of physical pounds (cwt). I translate gunpowder values into physical pounds by dividing the value of gunpowder into the 1699 official price of gunpowder.²⁶ β_1 and β_2 estimate the *additional* effects of one hundred pounds of gunpowder on $SLAVES_t$. We want to know if this additional effect was operating through the supply-side. Lagged $GUNPOWDER$ and lagged $CARGO$ are included to pick up any long-term effects of $GUNPOWDER_{t-1}$ on $SLAVES_t$.

An additional test falls out of this equation. $CARGO_{t-1}$ is a control variable added to the equation that force the coefficient on $GUNPOWDER_{t-1}$ to estimate the *additional* effect of $GUNPOWDER_{t-1}$ on $SLAVES_t$. However, the coefficient on $CARGO_{t-1}$ also tests the hypothesis that British cargo shipments helped finance expansion of slaving in the interior of Africa. Joseph Miller, in his classic book *Way of Death: Merchant Capitalism and the Angolan Slave Trade, 1730-1830*, argued that the trans-Atlantic slave trade was a two-stage process in Africa that required financing from international merchants. In the first stage, African slaver invested their imported cargo ($CARGO_{t-1}$) in local forms of wealth, which in labor-scarce Africa often meant accumulating the obligations of people – captives, servants, wives, porters, workers, soldiers, political supporters and allies. In the second stage, some of these accumulated people

²⁶ 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 Trade Statistics* 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.

were exported as slaves ($SLAVES_t$). β_4 tests this hypothesis. Call it credit-for-slaves.

5 RESULTS

5.1 Guns-for-slaves.

Table 4 reports the results for guns-for-slaves, the coefficient on $GUNPOWDER_t$ in Equation (2).²⁷ Like before, equation (2) is estimated on 11 sub-samples beginning in 1699, stepping by decade to 1807. Since the price-quantity analysis identified a break around mid-century, I also estimate equation (2) for six sub-samples that begin in 1750 and step by decade to 1807. I do this for annual observations (short-term), overlapping 3-year weighted moving averages (intermediate-term) and overlapping 5-year weighted moving-averages (long-term).

The regressions show statistically significant guns-for-slaves in the first half of the century, which is consistent with the idea that increases in gunpowder shipments drove increases in slave exports in the first half of the 18th century. The guns-for-slaves relationship is more-precisely estimated in the intermediate and long-runs cases, suggesting that the guns-for-slaves relationship was built upon a proven history of guns having produced slaves in the past. For example, in the intermediate-run, every 100 pounds of additional gunpowder shipped to Africa between 1699 and 1729 was correlated with 4.33 additional slave exports, on average. Table 4 also shows statistically significant evidence of short-run guns-for-slaves in 1750-1759 and long-run guns-for-slaves for the entire 18th century. Curiously, the relationship between guns and slaves is negative and significant in the middle of the century, precisely when the price-quantity relationship changes. More will be said about this in section 5.4.

Are these estimated guns-for-slave relationships supply-side or demand-side relationships? $CARGO_t$ controls for guns-for-slaves on the demand-side because $CARGO$ includes the $GUNPOWDER$ that was exchanged for slaves. As an additional test to see if the estimated coefficient on $GUNPOWDER_t$ is a supply-side relationship, I run a series of falsification tests. The tests are based on the fact that each item in $CARGO$ exchanged for slaves on the demand-side, but only gunpowder, shackles, firearms and other weapons were used to capture and transport slaves on the supply-side. One-by-one, I add to equation (2) the changes (and lagged

²⁷ The coefficient on $GUNPOWDER_{t-1}$ is never significant, so I do not report it.

changes) in the real value of each commodity class found in $CARGO_t$ to see if any other commodities produced additional slaves like $GUNPOWDER_t$ did. If they did not then the interpretation of gun-for-slave as a supply-side relationship passes this falsification test.

The *Anglo-African Trade Statistics* divide $CARGO$ into 18 classes of commodities that together sum to the value of $CARGO$.²⁸ I use 16 of these commodities in the falsification tests. I do not use Coins (only 5 non-zero entries) and Military Stores (because it includes $GUNPOWDER$). The *Anglo-African Trade Statistics* also single out wrought iron as a special sub-class “because it is thought to contain firearms, a commodity conspicuously absent elsewhere in the statistics (p. 24).” Call these 17 commodity classes $PLACEBO$ s. $PLACEBO_t$ and $PLACEBO_{t-1}$ are added to equation (2) and the equation is re-estimated. The set of 17 $PLACEBO$ tests are run for the periods and terms-lengths that revealed statistically significant gun-for-slaves relationships, excluding the negative estimates at mid-century.

Table 5 reports the results. In falsification tests for periods before 1739, the coefficient on $GUNPOWDER_t$ typically remains large and statistically significant when confronted with $PLACEBO$ challenges. It loses significance when it competes with iron and steel, wrought iron and other metals -- all of which are candidates for containing shackles, guns, knives, swords and other weapons. The regressions also show that a long-term guns-for-slaves relationship may have extended to 1749 or 1959. $GUNPOWDER_t$ typically remains significant at the 90 percent confidence level, but alcoholic beverages and tobacco products are added to the list of commodities that make $GUNPOWDER$ fail. There is little evidence of supply-side guns-for-slaves beyond 1759.

5.2 Credit-for-slaves.

Table 6 reports results for credit-for-slaves. These are the estimated coefficients on $CARGO_{t-1}$ in equation (2). The consistent pattern is for the period 1750-1789. Between 1750 and 1789 increases in British cargo increased future slave exports. This supports Miller’s view that the African slave trade was a two-stage process financed by European slave traders, at least for this

²⁸ These are listed and described in Johnson, et al (1990), Table 2, page 24. “A product category is an agglomeration of related commodities with a single range broad enough to enhance clarity but narrow enough to retain interesting differences in development (p. 23).”

period.²⁹ We can get a ballpark estimate of the importance of credit-for-slaves by evaluating the relationship at mean values. For the intermediate-term, every £100 of additional cargo that exchanged for slaves in year t also financed the capture and transport of an additional 1.77 slaves in year $t+1$. For the intermediate-run, mean $\Delta CARGO_{t-1}$ was £11,736 per year between 1750 and 1789, which financed expansion by an estimated 207.7 additional slaves per year (1.77×117.36). Slave exports during this period grew by only 150.7 slaves per year, so merchant capital financing essentially drove British expansion between 1750 and 1789.

Regressions of slave exports on lagged slave prices show no statistically significant relationship between the two variables.³⁰ African slave traders were not responding to the incentives of higher prices. They were responding to increases in the availability of working capital. Fenske and Kala (2013) present evidence that after 1730 negative climate shocks in Africa reduced slave exports. They interpret this as evidence that negative climate shocks reduced the carrying capacity of organized slaving networks in Africa. The evidence in Table 6 is consistent with this view for 1750-1789. By the second half of the 18th century, slaving in Africa had become structured-enough to be either finance by international capital or disrupted by negative climate shocks.

Institutions may have developed in Africa over the course of the 18th century to facilitate the flow of working capital,³¹ but a documented re-organization at the Royal African Company during this period may have also played a role. In 1750 the Royal African Company was reorganized again. The Company of Traders to Africa was formed on April 12, 1750 to maintain British forts on the coast of Africa, but the newly-formed company was not allowed to

²⁹ Miller's classic case-study was Angola in the southern hemisphere, which traded largely with Brazil. There, the travel time was shorter, travel was back-and-forth (so information flowed in both directions simultaneously), and the Portuguese had established permanent military and trade settlements inland Africa. It is not surprising that credit relations would be established under these conditions. This paper presents evidence of a similar kind of working-capital in the British Triangular Trade in the northern hemisphere between 1750 and 1789.

³⁰ In the regression $\Delta SLAVES_t = \alpha + \beta_1 * \Delta PRICE_{t-1} + \beta_2 * \Delta WARS_t + \mu_t$, estimated $\beta_1 = 139.3$ with a t-statistic = 0.36. This is for the intermediate run in the period 1750-1789.

³¹ A variety of institutions facilitated repeat exchanges between African and Europeans and served as enforcement mechanisms, including the use of factories and forts as holding pens and warehouses, African canoe houses and other African trade coalitions, secret societies, and treaties between European and African nations. Where treaties were not possible, the pawning of family members as collateral for debt was an effective collection mechanism. See Falola and Lovejoy (1994).

³¹ The coefficient on $GUNPOWDER_{t-1}$ is never significant, so I do not report it.

export slaves.³² Traders paid 40 shillings to use the forts and annual Parliamentary grants of £10-20,000 sterling were given each year

“...for the purchase of goods and stores which... are to be sent and exported to Africa, there to be sold, disposed of and applied for the sole use, preservation and improvement of the forts and settlements there, and for the payment of salaries and wages to the officers and other persons employed for keeping and preserving the said forts and settlements and not otherwise (31, Act Clause 5, quoted in Martin, 1970, p. 29)”

The annual grants were disbursed as annual shipments of cargo to Cape Coast Castle and distributed from there to the other British establishment on the Guinea Coast, and while these cargo shipments may or may be included in our measure of $CARGO_{t-1}$ they were deployed as working capital in the African slave trade. The parliamentary committee charged with oversight encouraged trading by officers (including trading for slaves) as a supplement to wages, but they discouraged direct competition with free traders. Company employees could trade with locals for slaves, stockpile them in the forts and sell them to free traders for export, but they could not engage in exporting activities directly. There is no way of knowing how wide-spread this practice was. If the turnover was reasonably quick (say a few weeks between slave purchasing and slave exporting) then the annual grants were large enough to gather much of the British slave trade, and reinvesting profits would further increase the carrying capacity of the annual grants.

5.3 Slaves-for-guns.

Is there any evidence in the data of slaves-for-guns -- of Africans capturing and selling more slaves in order to buy more guns? It is difficult to obtain direct evidence on the motivations of African slave traders, but one possibility is to use the annual time-series to infer from ex-post outcomes what British slave traders must have learned while on the coast of Africa. If British slave traders learned that African slave traders were selling more slaves but demanding more

³² The following discussion relied heavily on Martin (1970).

guns (if there was an excess demand for guns among African slave traders), then increases in slave exports in year $t-1$ should attract larger shipments of guns in year t . Historians often report a preference for guns among African slave traders, a preference that is not observed among other African traders, but these accounts cannot follow the effects of this preference on future gun flows.³³ If this year's British slave traders experienced excess-demand for gunpowder, then next year's gunpowder shipments should increase. We should see a positive inter-temporal relationship between $\Delta SLAVES_{t-1}$ and $\Delta GUNPOWDER_t$.

To test for this, I estimate the following slaves-for-guns equation:

$$\Delta GUNPOWDER_t = \alpha + \beta_1 \Delta SLAVES_{t-1} + \beta_2 \Delta CARGO_t + \beta_3 \Delta WARS_t + \varepsilon_t \quad (3)$$

In this equation, GUNPOWDER is measured in lbs. (not cwt) and CARGO is measure in £ (not £00).

Results are reported in Table 7. For the period 1699-1729, slaves-for-guns appears in the short, intermediate and long-run. The relationship gets stronger and longer as the run lengthen, stretching as far as 1749 in the long-run case. There is also evidence of slaves-for-guns in the periods ending in 1789, similar to the evidence on credit-for-slaves. These regressions also show a negative mid-century slaves-for-guns relationship, similar to the negative mid-century relationship in the guns-for-slaves equation.

Table 8 reports falsification tests. Since we are estimating correlations only, $\Delta SLAVES_{t-1}$ is put on the LHS of the regression and $\Delta GUNPOWDER_t$ on the RHS of the regression so that $\Delta GUNPOWDER_t$ can compete with $\Delta PLACEBO_t$. For the period 1699-1729, the interpretation of slaves-for-guns as a supply-side relationship passes this falsification test, and for all three terms lengths, and only infrequently do any of the $PLACEBO_t$ products show a positive,

³³ Inikori (1977): "These imports (guns) 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). Studies by Johnson (1966) and Richardson (1979) find similar preferences for firearms among slave traders.

statistically significant relationship with $SLAVES_{t-1}$.³⁴ In addition, a long-term slaves-for-guns relationship may have extended to 1749. In the 1699-1749 long-run case, most of the coefficients on $GUNPOWDER$ remain significant at the 90 percent confidence level. The coefficient on $GUNPOWDER$ loses statistical significance when it competes with English cottons, linen, iron and steel and wrought iron. Iron and steel and wrought iron are the only $PLACEBO$ products in this group that are statistically significant at the 90 percent confidence level. Iron and steel includes knives, swords and shackles. Wrought iron may include guns. The slaves-for-guns relationship does not pass any of the falsification tests for periods that extend beyond 1749.

5.4 The gun-slave cycle.

The results for guns-for-slave and slaves-for guns are remarkably similar. Both relationships were strong and systematic between 1699 and 1729, and both dissipated by mid-century. There is no statistical reason why a contemporaneous relationship between $\Delta GUNPOWDER_t$ and $\Delta SLAVES_t$ should generate an inter-temporal relationship running from $\Delta SLAVES_t$ to $\Delta GUNPOWDER_{t+1}$, and only in the first half of the 18th century.³⁵ The estimation procedure and the time-differencing of the variables removes serial-correlation and time-trends in the data, and $PLACEBO$ tests fail to falsify the relationships as supply-side phenomena. Still, guns-for-slave and slaves-for-guns show through, and at the same time. This is solid evidence of a gun-slave cycle in the British slave trade in the first half of the 18th century, characterized by Gemery and Hogendorn (1974) as a prisoners' dilemma arms race of "raid or be raided."

In self-enforcing cycles like this, it is difficult to identify ultimate cause. A King, victorious in an African war, exchanging captives for guns, or a British slave trader selling guns to a victorious African King, it doesn't really matter which scenario ignites the cycle. Once begun, even those having no stake in the slave trade will be forced to raid-or-be-raided. Still, it is important to emphasize that the cycle relied on a growing international demand for African

³⁴ Curiously, these include salt. A possible slaves-for-salt relationship deserves further investigation, given the controversy surrounding the claim that the interior of West Africa was a low-salt environment (Lovejoy, 1986; McDougall, 1990), that salt somehow played a role in surviving the Middle Passage, and that this link helps explain the high rates of hypertension among African Americans (Wilson and Grim, 1991; Curtin, 1992). This issue is beyond the scope of this paper.

³⁵ As further evidence that this is a social relation and not a statistical artifact, the inter-temporal relationship running in the opposite direction (from $GUNPOWDER_{t-1}$ to $SLAVES_t$) is never statistically significant.

slaves and the importation of a new gunpowder technology, so in a very real sense it was “the slave trade that caused the war,” not the other way around.

We can get a ballpark estimate of the magnitude of the gun-slave cycle’s effect by evaluating the components at their means. For the 1699-1729 intermediate run, the average $\Delta GUNPOWDER_t = 71.2$ cwt, so additional gunpowder produced an estimated 306.2 additional slaves per year (4.3×71.2).³⁶ For the period 1699-1729, average $\Delta SLAVES_{t-1}$ was only 161.7, so guns-for-slaves accounted for 189% of the additional slave exports per year ($306.2/161.7$). Without the additional gunpowder shipments British slave exports would have declined by an average of 144.5 slaves per year ($306.2-161.7$). Continuing through the cycle, the additional 306.1 slave exports attracted 1,641 additional lbs. of gunpowder the next year (306.2×5.36) or 16.41 cwt., so in the period 1699-1729 slaves-for-guns accounted for an estimated 23 percent of the growth in gunpowder shipments to Africa ($16.41/71.2$).³⁷

5.5 Mid-century

The relationship between $PRICE_t$ and $SLAVES_t$ changed sometime around mid-century. Before mid-century, slave exports increased without price inducements because Africans were caught in a gun-slave cycle that produced large numbers of slaves for exports. In the second half of the century British cargo shipments financed the expansion of slaving in the Africa interior. But what explains the negative gun-slave relationship around mid-century? Why would more gunpowder be correlated with *fewer* slaves exported around mid-century?

The most-obvious possibility is the use of imported weaponry to defend against enslavement. Defense is always a factor. The positive gun-slave relationships reported in Tables 4 and 7 are net of the use of guns for defensive purposes. Maybe gunpowder imports at mid-century were used in a wave of successful defensive stands, but it is unclear why the tide would turn in all of

³⁶ The guns-slave cycle could have begun before our data begin. This is the period of transition from indenture servitude to slavery in the Chesapeake region of the 13 British colonies of North America. Accounts tend to assume unlimited or highly elastic supplies of African slaves. See Galenson (1991), Grubb and Stitt (1994), Solow and Engerman, (1987, pp. 15, 73) and Atack and Passell, (1994, pp. 40-51). The gun-slave cycle helps explain why supplies were so abundant.

³⁷ In the calculation I use the 306.2 additional slaves from the 71.2 additional cwt of gunpowder, rather than the actual 161.7 additional slaves, because I want to estimate the average gun-slave cycle as the average prisoner’s dilemma arms race effect.

British Africa at the same time and then disappear.

Another possibility has to do with changes on the British side. West (1991) documents how British slave traders during the Seven-Years War (1756-62) successfully petitioned Parliament for exemptions to a national prohibition on private gunpowder exports, exactly when the negative gun-slave relationship appears. This exemption for slave traders may explain why British slave purchases did not collapse during the Seven Years War (see Tables 1 and 2), but it cannot explain the sign reversal in the gun-slave relationships unless the exemption encouraged British slavers to dump large amounts of gunpowder on Africa regardless of African demand. While British slave traders were allowed to export gunpowder during the Seven Years War, they were not allowed to threaten British military needs. The gunpowder shipped to Africa was low-quality gunpowder that was not needed for military purposes. When we control for this additional consideration the negative gun-slave relationship disappears.

West (1991, page 219, Table 7) collected data on “all deliveries, contracts, and results of proof” tests for gunpowder delivered to the British Ordnance Office between 1755 and 1770.³⁸ From these data she calculates the percentage that fails to pass the proof test for military use. When I add “percent failed” to the gun-slave regressions (as a control for changes in the amount of excess low-grade British gunpowder available for export to Africa) the negative gun-slave relationships become statistically insignificant. These results are reported in the first three columns of the top two panels of Table 9. The last three columns show that when “percent failed” is removed from these regressions the negative gun-slave relationship reappears for the 1755-1770 period.

The last panel of Table 9 reports tests for a post-1756 break in the British capacity to dump excess gunpowder on Africa. We do not have data on failure rates that span 1756. Instead, gunpowder shipments to Africa are regressed on a proxy for excess capacity in the British gunpowder industry. The data come from Mitchell’s *British Historical Statistics* (1988, pages 578-580). The proxy is the previous maximum level of government expenditure on ordnances

³⁸ West (1991, page 219, Table 7). These are data recorded in the British Ordnance Minute Books of the Surveyor General and the Ordnance Bill Books for the years 1755-1770.

minus the current level of government spending on ordnances. The Government Ordnance Office was the major purchaser of gunpowder in Britain. Wartime needs expanded capacity in the industry and government purchases always collapse at the end of hostilities, leaving excess capacity in the industry to be dumped on Africa (or anywhere else in the world).³⁹ The regressions reported in the last panel of Table 9 show no evidence of this measure of excess capacity influencing gunpowder shipments before 1756, but the regressions show large and significant effects after 1756. After 1756, for every £1,000 of excess capacity, 535 pounds of gunpowder were shipped to Africa, even after controlling for *WARS* and *CARGO*. This mid-century change in the factors driving British gunpowder exports to Africa (from excess demand in Africa to excess supply in Britain) also helps explain the passing of the gun-slave cycle around mid-century.

6 CONCLUSION

The British slave trade grew from small beginnings in the 1650s to become one of the largest slave trades in the world by 1807. This paper presents evidence that British growth in the first half of the 18th century relied on a guns-slaves cycle that produced large numbers of slaves for export. In the second half of the century British growth relied on dumping excess gunpowder on Africa when it was not needed for war and merchant-capital financing of slave production in the African interior. There is little evidence in these trade data that African slave exports were very responsive to changes in the export price of slaves.

The study has several limitations. First, it is a case-study of the British slave trade only. We do not know if or when these dynamics existed in the French or Portuguese trades.⁴⁰ Second, the empirical analysis identified correlations between changes in British gunpowder shipments and changes in British slave purchases, as if the British were the only traders shipping gunpowder to Africa and the only purchasers of the slaves captured with British gunpowder. Other nations

³⁹ Volatility in British government purchases and industry demand is clearly documented in West (1991): “The period of peace demonstrates severe problems for gunpowder makers. They had no government employment, due to the inability of the Ordnance Office to agree contracts prematurely for a substance which could not be stored indefinitely. They were therefore dependent entirely on private trade (p. 5).”

⁴⁰ Miller (1988) finds anecdotal evidence of a gun-slave cycle in the Portuguese-Angola slave trade in the South Sea: “The stories circulating about the bones of the vanished Africans yielding the gunpowder of the new trade, thus expressed the essence of a fatal and tragic exchange of people for power in a strikingly accurate metaphor... (pp. 103-04).”

shipped large quantities of guns and gunpowder to Africa too, and other nations competed with British traders for slaves. Finally, the *Anglo-African Trade Statistics* do not report trade by region or port, so we cannot identify the regions or ports where British slave traders unloaded their gunpowder and cargo.

We can, however, identify the major ports of British activity. We can also situate British activity in these ports within the context of their competitors. Figure 6 summarizes British activity in its major ports of trade – the 18 African slave trading ports where British traders purchased 25,000 or more slaves over the course of the 18th century.⁴¹ The Figure shows the increasing competitiveness of British slave traders in these identifiable places. The dotted line at the top of the figure shows the percentage of all British slave purchases that were conducted in these 18 ports.⁴² British traders always purchased the majority of their slaves in these ports, around 90 percent over the course of the 18th century. The solid line in Figure 6 shows the British share of the slaves exported from these ports. British growth over the 18th century came primarily from improved competitiveness in these 18 ports. The regression line estimates that British traders held a 45-50 percent share of these markets in the early 18th century and penetrated to an 80 percent share by the end of the 18th century. The point of the graph is not to summarize this complex history (which is indeed complex) but to show that the British case was not an isolated case. It was a successful case that forced other traders to emulate or vacate. As such, the British experience can serve as a window onto the experiences of other slave trading nations.

⁴¹ The ports are Gambia and St. Louis in Senegambia; Ilse de Los and the Sierra Leone Estuary in Sierra Leone; Bassa and Cape Mount on the Windward Coast; Anombu and Cape Coast Castle on the Gold Coast; Benin and Whydah in the Bight of Benin; Bonny, Calabar, Cameroons and New Calabar in the Bight of Biafra; and Cabina, Congo River, Loango and Malembo in West Central Africa.

⁴² The calculation is the percentage of all exports for which we know the port of embarkation.

Appendix: WARS and their dates

The War of Spanish Succession (1701-1711)

In Britain, the war ended following the Tory political victory in 1710 which led to the Peace of Utrecht. France and Great Britain came to terms in October 1711, when the preliminaries of peace were signed in London. Following this, the Congress of Utrecht opened on 29 January 1712. In Spain the war continued until it was decided by the Siege of Barcelona, on September 11, 1714.

The War of Austrian Succession (1743 – 1748)

In 1743 an Anglo-allied army commanded by King George II formed on the lower Rhine upon the withdrawal of the French (Westphalian) Army. This English army became known as the "Pragmatic Army." British hostilities ended with the Treaty of Aix-la-Chapelle of October 18, 1748, which ended the war and was signed by Great Britain, France, and the Dutch Republic.

The Seven Years War (1756-1762)

War between Britain and France was formally declared on 18 May of 1756. The Treaty of Paris, also known as the Treaty of 1763, was signed on 10 February 1763 by the kingdoms of Great Britain, France and Spain.

The American Revolution (1775-1782)

The outbreak of fighting between militia and British regulars began at Lexington and Concord in April of 1775. In April 1782, the British House of Commons voted to end the war in America. The formal end of the war did not occur until the Treaty of Paris (for the U.S.) and the Treaties of Versailles (for the other Allies) were signed on September 3, 1783.

The Great French Wars (1793-1801 and 1803-15)

The French Revolutionary Wars lasted from April 20, 1792 to March 25, 1802. The British got involved in 1793. The Treaty of Amiens (March 25, 1802 to May 18 1803) temporarily ended hostilities between the French the United Kingdom and was the only period of peace during the so-called 'Great French War' between 1793 and 1815, which included the Napoleonic Wars

between May 18, 1803 and November 20, 1815.

Asiento (1713-1743)

The Spanish Asiento (the right to carry the Spanish slave trade) was awarded to Britain in 1713 for 30 years as part of the Treaty of Utrecht.

Post Haitian Revolution (1791 --)

The Haitian Revolution (1791–1804), was a slave revolt in the French colony of Saint-Domingue that culminated in the founding of the free state of Haiti, and is considered to be a significant event that may have hastened the end of the transatlantic slave trade.

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Figure 1. Transatlantic Slave Trade by National Carrier

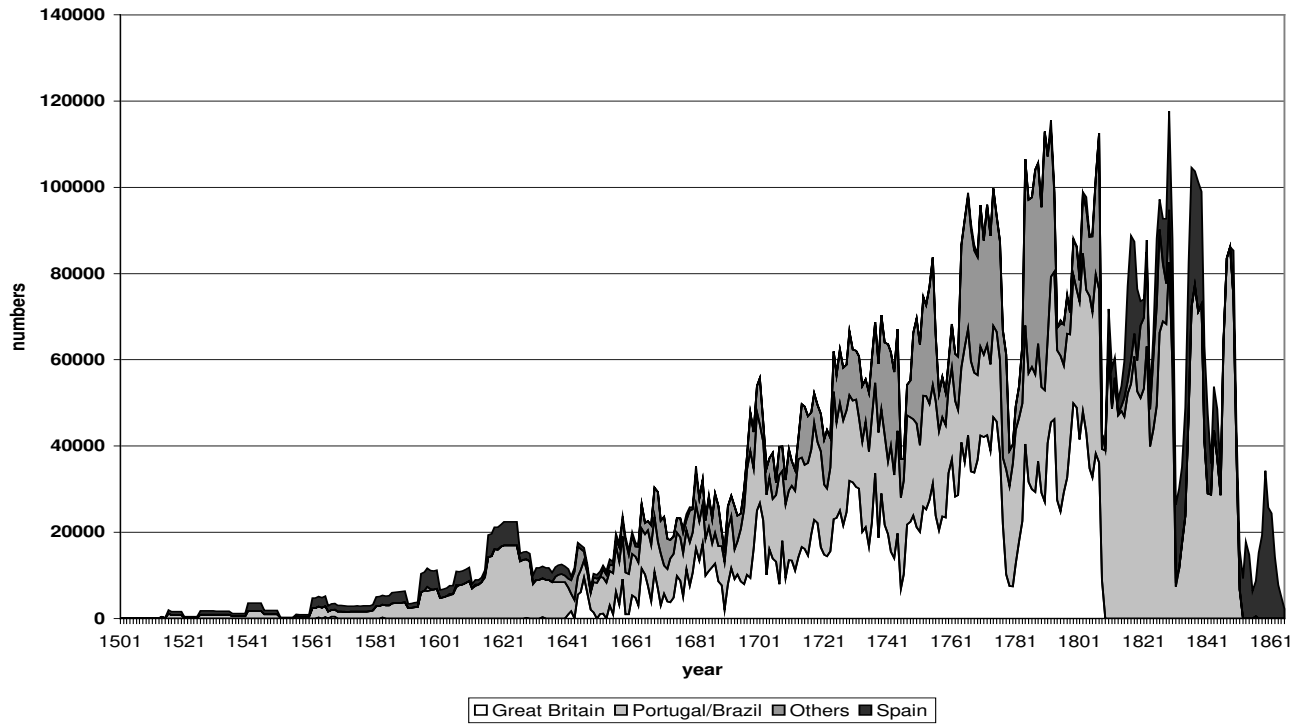


Figure 2
Slave Prices, 1676-1807

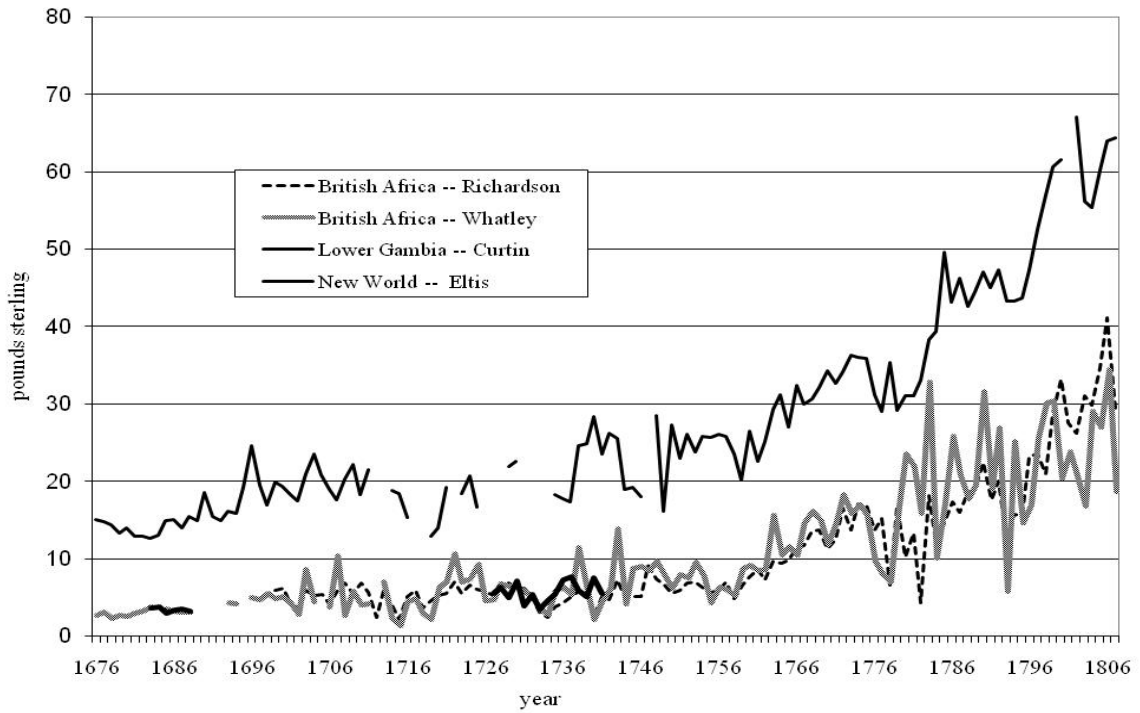


Figure 3. Annual British Slave Prices and Quantities

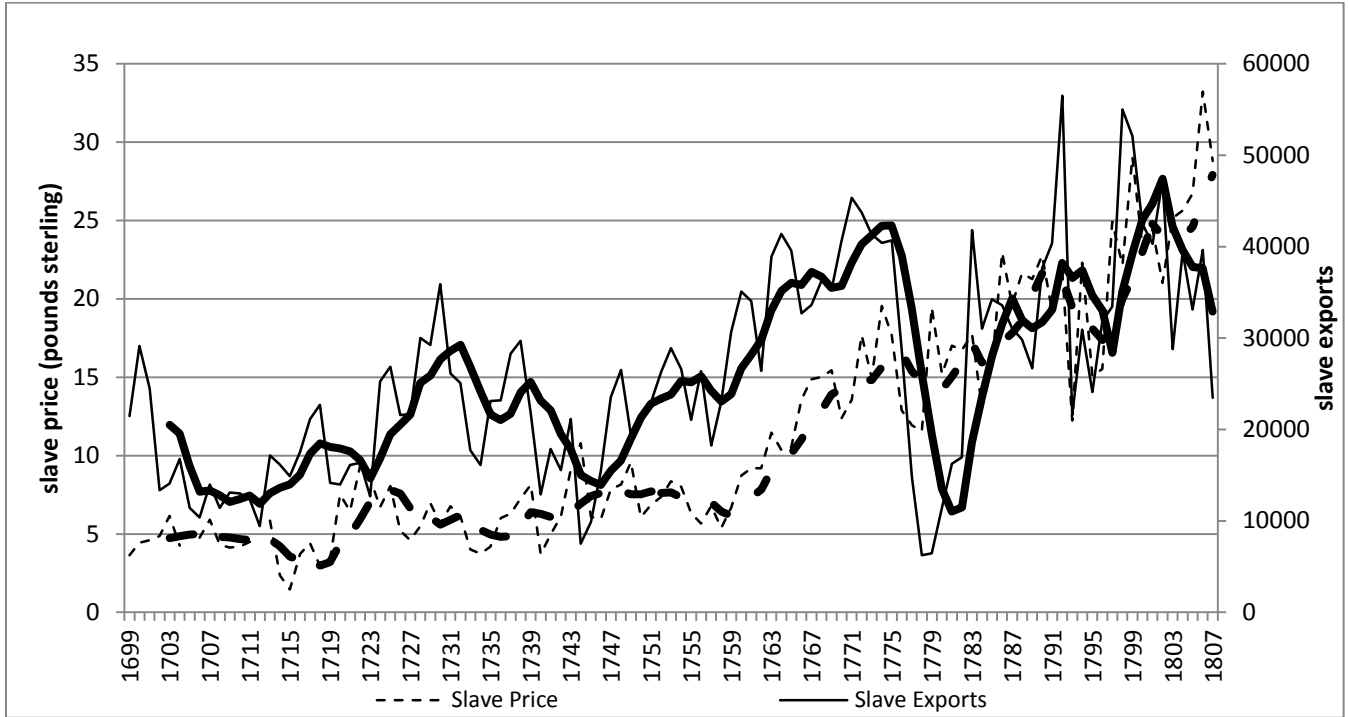


Figure 4. Gunpowder and the Slave Trade

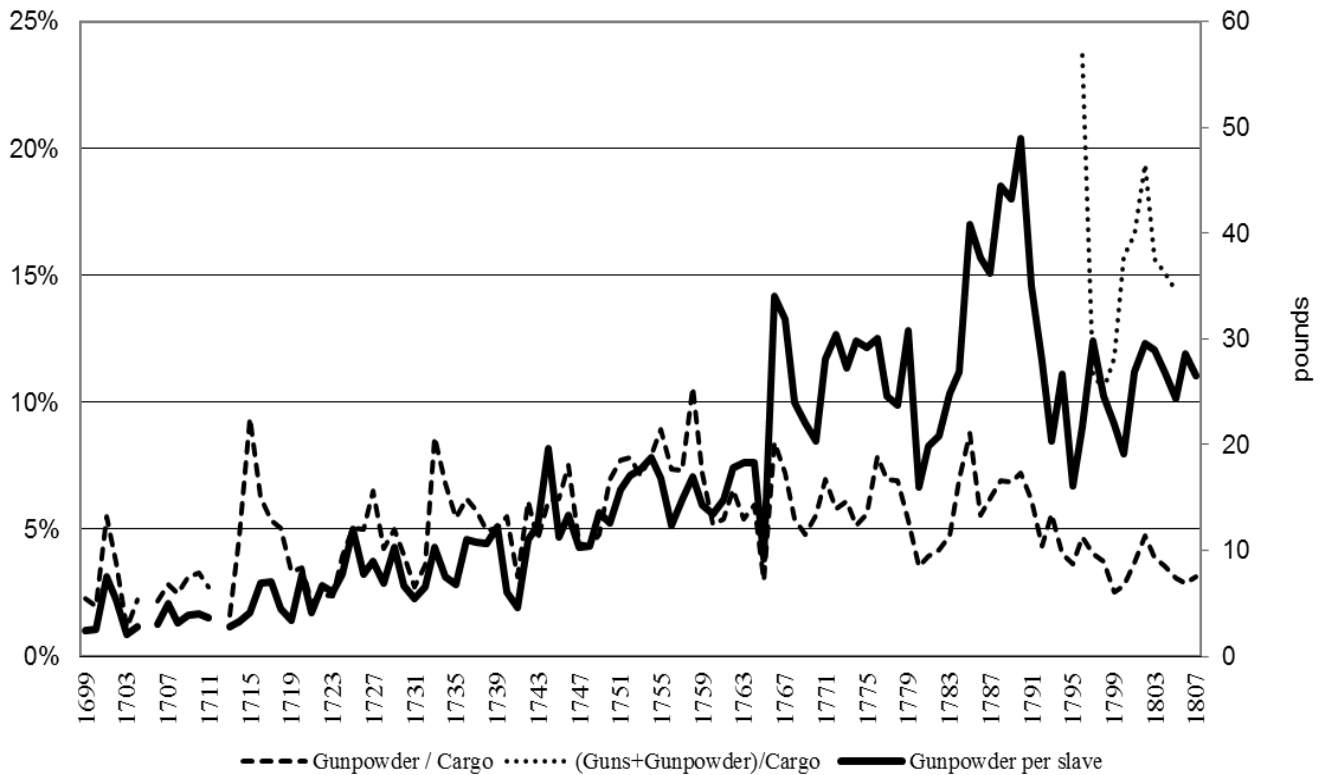


Figure 5. Days from Europe to the Americas: British Slavers, 1699-1807

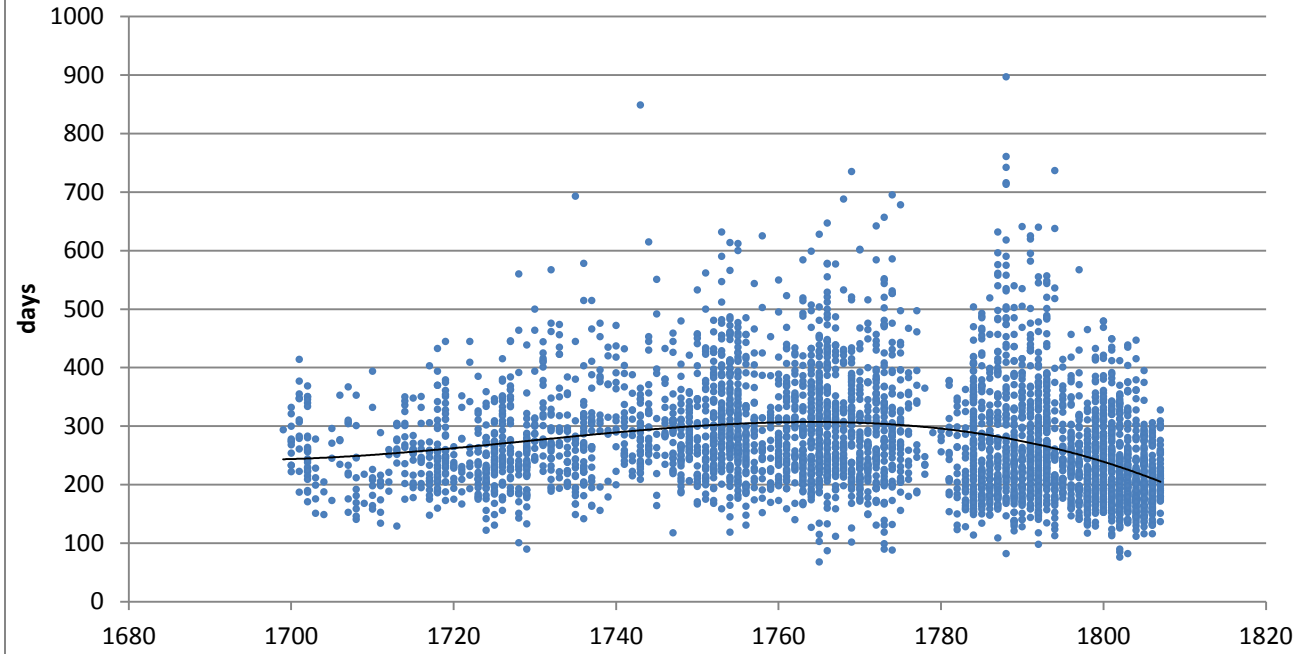


Figure 6. The British Market Share of Major African Slave Ports

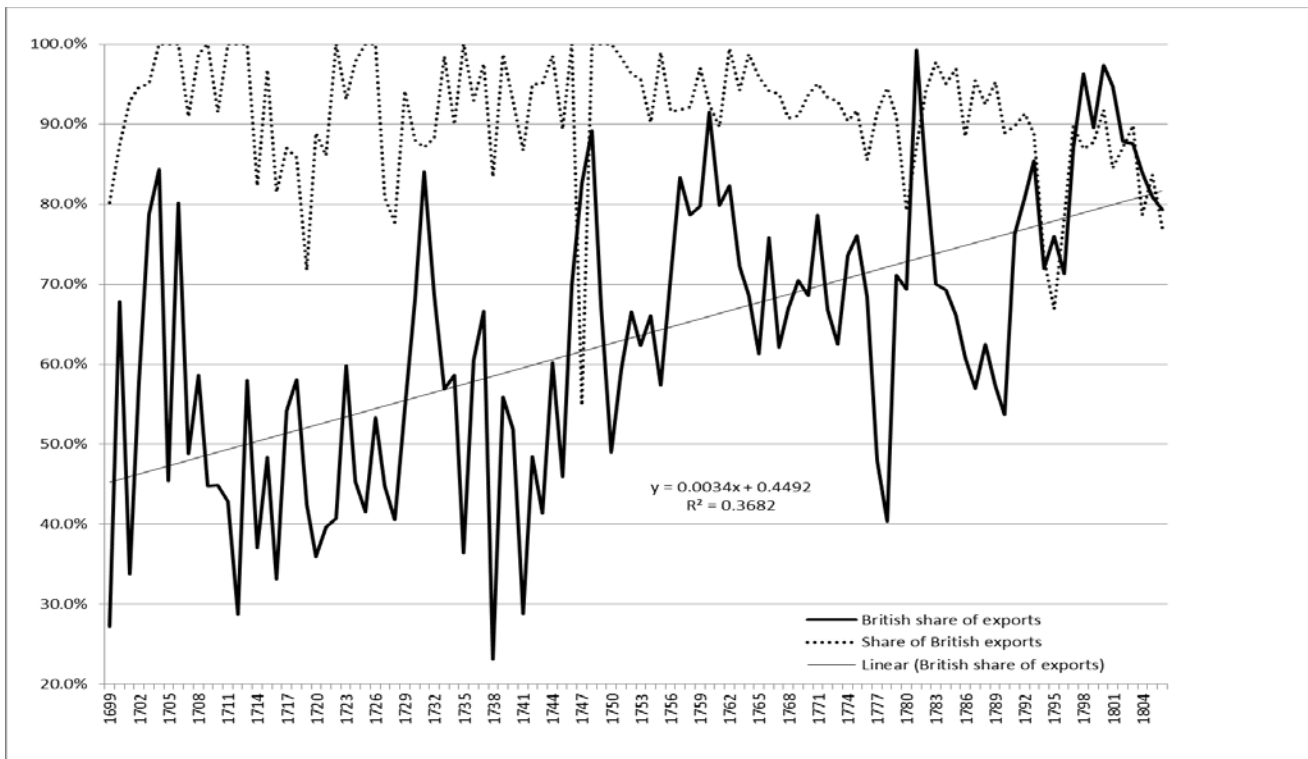


Table 1. Price-Quantity Relationship, 18th Century British Slave Trade (Linear)

(Dependent variable = annual slave exports)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|----------------------------|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|
| | For years beginning in 1699 and ending in: | | | | | | | | | | |
| VARIABLES | 1709 | 1719 | 1729 | 1739 | 1749 | 1759 | 1769 | 1779 | 1789 | 1799 | 1807 |
| Slave price (£) | 271.2 (1,192) | 302.4 (452.7) | 250.8 (611.9) | 637.0 (676.9) | 470.9 (554.3) | 653.3 (540.3) | 1,391*** (301.5) | 1,509*** (241.4) | 981.2*** (295.1) | 1,048*** (243.4) | 921.3*** (212.7) |
| War of Spanish Succession | -10,827*** (2,391) | -6,646 (4,093) | -6,615* (3,807) | -7,916*** (1,889) | -5,943*** (1,980) | -6,663*** (1,773) | -7,098*** (1,858) | -7,481*** (1,951) | -8,790*** (2,198) | -8,336*** (2,081) | -9,180*** (2,167) |
| Spanish Asiento | | -3,079 (4,420) | -1,442 (4,415) | -1,817 (2,621) | 274.3 (2,801) | -574.9 (2,656) | -1,534 (2,952) | -2,002 (2,981) | -2,935 (2,925) | -2,529 (2,861) | -3,283 (2,863) |
| War of Austrian Succession | | | | | -4,609 (3,766) | -5,911 (3,536) | -8,701** (3,742) | -9,464** (3,764) | -9,086** (3,688) | -8,844** (3,695) | -9,285** (3,692) |
| Seven Years War | | | | | | 2,533 (1,961) | 2,497 (2,154) | 1,808 (2,079) | 1,859 (2,388) | 2,142 (2,338) | 1,623 (2,431) |
| American Revolutionary War | | | | | | | | -17,562** (6,907) | -15,917*** (5,417) | -16,162*** (5,432) | -15,677*** (5,294) |
| Post-Haitian Revolution | | | | | | | | | | 15,990*** (3,496) | 12,948*** (4,397) |
| Great French Wars | | | | | | | | | | -19,387*** (3,822) | -18,401*** (4,855) |
| Constant | 24,205*** (5,502) | 19,708*** (4,624) | 19,923*** (5,288) | 19,372*** (4,323) | 18,196*** (3,674) | 18,040*** (3,669) | 14,936*** (2,693) | 14,750*** (2,632) | 18,594*** (2,996) | 17,821*** (2,620) | 19,272*** (2,548) |
| Observations | 10 | 19 | 29 | 39 | 49 | 59 | 69 | 79 | 89 | 99 | 107 |

Notes: Coefficients are estimated using OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. Observations are annual observations, 1699-1807. Missing years are 1705 and 1712. Slave price = Cargo/Slaves. Cargo is net British exports to Africa (£), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The dummy variables' dates are War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion.

Table 2. Price-Quantity Relationship, 18th Century British Slave Trade (Logs)

[Dependent variable = ln (annual slave exports)]

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|----------------------------|--|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | For years beginning in 1699 and ending in: | | | | | | | | | | |
| VARIABLES | 1709 | 1719 | 1729 | 1739 | 1749 | 1759 | 1769 | 1779 | 1789 | 1799 | 1807 |
| ln(Slave price) | 0.11 (0.33) | 0.10 (0.08) | 0.09 (0.13) | 0.18 (0.14) | 0.16 (0.13) | 0.20 (0.13) | 0.36*** (0.11) | 0.42*** (0.10) | 0.37*** (0.09) | 0.39*** (0.08) | 0.38*** (0.08) |
| War of Spanish Succession | -0.58*** (0.14) | -0.35 (0.22) | -0.35 (0.21) | -0.43*** (0.10) | -0.33*** (0.10) | -0.37*** (0.09) | -0.41*** (0.10) | -0.42*** (0.10) | -0.43*** (0.10) | -0.42*** (0.10) | -0.42*** (0.10) |
| Spanish Asiento | | -0.10 (0.24) | -0.04 (0.24) | -0.08 (0.13) | 0.02 (0.13) | -0.02 (0.13) | -0.07 (0.14) | -0.09 (0.15) | -0.09 (0.14) | -0.08 (0.14) | -0.08 (0.14) |
| War of Austrian Succession | | | | | -0.30 (0.22) | -0.36* (0.21) | -0.48** (0.21) | -0.52** (0.21) | -0.50** (0.21) | -0.50** (0.21) | -0.50** (0.21) |
| Seven Years War | | | | | | 0.11 (0.09) | 0.09 (0.09) | 0.06 (0.08) | 0.07 (0.08) | 0.08 (0.08) | 0.07 (0.08) |
| American Revolutionary War | | | | | | | | -0.84** (0.39) | -0.81*** (0.26) | -0.82*** (0.27) | -0.81*** (0.27) |
| Post-Haitian Revolution | | | | | | | | | | 0.39*** (0.08) | 0.31*** (0.10) |
| Great French Wars | | | | | | | | | | -0.47*** (0.12) | -0.44*** (0.12) |
| Constant | 9.97*** (0.48) | 9.74*** (0.25) | 9.77*** (0.31) | 9.70*** (0.25) | 9.63*** (0.24) | 9.62*** (0.24) | 9.41*** (0.22) | 9.32*** (0.22) | 9.41*** (0.20) | 9.37*** (0.19) | 9.39*** (0.19) |
| Observations | 10 | 19 | 29 | 39 | 49 | 59 | 69 | 79 | 89 | 99 | 107 |

Notes: Coefficients are estimated using OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. Observations are annual observations 1699-1807. Missing years are 1705 and 1712. Slave price = Cargo/Slaves. Cargo is net British exports to Africa (£), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The dummy variables' dates are War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion

Table 3. Tests for a post-1756 break in the price-quantity relationship

(Dependent variable = slave exports)

| VARIABLES | Linear | | | | Log-Linear | | | |
|-------------------------------------|-----------------------|----------------------|----------------------|----------------------|-------------------|------------------|------------------|------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| annual observations | | | | | | | | |
| Slave price (£) | -144.39 (443.43) | -144.39 (482.00) | -144.39 (485.41) | -144.39 (492.06) | 0.17 (0.10) | 0.17 (0.11) | 0.17 (0.12) | 0.17 (0.10) |
| G1756*Slave price (£) | 869.74*** (323.60) | 869.74** (353.29) | 869.74** (356.03) | 869.74** (373.66) | 0.13*** (0.05) | 0.13** (0.05) | 0.13** (0.05) | 0.13** (0.05) |
| 3-year overlapping weighted average | | | | | | | | |
| Slave price (£) | -83.17 (477.77) | -83.17 (547.56) | -83.17 (579.53) | -83.17 (567.67) | 0.18 (0.12) | 0.18 (0.13) | 0.18 (0.14) | 0.18 (0.12) |
| G1756*Slave price (£) | 813.08** (323.66) | 813.08** (370.98) | 813.08** (393.93) | 813.08* (410.87) | 0.11** (0.05) | 0.11** (0.05) | 0.11** (0.05) | 0.11** (0.05) |
| 5-year overlapping weighted average | | | | | | | | |
| Slave price (£) | -128.46 (486.19) | -128.46 (579.77) | -128.46 (619.82) | -128.46 (603.64) | 0.18 (0.12) | 0.18 (0.14) | 0.18 (0.15) | 0.18 (0.13) |
| G1756*Slave price (£) | 838.47*** (317.64) | 838.47** (385.03) | 838.47** (418.04) | 838.47* (435.21) | 0.11** (0.04) | 0.11** (0.05) | 0.11* (0.06) | 0.11** (0.05) |
| WARS | YES | YES | YES | YES | YES | YES | YES | YES |
| Lag periods | 1 | 3 | 5 | 10 | 1 | 3 | 5 | 10 |
| Observations | 107 | 107 | 107 | 107 | 107 | 107 | 107 | 107 |

Notes: Coefficients are estimated using OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 1, 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. Base observations are annual observations for 1699-1807. Missing years are 1705 and 1712. 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). Slave price = Cargo/Slaves. Cargo is net British exports to Africa (£), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). G1756 = 1 if year ≥ 1756, zero otherwise. The WARS dummy variables' dates are War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion.

Table 4. Guns-for-Slaves in the 18th Century British Slave Trade

$$(\Delta SLAVES_t = \alpha + \beta_1 \Delta GUNPOWDER_t + \beta_2 \Delta GUNPOWDER_{t-1} + \beta_3 \Delta CARGO_t + \beta_4 \Delta CARGO_{t-1} + \beta_5 \Delta WARS_t + \varepsilon_t)$$

| END DATES | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|-------------|------------------------|------------------|----------------------------|-------------------|-----------------------------|-------------------|---------------------|------|
| | est. β_1 (1 yr.) | | est β_1 (3 yr. avg.) | | est. β_1 (5 yr. avg.) | | No. of Observations | |
| | BEGIN DATES | | | | | | | |
| | 1699 | 1750 | 1699 | 1750 | 1699 | 1750 | 1699 | 1750 |
| 1709 | 2.59 (3.72) | | 1.31 (3.47) | | | | 8 | |
| 1719 | 2.26 (1.76) | | 4.03*** (0.98) | | 4.34*** (0.77) | | 17 | |
| 1729 | 1.30 (1.70) | | 4.33*** (1.36) | | 5.71*** (1.01) | | 27 | |
| 1739 | 0.93 (1.12) | | 2.70 (1.67) | | 3.65** (1.67) | | 37 | |
| 1749 | 0.52 (0.96) | | 1.97 (1.47) | | 2.94* (1.52) | | 47 | |
| 1759 | 1.31 (0.91) | 4.79** (1.38) | 1.69 (1.19) | 1.72 (1.99) | 2.30* (1.31) | | 57 | 10 |
| 1769 | -0.39 (0.45) | -0.48 (0.42) | -0.39 (0.72) | -0.97** (0.40) | 0.07 (0.95) | -0.87** (0.39) | 67 | 20 |
| 1779 | -0.00 (0.57) | -0.00 (0.60) | 0.05 (0.75) | -0.11 (0.84) | 0.29 (0.81) | -0.21 (0.74) | 77 | 30 |
| 1789 | 0.23 (0.55) | 0.28 (0.60) | 0.40 (0.70) | 0.26 (0.75) | 0.45 (0.66) | 0.13 (0.68) | 87 | 40 |
| 1799 | 0.58 (0.57) | 0.61 (0.60) | 0.80 (0.67) | 0.69 (0.72) | 0.91 (0.63) | 0.73 (0.68) | 97 | 50 |
| 1807 | 0.64 (0.55) | 0.63 (0.58) | 0.86 (0.61) | 0.72 (0.64) | 1.01* (0.59) | 0.82 (0.60) | 105 | 58 |
| Lag periods | 3 | 3 | 5 | 5 | 10 | 10 | | |

Notes: $(\Delta SLAVES_t = \alpha + \beta_1 \Delta GUNPOWDER_t + \beta_2 \Delta GUNPOWDER_{t-1} + \beta_3 \Delta CARGO_t + \beta_4 \Delta CARGO_{t-1} + \beta_5 \Delta WARS_t + \varepsilon_t)$. Coefficients are estimated OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. Δ denotes change between year t and year t-1. Base observations are annual observations for 1699-1807. Missing years are 1705 and 1712. 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). GUNPOWDER is measured in hundreds of pounds of gunpowder (cwt). Cargo is net British exports to Africa (£00), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The WARS dummy variables' dates are: War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion.

Table 5. Guns-For-Slaves Falsification Tests
(Dependent variable = Δ SLAVES_t)

| PLACEBO COMMODITIES | (1) | | (2) | | (3) | | (4) | | (5) | | (6) | | (7) | |
|---------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|--------------------|------------------|--------------------|------------------|--------------------|-----------------|--------------------|
| | 1-year | | 3-year | | 5-year | | 5-year | | 5-year | | 5-year | | 5-year | |
| | 1750-1759 | | 1699-1729 | | 1699-1729 | | 1699-1739 | | 1699-1749 | | 1699-1759 | | 1699-1807 | |
| | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo |
| Salt | 1.58*** (0.25) | -28.07 (17.34) | 1.14*** (0.38) | 61.86 (42.92) | 1.50*** (0.25) | 64.70* (35.38) | 0.95** (0.39) | 45.59 (38.59) | 0.77** (0.36) | 45.10 (42.46) | 0.67* (0.36) | 1.83 (12.96) | 0.30* (0.17) | -0.63 (1.23) |
| English cottons | 1.56* (0.61) | -0.04 (0.10) | 1.24** (0.44) | -0.07 (0.12) | 1.63*** (0.34) | -0.08 (0.07) | 1.07* (0.54) | -0.11 (0.09) | 0.87* (0.47) | -0.12 (0.13) | 0.89** (0.39) | -0.12** (0.05) | 0.28* (0.16) | -0.02 (0.02) |
| Woolens | 1.32* (0.44) | -0.05 (0.06) | 1.21** (0.48) | -0.07 (0.05) | 1.67*** (0.32) | -0.05** (0.02) | 1.08** (0.49) | 0.00 (0.04) | 0.87* (0.44) | -0.01 (0.05) | 0.69* (0.37) | 0.01 (0.05) | 0.31* (0.19) | 0.02 (0.03) |
| Linen | 1.15** (0.29) | -0.17 (0.09) | 1.11** (0.51) | 0.16 (0.16) | 1.62*** (0.35) | 0.06 (0.17) | 1.08** (0.43) | 0.01 (0.15) | 0.87** (0.42) | -0.00 (0.13) | 0.69* (0.40) | 0.04 (0.11) | 0.26 (0.17) | 0.05 (0.06) |
| India piece goods | 1.44** (0.35) | 0.06 (0.06) | 1.34*** (0.36) | -0.05 (0.05) | 1.70*** (0.23) | -0.06 (0.06) | 1.09** (0.49) | -0.04 (0.05) | 0.86* (0.48) | 0.01 (0.06) | 0.72* (0.40) | 0.06 (0.04) | 0.30* (0.17) | 0.03** (0.02) |
| Other textiles | 1.42** (0.39) | -0.02 (3.11) | 1.63*** (0.40) | -0.95* (0.51) | 1.99*** (0.29) | -1.01** (0.43) | 1.41*** (0.48) | -1.02*** (0.35) | 0.90* (0.50) | -0.15 (0.72) | 0.71* (0.41) | -0.17 (0.63) | 0.24 (0.16) | -0.32** (0.13) |
| Iron and steel | 1.33** (0.36) | -0.16 (0.38) | 0.98* (0.49) | 0.33 (0.30) | 1.27*** (0.32) | 0.45 (0.38) | 0.84 (0.53) | 0.53*** (0.13) | 0.67 (0.45) | 0.51*** (0.07) | 0.56 (0.39) | 0.39*** (0.12) | 0.24 (0.18) | 0.23* (0.13) |
| Copper and brass | 2.02 (1.38) | -0.66 (1.37) | 1.26** (0.50) | 0.03 (0.23) | 1.67*** (0.35) | 0.04 (0.24) | 1.13** (0.46) | -0.08 (0.33) | 0.82* (0.47) | 0.11 (0.32) | 0.68* (0.39) | -0.01 (0.26) | 0.27 (0.18) | 0.05 (0.11) |
| Other metals | 2.19** (0.43) | -2.04 (1.54) | 0.55 (0.44) | 1.49** (0.57) | 1.13*** (0.23) | 1.25*** (0.43) | 0.70 (0.46) | 1.16** (0.43) | 0.53 (0.37) | 1.24*** (0.45) | 0.40 (0.33) | 1.21*** (0.39) | 0.24 (0.15) | 0.86*** (0.31) |
| Alcoholic beverages | 0.65 (0.59) | 0.84 (0.48) | 1.17** (0.44) | 0.77 (1.25) | 1.62*** (0.34) | 0.56 (1.61) | 1.00* (0.50) | 0.36 (0.69) | 0.69 (0.52) | 0.81 (0.70) | 0.59 (0.42) | 0.41 (0.35) | 0.31* (0.19) | -0.03 (0.04) |
| Tobacco products | 1.45** (0.35) | -0.19 (0.67) | 0.96** (0.36) | 8.59*** (1.24) | 1.50*** (0.30) | 7.09*** (1.50) | 0.97* (0.49) | 7.03*** (1.25) | 0.81* (0.43) | 7.97*** (1.36) | 0.57 (0.37) | 1.48 (1.40) | 0.30 (0.18) | -0.20 (0.15) |
| Cowries | 1.63** (0.39) | -2.14* (0.73) | 1.24*** (0.41) | -0.04 (0.05) | 1.70*** (0.28) | 0.01 (0.10) | 1.04** (0.49) | -0.10* (0.05) | 0.82* (0.44) | -0.12*** (0.03) | 0.64* (0.37) | -0.14*** (0.05) | 0.30* (0.17) | 0.03 (0.12) |
| Beads | 1.25** (0.34) | -1.84 (0.92) | 1.31*** (0.41) | -0.32** (0.14) | 1.56*** (0.26) | -0.37*** (0.11) | 1.05** (0.45) | -0.39*** (0.14) | 0.86** (0.41) | -0.37*** (0.12) | 0.72** (0.34) | -0.36*** (0.12) | 0.32* (0.18) | -0.15* (0.09) |
| Glass | 1.55* (0.49) | -0.37 (0.56) | 1.29** (0.49) | -0.45 (10.56) | 1.73*** (0.38) | -2.79 (10.06) | 0.96* (0.47) | 10.39 (7.79) | 0.81* (0.40) | 8.92* (4.78) | 0.71* (0.39) | -0.79 (0.79) | 0.31* (0.17) | -1.04 (1.42) |
| Wooden products | 1.48** (0.29) | -1.68 (0.96) | 1.28*** (0.42) | 0.41 (5.28) | 1.69*** (0.26) | 2.09 (3.57) | 1.08** (0.50) | 0.11 (3.75) | 0.88* (0.46) | -1.48 (4.59) | 0.71* (0.38) | -2.00 (3.14) | 0.27* (0.14) | -2.07*** (0.55) |
| Misc. | 1.38** (0.36) | -0.21 (0.72) | 0.77 (0.56) | -4.57** (1.63) | 1.13*** (0.33) | -4.11*** (1.13) | 0.86** (0.40) | -3.19*** (0.69) | 0.73** (0.36) | -2.69*** (0.61) | 0.75** (0.35) | -1.57*** (0.54) | 0.26 (0.18) | -0.05 (0.04) |
| Wrought iron | 1.08* (0.44) | -0.54 (0.50) | 1.45*** (0.50) | -0.22 (0.34) | 1.85*** (0.34) | -0.22 (0.22) | 0.94 (0.65) | 0.29 (0.31) | 0.67 (0.51) | 0.50*** (0.17) | 0.59 (0.41) | 0.40** (0.18) | 0.27 (0.17) | 0.15 (0.10) |
| Lag periods | 3 | | 5 | | 10 | | 10 | | 10 | | 10 | | 10 | |
| Observations | 10 | | 27 | | 27 | | 37 | | 47 | | 57 | | 105 | |

Notes: Coefficients are estimated OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. All variables are change between year t and year t-1. Base observations are annual observations for 1699-1807. Missing years are 1705 and 1712. 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). GUNPOWDER, CARGO and PLACEBO are measured in real values (£). CARGO is net British exports to Africa (£), taken from Johnson (1991), *The Anglo-African Trade Statistics*. The variable SLAVES is taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The WARS dummy variables' dates are: War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion.

Table 6. Credit-For-Slaves in the 18th Century British Slave Trade

$$(\Delta SLAVES_t = \alpha + \beta_1 \Delta GUNPOWDER_t + \beta_2 \Delta GUNPOWDER_{t-1} + \beta_3 \Delta CARGO_t + \beta_4 \Delta CARGO_{t-1} + \beta_5 \Delta WARS_t + \varepsilon_t)$$

| END DATES | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|-------------|------------------------|-------------------|----------------------------|-------------------|-----------------------------|-------------------|---------------------|------|
| | est. β_4 (1 yr.) | | est β_4 (3 yr. avg.) | | est. β_4 (5 yr. avg.) | | No. of Observations | |
| | BEGIN DATES | | | | | | | |
| | 1699 | 1750 | 1699 | 1750 | 1699 | 1750 | 1699 | 1750 |
| 1709 | 7.64 (6.76) | | 7.53 (5.69) | | | | 8 | |
| 1719 | 4.76 (3.02) | | 3.56 (2.18) | | 2.31 (1.32) | | 17 | |
| 1729 | 0.72 (3.29) | | -0.85 (3.21) | | -1.99 (2.66) | | 27 | |
| 1739 | -0.60 (2.84) | | -1.68 (2.68) | | -2.14 (2.33) | | 37 | |
| 1749 | -1.54 (2.24) | | -3.29 (2.31) | | -3.07 (2.42) | | 47 | |
| 1759 | -2.24 (1.86) | -6.06 (3.81) | -2.76 (1.78) | -2.61 (2.99) | -2.08 (2.02) | | 57 | 10 |
| 1769 | -0.84 (1.05) | -0.40 (1.70) | -1.45 (0.94) | -1.12 (1.27) | -1.48 (1.09) | -0.94 (1.12) | 67 | 20 |
| 1779 | 0.33 (0.85) | 1.09 (0.70) | 0.06 (1.33) | 1.40 (1.15) | -0.05 (1.64) | 1.69 (1.18) | 77 | 30 |
| 1789 | 1.02** (0.47) | 1.17*** (0.40) | 1.15 (0.85) | 1.77*** (0.61) | 1.16 (0.95) | 1.97*** (0.54) | 87 | 40 |
| 1799 | 0.53 (0.56) | 0.54 (0.55) | 0.72 (0.78) | 0.97 (0.77) | 0.81 (0.73) | 1.15* (0.66) | 97 | 50 |
| 1807 | 0.69* (0.38) | 0.66 (0.40) | 0.62 (0.41) | 0.67 (0.44) | 0.56 (0.40) | 0.67 (0.42) | 105 | 58 |
| lag periods | 3 | 3 | 5 | 5 | 10 | 10 | | |

Notes: $(\Delta SLAVES_t = \alpha + \beta_1 \Delta GUNPOWDER_t + \beta_2 \Delta GUNPOWDER_{t-1} + \beta_3 \Delta CARGO_t + \beta_4 \Delta CARGO_{t-1} + \beta_5 \Delta WARS_t + \varepsilon_t)$. Coefficients are estimated OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Δ denotes change between year t and year $t-1$. Base observations are annual observations for 1699-1807. Missing years are 1705 and 1712. 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). GUNPOWDER is measured in hundreds of pounds of gunpowder (cwt). CARGO is net real British exports to Africa (£00), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The WARS dummy variables' dates are: War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion.

Table 7. Slaves-For-Guns in the 18th Century British Slave Trade

$$(\Delta GUNPOWDER_t = \alpha + \beta_1 \Delta SLAVES_{t-1} + \beta_2 \Delta CARGO_t + \beta_3 \Delta WARS_t + \varepsilon_t)$$

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|-------------|------------------------|-----------|----------------------------|-----------|-----------------------------|--------|---------------------|------|
| | est. β_1 (1 yr.) | | est β_1 (3 yr. avg.) | | est. β_1 (5 yr. avg.) | | No. of Observations | |
| END DATES | BEGIN DATES | | | | | | | |
| | 1699 | 1750 | 1699 | 1750 | 1699 | 1750 | 1699 | 1750 |
| 1709 | 8.51*** | | 6.68*** | | | | 8 | |
| | (1.14) | | (0.71) | | | | | |
| 1719 | 6.32** | | 4.66 | | 4.91** | | 17 | |
| | (2.46) | | (2.63) | | (1.63) | | | |
| 1729 | 4.04** | | 5.36*** | | 5.71*** | | 27 | |
| | (1.44) | | (1.06) | | (0.50) | | | |
| 1739 | 2.36 | | 2.46 | | 3.58** | | 37 | |
| | (1.82) | | (2.06) | | (1.60) | | | |
| 1749 | 2.43* | | 2.23 | | 3.43*** | | 47 | |
| | (1.30) | | (1.41) | | (1.25) | | | |
| 1759 | 1.23 | -10.09*** | 1.17 | -10.26*** | 2.49 | | 57 | 10 |
| | (1.53) | (1.46) | (1.74) | (1.64) | (1.74) | | | |
| 1769 | 0.16 | -5.36 | -0.23 | -6.13* | 1.03 | -6.11* | 67 | 20 |
| | (1.59) | (3.14) | (1.94) | (2.99) | (2.20) | (3.01) | | |
| 1779 | 2.61 | 2.78 | 2.76 | 4.29 | 3.15 | 3.82 | 77 | 30 |
| | (2.07) | (4.55) | (2.42) | (4.75) | (2.19) | (4.81) | | |
| 1789 | 1.46 | 0.79 | 4.99** | 7.48** | 6.11** | 8.49** | 87 | 40 |
| | (2.34) | (4.21) | (2.43) | (3.36) | (2.64) | (3.17) | | |
| 1799 | -2.28 | -4.04 | 1.24 | 0.99 | 3.06 | 3.14 | 97 | 50 |
| | (3.15) | (4.39) | (3.12) | (4.61) | (3.61) | (5.28) | | |
| 1807 | -2.82 | -4.63 | 1.02 | 0.60 | 2.50 | 2.30 | 105 | 58 |
| | (3.04) | (3.96) | (3.37) | (4.72) | (3.82) | (5.29) | | |
| lag periods | 3 | 3 | 5 | 5 | 10 | 10 | | |

Notes: Coefficients are estimated OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. Δ denotes change between year t and year t-1. Base observations are annual observations for 1699-1807. Missing years are 1705 and 1712. 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). GUNPOWDER is measured in pounds of gunpowder. Cargo is net British exports to Africa (£), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The WARS dummy variables' dates are: War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion

Table 8. Slaves-For-Guns Falsification Tests
(Dependent variable = $\Delta\text{SLAVES}_{t-1}$)

| | (1) | | (2) | | (3) | | (4) | | (5) | | (6) | | (7) | | (8) | | (9) | |
|---------------------|---------------------|-------------------|-------------------|----------------------|-------------------|----------------------|-----------------|--------------------|-----------------|--------------------|-------------------|----------------------|------------------|----------------------|-----------------|--------------------|----------------|--------------------|
| | 1 year | | 1 year | | 3 year | | 3 year | | 3 year | | 5 year | | 5 year | | 5 year | | 5 year | |
| | 1699-1729 | | 1699-1749 | | 1699-1729 | | 1699-1789 | | 1750-1789 | | 1699-1729 | | 1699-1749 | | 1699-1789 | | 1750-1789 | |
| PLACEBO COMMODITIES | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo | Gunpowder | Placebo |
| Salt | 109.61** (42.57) | 1.55** (0.74) | 0.957 (0.679) | 54.69 (36.56) | 1.77** (0.65) | 159.07*** (41.07) | 0.41 (0.27) | -5.11* (2.96) | 0.40 (0.31) | -3.23 (2.79) | 1.89*** (0.57) | 176.08*** (36.79) | 0.96* (0.53) | 123.60*** (38.59) | 0.58 (0.36) | -3.79 (2.92) | 0.57 (0.43) | -2.35 (2.96) |
| English cottons | 1.83*** (0.51) | 0.19 (0.24) | 1.073* (0.609) | -0.0144 (0.312) | 2.22*** (0.64) | 0.17 (0.14) | 0.36 (0.24) | 0.04 (0.03) | 0.34 (0.26) | 0.06** (0.03) | 2.66*** (0.56) | 0.26** (0.11) | 1.20 (0.72) | 0.02 (0.29) | 0.54 (0.34) | 0.03 (0.03) | 0.52 (0.39) | 0.05** (0.02) |
| Woolens | 1.66*** (0.50) | -0.11 (0.08) | 0.756 (0.544) | -0.115** (0.0441) | 2.08*** (0.67) | -0.07 (0.07) | 0.18 (0.24) | -0.09*** (0.04) | 0.14 (0.26) | -0.11*** (0.04) | 2.41*** (0.65) | -0.12 (0.07) | 1.13* (0.63) | -0.09 (0.07) | 0.35 (0.31) | -0.10*** (0.03) | 0.30 (0.35) | -0.11*** (0.03) |
| Linen | 1.74** (0.77) | 0.07 (0.25) | 0.921 (0.709) | 0.235 (0.169) | 2.32*** (0.75) | -0.18 (0.21) | 0.36 (0.32) | 0.08 (0.09) | 0.37 (0.37) | 0.05 (0.10) | 2.78*** (0.69) | -0.31* (0.16) | 1.12 (0.75) | 0.13 (0.21) | 0.56 (0.40) | 0.05 (0.07) | 0.55 (0.47) | 0.04 (0.08) |
| India piece goods | 1.59* (0.78) | 0.16 (0.10) | 0.974* (0.553) | 0.0420 (0.103) | 2.10*** (0.73) | 0.03 (0.07) | 0.41 (0.28) | 0.04 (0.05) | 0.40 (0.32) | 0.01 (0.06) | 2.43*** (0.79) | 0.06 (0.05) | 1.18* (0.66) | 0.01 (0.06) | 0.58 (0.37) | 0.05 (0.06) | 0.57 (0.43) | 0.03 (0.07) |
| Other textiles | 1.37 (0.85) | 1.04 (0.87) | 1.035 (0.637) | 0.152 (0.894) | 2.24** (1.02) | -0.30 (1.01) | 0.35 (0.28) | 1.14** (0.50) | 0.35 (0.31) | 1.48** (0.66) | 2.76*** (0.92) | -0.99 (0.84) | 1.29* (0.66) | -0.50 (0.39) | 0.50 (0.36) | 1.11** (0.52) | 0.46 (0.42) | 1.73*** (0.47) |
| Iron and steel | 2.03*** (0.67) | -0.29 (0.48) | 1.036 (0.704) | 0.0578 (0.235) | 2.16** (1.04) | -0.04 (0.46) | 0.31 (0.26) | 0.58** (0.24) | 0.32 (0.29) | 0.61 (0.39) | 2.46* (1.20) | -0.03 (0.56) | 0.90 (0.80) | 0.57* (0.31) | 0.47 (0.34) | 0.65*** (0.19) | 0.47 (0.39) | 0.65** (0.30) |
| Copper and brass | 1.64** (0.62) | 0.25 (0.31) | 1.008* (0.586) | 0.131 (0.204) | 1.93** (0.77) | 0.24 (0.36) | 0.27 (0.19) | 0.46 (0.33) | 0.26 (0.21) | 0.55 (0.45) | 2.15*** (0.71) | 0.50 (0.30) | 1.05* (0.57) | 0.34 (0.51) | 0.36 (0.23) | 0.60** (0.29) | 0.34 (0.26) | 0.68* (0.37) |
| Other metals | 1.99*** (0.59) | -0.67 (0.74) | 1.217* (0.621) | -0.811 (0.507) | 2.17** (0.78) | -0.11 (0.87) | 0.37 (0.28) | 0.92* (0.50) | 0.39 (0.31) | 0.98 (0.62) | 2.41** (0.92) | 0.07 (0.96) | 1.02* (0.58) | 0.71 (0.71) | 0.54 (0.37) | 1.02** (0.46) | 0.55 (0.43) | 0.90** (0.40) |
| Alcoholic beverages | 1.60* (0.79) | 1.27 (1.30) | 1.105* (0.566) | -0.188 (1.356) | 2.01* (1.06) | 0.49 (1.43) | 0.32 (0.24) | 0.24** (0.11) | 0.28 (0.25) | 0.38*** (0.10) | 2.41** (1.07) | 0.11 (1.32) | 1.25* (0.67) | -0.29 (0.88) | 0.45 (0.29) | 0.27** (0.12) | 0.39 (0.30) | 0.42*** (0.07) |
| Tobacco products | 1.92*** (0.62) | 2.62 (3.15) | 1.055* (0.599) | -2.540 (3.186) | 1.98** (0.81) | 3.33 (3.42) | 0.41 (0.28) | 0.24 (0.29) | 0.42 (0.31) | 0.38 (0.31) | 2.37** (0.91) | 1.89 (3.76) | 1.16* (0.65) | 3.13 (2.72) | 0.55 (0.33) | 0.40 (0.28) | 0.54 (0.38) | 0.57* (0.30) |
| Cowries | 1.77** (0.64) | -0.09 (0.12) | 1.121* (0.578) | -0.177 (0.131) | 2.10** (0.85) | -0.02 (0.13) | 0.39 (0.27) | -0.18* (0.10) | 0.40 (0.31) | -0.01 (0.19) | 2.49** (0.90) | 0.04 (0.14) | 1.07* (0.64) | -0.29* (0.15) | 0.57 (0.37) | -0.18 (0.13) | 0.56 (0.43) | 0.12 (0.13) |
| Beads | 1.79*** (0.56) | 0.03 (0.23) | 1.081* (0.594) | -0.0343 (0.292) | 2.08*** (0.69) | 0.15 (0.29) | 0.39 (0.26) | 0.15 (0.24) | 0.39 (0.30) | 0.16 (0.34) | 2.42*** (0.73) | 0.28 (0.24) | 1.18* (0.63) | 0.11 (0.29) | 0.55 (0.33) | 0.15 (0.24) | 0.54 (0.39) | 0.21 (0.32) |
| Glass | 1.34** (0.55) | 20.76** (7.80) | 1.044* (0.599) | 5.119 (7.896) | 1.69** (0.65) | 18.71 (15.27) | 0.38 (0.28) | 1.85** (0.90) | 0.38 (0.32) | 2.19** (0.94) | 2.13*** (0.65) | 18.39 (16.58) | 1.13** (0.49) | 16.93 (11.50) | 0.54 (0.37) | 1.76** (0.81) | 0.53 (0.44) | 2.15** (0.82) |
| Wooden products | 2.03*** (0.71) | -7.13* (3.71) | 1.080* (0.611) | -0.545 (5.181) | 2.12*** (0.71) | 0.07 (3.63) | 0.48* (0.25) | -2.18 (1.31) | 0.50* (0.29) | -2.50* (1.37) | 2.47*** (0.59) | 5.67** (2.69) | 1.20** (0.59) | 6.96 (6.34) | 0.59* (0.35) | -0.71 (1.42) | 0.60 (0.42) | -1.01 (1.48) |
| Misc. | 1.70** (0.61) | -1.37 (2.39) | 1.010* (0.588) | -1.221 (1.266) | 1.99** (0.77) | -1.22 (1.78) | 0.40 (0.26) | -0.10 (0.21) | 0.40 (0.30) | -0.04 (0.21) | 2.35** (0.89) | -0.66 (1.40) | 1.10* (0.63) | -1.62 (1.41) | 0.57 (0.36) | -0.04 (0.15) | 0.57 (0.43) | 0.04 (0.14) |
| Wrought iron | 1.83* (0.98) | -0.03 (0.68) | 0.908 (0.803) | 0.221 (0.299) | 2.18** (1.01) | -0.08 (0.58) | 0.42* (0.24) | 0.57*** (0.20) | 0.45 (0.28) | 0.66** (0.29) | 2.57** (0.91) | -0.16 (0.64) | 1.01 (0.71) | 0.39* (0.23) | 0.56* (0.31) | 0.66*** (0.17) | 0.58 (0.37) | 0.68** (0.25) |
| Lag periods | 3 | | 3 | | 5 | | 5 | | 5 | | 10 | | 10 | | 10 | | 10 | |
| Observations | 27 | | 47 | | 27 | | 87 | | 40 | | 27 | | 47 | | 87 | | 40 | |

Notes: Coefficients are estimated OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. All variables are changes between year t and year t-1. Base observations are annual observations for 1699-1807. Missing years are 1705 and 1712. 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). GUNPOWDER is measured in real values (£). CARGO and PLACEBO are net British exports to Africa (£), taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The WARS dummy variables' dates are: War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion.

Table 9. The Gun-Slave Relationship at Mid-Century

| VARIABLES | 1-year | 3-years | 5-years | 1-year | 3-years | 5-years |
|---|------------------------|------------------------|----------------------|-----------------|--------------------|--------------------|
| Guns-for-slaves 1755-1770 (Dependent Variable = Δ SLAVES _t) | | | | | | |
| Δ Percent Fail _t | 260.92** (92.04) | 184.61** (73.70) | 193.89*** (43.11) | | | |
| Δ cwt. Gunpowder _t | -0.79 (0.71) | -1.03 (0.61) | -0.99 (0.53) | -0.45 (0.41) | -1.13*** (0.31) | -1.08*** (0.25) |
| CONTROLS | YES | YES | YES | YES | YES | YES |
| Lags | 3 | 5 | 10 | 3 | 5 | 10 |
| Observations | 14 | 14 | 14 | 14 | 14 | 14 |
| Slaves-for-guns 1755-1770 (Dependent Variable = Δ lbs. GUNPOWDER _t) | | | | | | |
| Δ Percent Fail | 5,265.93 (4,625.91) | 2,425.24 (3,673.83) | 745.5 (2,277.67) | | | |
| Δ SLAVES _{t-1} | -3.63 (5.27) | -5.03 (3.58) | -5.93 (3.20) | -6.14 (3.63) | -6.98** (2.99) | -6.59** (2.70) |
| CONTROLS | YES | YES | YES | YES | YES | YES |
| Lags | 3 | 5 | 10 | 3 | 5 | 10 |
| Observations | 15 | 15 | 15 | 16 | 16 | 16 |
| Test of Break at 1756 (Dependent Variable = lbs. GUNPOWDER _t) | | | | | | |
| Excess Capacity in Ordinance Procurements _t (£000) | -191.96 (257.95) | -191.93 (299.87) | -533.22 (375.73) | | | |
| G1756*Excess Capacity in Ordinance Procurements _t (£000) | 535.86** (248.69) | 570.04* (306.23) | 576.37 (383.32) | | | |
| CONTROLS | YES | YES | YES | | | |
| Lags | 3 | 5 | 10 | | | |
| Observations | 99 | 101 | 103 | | | |

Notes: Coefficients are estimated OLS. Newey-West standard-errors are reported in parentheses, allowing for up to 3, 5, or 10 periods lag in the autocorrelation structure. Asterisks denote statistical significance levels: *** p<0.01, **p<0.05, * p<0.1. Δ denotes change between year t and year t-1. Panel (1) adds the variable “percent failed” and lagged “percent failed” to equation (2) and panel (2) adds them to equation (3). The 3-year overlapping moving average weights are (3, 2, 1). 5-year weights are (5, 4, 3, 2, 1). GUNPOWDER and CARGO are taken from Johnson (1991), *The Anglo-African Trade Statistics*. Slave quantities are taken from the *Transatlantic Slave Trade Database* (downloaded 5/7/2013 from www.slavevoyages.org). The WARS dummy variables’ dates are: War of Spanish Succession (1701-1711), the War of Austrian Succession (1743-1748), the Seven Years War (1756-1762), the American Revolutionary War (1775-1782), the Great French Wars (1793-1801 and 1803-1807) the years Britain held the Spanish Asiento (1713-1743) and the years following the Haitian Revolution (1791-1807). See the Appendix for a discussion. The variable “Excess Capacity” is taken from Mitchell’s *British Historical Statistics* (1988, pages 578-580). It measures the previous maximum level of government ordnance purchases minus the current level of government ordnance purchase. G1756 = 1 if year \geq 1756, zero otherwise. Controls are CARGO and WARS.