East Indiamen: East India Company shipping and Asian trade 1610-1830

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Abstract[1]

The English East India Company was one of the most powerful and successful European companies operating in Asia before the modern corporation. Its trade grew substantially over time with suppliers and customers spanning multiple continents. By 1800 it was by far the major supplier of Asian imports in Europe. In the literature it has been suggested that the evolution of shipping strongly shaped the Company's trade. This paper is the first to examine their dynamic relationships by using a new annual series on shipping capacity from 1664 to 1833 merged with annual trade values. Our long run-analysis finds that a positive shock to shipping capacity significantly increased the value of the Company's exports and imports over the short and medium run. The effects on imports were larger and more persistent across time, especially imports outside of India. We also find that shocks to trade had a less clear impact on shipping. More broadly, our findings show how the Company's shipping capacity was a fundamental driver of Asian trade. The results contribute to a broader economic history of shipping, trade, development, and early trading companies.

Keywords: Investment, East India Company, Asian-European Trade, Shipping

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I. Introduction

The English East India Company was one of the most significant and powerful European trading companies operating in China, India, and the rest of Southeast Asia during the Age of Sail. The English Company was involved in a triangular trade, in which new world silver was brought to Europe, and then bundled with English goods as exports to Asia. Company exports were sent to Asia in ships, known as East Indiamen, which arrived approximately six months to one year later. Once in Asian ports, like Bombay, Madras, and Canton, the exports were sold and the proceeds were largely used to purchase imports, like cotton textiles, spices, tea, and other goods. Asian imports were then shipped to England by East Indiamen and after approximately one year, they were sold, often at Company auctions. Famously, the English Company was given exclusive rights to import Asian goods into the territories of the English monarch (later extended to Britain). The prevailing view favored a single firm as the trade required large investments and exhibited some economies of scale (Chaudhuri 1978; Carlos and Nicholas 1988; Roy 2012). In Asia and the wider European market, there was more competition. The Dutch and Portuguese East India Companies were the leaders in the 16th and 17th centuries. The English and French Companies grew in importance during the 1700s, as did the Danish and Swedish. Yet by the late-18th century the English Company emerged as the largest based on its share of the annual number of ships departing from Europe (De Vries 2003; Solar 2013). Like the others, the English Company also took control of territories and tax revenues in Asia. A key turning point was the Battle of Plassey in 1757, which began a process of territorial expansion resulting in the British colonization of India (Oak and Swamy 2012).

The history of the English East India Company or EIC has been written from many perspectives. As two examples, Stern (2011) examines its role in establishing colonial rule in India and Erikson (2014) examines how ship captains developed their own, private trade in Asia. In this paper, we have a different focus by examining the role of shipping capacity in the EIC's trade with Asia. EIC ships, sailing between Britain and Asia, were the most sophisticated vessels in the British merchant fleet. They were typically large, often with armaments, but generally designed for bulk cargos and some passengers. EIC ships generally embodied the latest technology and had higher speeds than others sailing between Europe and Asia (Solar and Hens 2016; Kelly and Ó Gráda 2019; de Jong 2020). Their design and instruments were often imitated in other trades (Kelly, O'Grada, and Solar 2021).

We argue that the evolution of EIC shipping capacity had a significant effect on the value of EIC trade, while the evolution of its trade did not have a clear effect on EIC shipping. In our empirical analysis we estimate how 'independent shocks' to shipping capacity, defined below, affected the value of EIC exports and imports over the short and medium run. We also estimate how independent shocks to imports or exports affected each other and shipping capacity. We create a new time series on EIC shipping capacity, measured in number of tons employed by the EIC each year. While previous studies have reported annual ship departures (e.g., Chaudhuri 1993, Solar 2013, Erikson 2014), our new series is the first to measure capacity, following the entry of new ships to their permanent exit from service. We combine our new time series on capacity with the annual value of EIC exports in pounds sterling when they were purchased in Britain. Capacity is also combined with the value of EIC imports in pounds sterling when they were purchased in Asia. Chaudhuri (1978) reports these series from 1660 to 1760. Bowen (2005) reports the same from 1760 to 1833. To our knowledge, we are the first to combine their export and import series and analyze them from 1660 to 1833. They illustrate the long-term term growth of the EIC's trade, along with its medium and short-term volatility. Naturally, there may be differences in the EIC's trade values over such a long-time span, and we consider different sub-periods in our analysis.

As a first step, the dynamic relationships between shipping and trade are identified using vector auto regressions (VARs). The baseline VAR specifications have three variables in natural logs or equivalents: (1) shipping capacity in tons, (2) EIC exports in values, and (3) EIC imports in values. We use a Cholesky decomposition to construct a shock to each variable which is independent from the others. Then we calculate orthogonalized impulse response functions (OIRFs) to examine the impacts of those shocks on other variables. Of special interest is the shock from shipping capacity to imports or exports. While they require an ordering assumption, which is explained below, the OIRFs are especially useful in documenting the dynamic relationships between individual time-series.[2]

In extensions, we also use Local Projection models to estimate the effects of shipping capacity. Local Projections or LPs specify a single equation for exports or imports at a point in time as a function of a past value for shipping plus further past values of all time-series. Local projections make the estimation of nonlinear response functions simpler and less sensitive to

[2] Here we refer the reader to classic works in time series, Sims, Stock, and Watson (1990) and textbook treatments like Enders (2008).

misspecification at longer time horizons (Jordà 2005, 2023).[3] LPs show the robustness of the OIRFs and yields further quantitative insights.

Our baseline estimates yield several findings. (i) Shipping capacity shocks increased exports in the short run, with effects lasting three years. (ii) Shipping shocks increased imports over an extended period, at least five years. (iii) Export shocks increased shipping, but the effect is short-lived and small in magnitude. (iv) Exports shocks increased imports after about two years. (v) Import shocks do not have any dynamic effect on shipping or exports. We also find similar results deflating exports with a price index, detrending the series, and restricting to the period after 1700 or after 1757.

The analysis establishes the quantitative significance of shipping capacity, especially for the import trade. Across the entire time period, from 1665 to 1833, we estimate that a one SD shock to log shipping capacity increases imports by 25% after two years and by 22% after four years. The extended impact suggests ships did more than functionally move imports from Asia to Britain. They also seem to have stimulated the supply in Asia. While our methods cannot exactly say what caused a shipping shock, we think they capture the collective impacts of storms, wars in Europe and Asia, regulatory disputes surrounding the EIC's charter, and features of ship procurement. Our results also show that shocks to EIC exports had a quantitively small effect on shipping capacity. A one SD shock to exports increased shipping capacity by approximately 3% after three years, but after four or five years this small effect is not significantly different from zero. We find no significant quantitative effect of imports on shipping across the entire time period. We conclude that the evolution of the EIC's trade was not a major factor in driving shipping capacity.

In extensions, we focus on how shipping capacity affected additional trade outcomes. One separates the export series into precious metals and all other exports from 1664 to 1822. These two series are again taken from a merging of Chaudhuri and Bowen's series. Briefly, precious metals were the main export of the EIC up to the late 1700s, after which textiles and other goods were more important in terms of value. Our LPs results show that a shock to shipping has a positive, but imprecisely estimated effect on precious metal exports in the short-run, and no effect after. Thus, precious metals exports were not significantly affected by EIC shipping. We have two

[3] Local projections estimate the same impulse response functions as VARs when the data generation process is not linear and when the VAR controls for a large number of lags (Plagborg-Moller and Wolf, 2021).

interpretations: Ships were not filled to capacity with precious metals, implying shocks to capacity had little impact. Second, the EIC exports of precious metals were likely more affected by shocks in the transatlantic silver trade (Palma 2022). However, we do find that shipping has a positive and precisely estimated effect on non-precious metals exports over three years. The difference with precious metals is potentially related to the procedure of adding textiles and other goods to ships depending on available cargo space, or due to requirements that ships export a certain amount of non-precious metals, especially after 1790 (Solar 2013).

A second extension separates imports into values of goods from India and not from India. It is well established that Indian imports, like cotton textiles, were more valuable than others up to the late 1700s, but afterwards imports from China, especially tea, became more valuable. Our LPs estimates show that shocks to shipping had positive effects on both Indian and non-Indian imports, but effects on the latter were more lasting. Our interpretation is that shipping contributed to greater import supply in the non-Indian trade. This result matches Mui and Mui (1984)'s view that the EIC's greatest business accomplishment was to increase the supply of tea (p. 94-95). A similar long-run supply response appears absent in India, which matches with deteriorating productive capacity of India following famines and war (Clingingsmith and Williamson 2008, Roy 2013).

The third extension examines dynamic relationships between shipping and the value of import sales in Britain. The sale value of imports was generally higher than the value of imports purchased in Asia, which is one way the EIC made a profit. Import sales are available from 1710 to 1833. Over this time-period, we show import sales and shipping capacity are cointegrated, implying there was a long-term relationship between the series. Our LPs provide suggestive evidence that it was shipping which was driving import sales and not the other way around. We conjecture that greater shipping capacity, and its associated skill upgrading, helped the EIC select imports having a higher value in Britain than in Asia.

This paper contributes to a diverse literature on trading companies in Asia, and the English East India Company in particular.[4] Our paper adds in several ways. First, we draw on several published sources to estimate EIC annual shipping capacity for the first time. The new series is

[4] See Scott (1912), Chaudhuri (1965, 1978, 1993), Sutherland (1962), Watson (1980), Desai (1984),Mui and Mui (1984), Carlos and Nicholas (1988), Lawson (1994), Bowen (2005), Hejeebu (2005), Robins (2006), Kranton and Swamy (2008), Webster (2009), Stern (2011), Roy (2013), Philips (2013), Solar (2013), Erikson (2014), and, Bogart (2017) for works on the EIC. See De Vries (2003, 2010), Rei (2011), Gelderblom et al. (2013), and Dari-Mattiacci et al. (2017) for comparative works.

made from an integrated database on individual ships using several published sources, including Sutton (1981), Farrington (1999), Hackman (2001), and Erikson (2014). These sources provide details on each ship's voyage, including date of sailing to Asia from England and the date of return from Asia. They indicate that ships entered the EIC's employment following a maiden voyage, and in many cases, continued for several voyages until they were sunk, taken, scrapped, or retired from the British-Asian trade. A small number retired and took up services in another trade, not involving Asia. We calculate tonnage of new ships sailing to Asia (or shipping tonnage added) in each month and year between 1601 and 1833. We also track the exit of ships from the fleet and estimate the annual tonnage of ships leaving the EIC. Through an accounting identity, tons added and tons exiting are combined to calculate the stock of shipping capacity in every year from the EIC's founding around 1600 to its end as a monopoly trading company in 1833. Our approach provides a model for estimating the capacity of other trading companies.

Our second major contribution shows how EIC shipping capacity was a fundamental driver of Asian trade, not the other way around. While shipping is often featured in studies of long-distance trading companies (de Vries 2010, Bruijn 2013), its role in explaining trade has never been examined empirically. Our analysis gives quantitative significance to support Chaudhuri (1978, p. 35) description of shipping as a functional variable operating in various subsystems. According to Chaudhuri, subsystem 1 was based in London and involved the procurement and shipment of exports from Britain to Asia. Subsystem 2 was based in Asia and involved the procurement and shipment of imports from Asia to Britain. Subsystem 3 was based in London and involved the sale of Asian imports and management of finances. We show that EIC ships were quantitively important to the operation of all subsystems. Our results also align with Solar (2014), Chilosi and Federico (2015), and De Zwart (2016), who argue that shipping advances played a role in the integration of European and Asian markets over the longer term. Moreover, our findings that shocks to trade did not significantly affect shipping is consistent with a literature that points to the challenges associated with expanding and maintaining long distance shipping fleets.[5]

We also contribute to the literature on shipping, trade, and economic development more broadly. Our results fit with the broader logistics literature emphasizing shipping-trade synergies. As Lun et al. (2023) explain, "Shipping supports international trading activities by enabling

[5] There is a large literature explaining how shipping evolved in relation to procurement, rent seeking, wars, and weather. See Sutton (1981), Chaudhuri (1993), Zahedieh (2010); Arteaga, Desierto, and Koyama (2024).

physical cargo movements to complete the exchange transactions, while international trade growth promotes shipping-related investments including new shipbuilding, expansion of port and terminal, and use of cargo handling equipment, facilities, and technologies (p. 3)." Our results add to several others arguing for a similar synergy in the Age of Sail. For example, several studies document the significant improvement in shipping productivity (e.g., chapters in Unger 2011, Kelly, O'Grada, Solar 2019, Bogart et al. 2024), or how shipping was a key driver of trade and aggregate economic activity (see Harlaftis and Kostelenos 2012, Pascali 2017).

Finally, we contribute to a literature studying the British macro-economy. The GDP series made by Broadberry et al. (2015) has contributed to several papers examining dynamics over the long-run.[6] Ours is one of the few papers to estimate VARs and Local Projections using pre 1850 series. Previous works have used these time-series methods to quantify the importance of monetary factors (see Palma 2018) and legal changes (see, Grajzl and Murrell 2024). We use VARs and LPs to identify new dynamic relationships between EIC shipping capacity and trade.

II. Background on EIC trade and shipping

The English East India Company or EIC operated in various trades. Perhaps most famously, the EIC had a monopoly over all Asian goods imported to England and Wales from its founding in 1601. It would have a monopoly over imports into Scotland after the early 1700s. For ease of exposition, we call these British markets. Asian goods were defined as any products produced in economies east of the Cape of Good Hope and west of the Asian-Pacific region, but principally India and China. Asian goods brought the EIC profits, estimated between 5% to 20% of nominal share capital in the mid-eighteenth century (Chaudhuri 1978). When the EIC's profits were high, there was an incentive for others to enter and indeed groups known as interlopers tried exactly that. In practice, interlopers should be denied entry into British ports, but enforcement was not perfect and a major issue up to the early 1700s (Bogart 2017). The monopoly over Indian imports ended in 1813 and for all Asian imports in 1833 (Webster 2009).

Exports from England were used to purchase goods in Asia. Using a pioneering combination of econometrics and archival records, Chaudhuri (1978) argues that EIC directors set the level of exports with the aim of maximizing import revenues one or two years later. Directors

[6] An abbreviated list includes Mills (2009), Greasley, Madsen, and Wohar (2013), Crafts and Mills (2017), Madsen and Murtin (2017), Humphries and Weisdorf (2019), Nuvolari, Tartari, and Tranchero (2021).

used current prices of Asian goods in England to judge how valuable it would be to send more or less exports to Asia (pp. 300). Silver and other precious metals, sometimes called 'treasure,' were the most common export. The EIC would purchase precious metals from suppliers in England. These markets appear to have been broadly competitive (Chaudhuri 1978, pp. 166-67). The dearth of silver was a regular problem, however. The EIC was continually trying to find alternative sources of export revenue. After the 1760s there was a shift to procuring metals in India and using that to purchase additional Asian goods. While Indian tribute was important, exports of precious metals from England continued to be high through the early 1800s (Esteban 2001, Bowen 2005).

Shipping was crucial to the operations of the EIC as it moved goods and commodities between Britain and Asia. Originally the EIC built its own ships, but from the mid-1600s it leased them from private owners (Sutton 1981). The latter would hire the crew and provision the ship. This policy was based on the view that outsourcing shipping services was more profitable. This view may have been wrong however because its major competitor, the Dutch Company, generally owned their ships. Regardless of the rationale, in return, ship owners were paid a 'freight' for each voyage based on the tonnage of their ship. There was an agreed payment upon return date to Britain, after which ship owners would be paid an additional fee for each day.

EIC ships were generally larger than others in the British fleet. In fact, they were called 'East Indiamen' because of their distinctive size. This created a hold-up problem because EIC ships could not easily transfer to other trades. Several solutions were developed to address the hold-up problem. First, ship owners were drawn from a narrow circle of large merchants (often shareholders in the EIC), giving them extra bargaining power. This group was called the shipping interest, and came to exercise great authority over the EIC's operations. Second, as Chaudhuri (1993) notes there was an agreement that ships would be hired for multiple voyages, generally four. With time it appears that shipowners rarely opted out prior to four voyages and that the EIC did not renege on the agreement. Thus, we think of the multi-voyage agreement between ship owners and the EIC as an implicit contract.

Each voyage began with a departure from Britain. Ships generally departed during the season which lasted from November to May. There was a main destination port in Asia, where the ship was supposed to deliver exports and pick up Asian imports. But ships would stop in other Asian ports to accumulate more goods. These extra stops would allow ship captains to engage in local trade, which represented a profitable side business and an indication of entrepreneurial effort (Erikson 2014).

EIC ships could encounter several problems while sailing, many of which were fatal. First, some ships were sunk or badly damaged by storms. Second, some ships were damaged due to errors by the captain and crew. For example, they might sail into a sand bar or rocks. Third, some ships were attacked by enemies and either taken or damaged beyond repair. The enemies could be pirates, rival companies, or foreign navies, most commonly the Dutch and French. Sinking by enemy attack was particularly problematic during wars between European powers and between the EIC and Asian polities.

In sum, shipping evolved due to many factors and did not always meet the immediate needs of trade. We can imagine there were shocks, say a storm which sunk a ship, or the end of a distortionary tax which limited shipping investment. Our empirical analysis, explained in the next section, emphasizes shocks to shipping of the EIC not directly related to its imports and exports. We then examine how those shocks to shipping affected EIC imports and exports. As shipping was functionally relevant in the movement of goods, we expect that a positive shock should increase imports and exports. We do not examine how shocks to shipping emerge empirically, but there are several natural possibilities. Sinkings and shipwrecks were shocks that clearly led to lower capacity. The decisions of the shipping interest, like delaying contracts for new construction, could also be conceived as a shock. The EIC's evolving relationship with the Government could also alter incentives to invest in EIC ships or use them in alternatives, like the Atlantic timber trade (see Robins 2006, Bogart 2017).

The empirical analysis also emphasizes effects of shocks to EIC imports or exports that were not directly related to shipping or the other side of the trade. One might expect that an import or an export shock affected incentives to build and use EIC ships, however, the long-term implicit contract between shipowners and the EIC could imply little effect. There is a large literature in economics which shows such contracts tend to dampen effects of economic shocks.[7] Again, we do not examine how import and export shocks emerge empirically, yet the literature suggests some obvious sources. In Asia, there could be a famine or poor seasonal weather which reduced products available for import to England (Roy 2013). There could be political unrest in Asia that would then affect the supply of imports. With respect to exports, precious metals could be in short supply due

[7] For example, Naidu and Yuchtman (2013).

to ship sinkings in the bullion trade or factors in the Americas. In Britain there might also be weather events that affect the supply of British goods used for EIC exports, like cloth. Now we describe our data, including a new series.

III. New series on EIC shipping capacity

We define capacity as the amount of shipping tonnage involved in the EIC's British-Asian trade at any given point in time. That means capacity applies to ships which are enroute from Britain to Asia, sailing within Asia, waiting in an Asian port, enroute from Asia to Britain, or waiting in a British port. Our aim is to omit ships which became permanently involved in intra-Asian trade, as their history is less detailed.

Our efforts build on two published works detailing the histories of EIC ships: Sutton (1981) and Farrington (1999). Farrington lists departure and arrival dates for 1,484 ships in the service of the EIC between 1601 and 1834. For example, Farrington lists when a ship departed Britain on its first voyage, when it arrived at ports in Asia, and when it returned to Britain. If the ship had subsequent voyages between Britain and Asia, Farrington records the same information. Many ships did not return to Britain on their last voyage. In these cases, Farrington records their last departure date from Britain or their last arrival in Asia. Farrington provides a figure for the ship's tonnage, which is based on its dimensions. Thus, tonnage is a capacity measure. Turning to Sutton (1981), this work provides a list of all EIC ships, identifying its first and last sailing season. The season started around November and ended around May. Sutton is especially valuable in providing tonnage for nearly every listed ship.

The starting point for our data construction is Farrington's list of 1,484 ships in part because it is very detailed and has been used by previous scholars like Erikson (2014).[8] After dropping some ships whose first departure was from Asia or with missing information, we have 1,346 'Farrington' ships. Next, we match Farrington ships to Sutton based on name and dates of first sail. The match rate is 87%, which means we have tonnage for most Farrington ships. For those ships without tonnage information in Sutton or Farrington, we estimate it based on the average tonnage across time. To summarize, we have the following information for 1,346 EIC ships: (1) tonnage, (2) number of completed voyages between Britain and Asia, (3) the date of first sailing

[8] We thank Emily Erikson for kindly sharing the first digitized version of Farrington's data on ships. We expanded on this dataset.

to Asia, (4) the date of return to Britain if they returned on their last voyage, and (5) the date of their last departure from Britain if they did not return.

From the individual ship data, we create two annual series: tons added and tons exiting. The difference between the two series gives net tonnage added, which we use to calculate total shipping capacity using the formula: $capacity_t = capacity_{t-1} + tonsadded_t - tonsexiting_t$. Tons added sums the tonnage of all ships sailing for the first time in that year. The date of first sail is taken directly from our data so we believe there is little measurement error in $tonsadded_t$. $tonsexiting_t$ is measured in two parts depending on whether ships returned to Britain on their last voyage. If a final return was made, then the ship was sold or retired at some point after, or what we call exit. We don't know exactly when, but it is reasonable to assume that exit occurred 6 months later. Ships normally spent anywhere from 6 months to 2 years in Britain between their voyages to Asia. Therefore, decisions about whether a ship would sail again were probably made less than a year after the return. The first part of $tonsexiting_t$ equals the tonnage of all ships that six months earlier returned to Britain from their final voyage.

As noted earlier, there were some ships that did not return to Britain on their last voyage. We have some information on why ships exited. As Hackman (2001) explains many sunk, were taken by enemies, or chose to stay in the intra-Asian trade. Without a complete record of all details, we assume if a ship left Britain, but did not return, its exit date was 12 months after departure from Britain. This timing is reasonable because the time to sail from Britain to Asia usually took 9 months and the time to return was broadly similar. Thus, the second part of $tonsexiting_t$ equals the tonnage of all ships that 12 months earlier departed on their final voyage from Britain but did not reach Asia or return to Europe. In summary, $tonsexiting_t$ is the sum of the two parts which represent series for ships that did or did not return to Europe on their final voyage. The trends and cycles in EIC shipping capacity will be discussed more below.

III.A Other time-series

We use several published time-series relating to the EIC's trade. Chaudhuri (1978, pp. 507) provides an annual series on EIC export values from 1660 to 1760 and EIC import values from 1664 to 1760. The export values are reported separately for treasure (precious metals), cloth, draperies, and lead. Export values appear to represent market values, or the quantity of goods purchased in Britain times the price paid there. Import values are also reported separately by commodity. These values represent the quantity of goods purchased in Asia times the price in Asia plus a mark-up which appears to be 10%. The Asian prices may not reflect market prices accurately, and they were less than market prices in Britain. For this reason, we think import values represent official values, commonly used in British trade at this time. Chaudhuri (p. 440) also reports a series on the value of import sales in Britain for the years 1710 to 1745. We use the import sales series in an extension. In another extension, we use Chaudhuri series on imports from each of the major India ports, from China, and the rest of Southeast Asia.

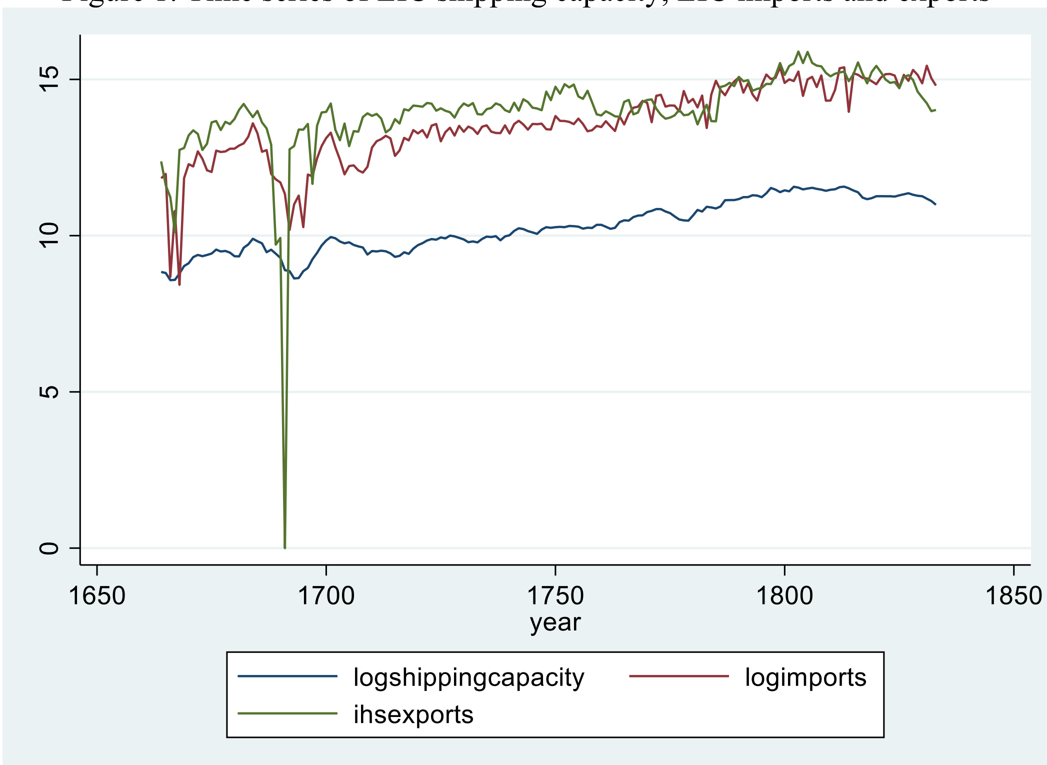
In an important later book, Bowen (2005) provides many of the same annual series for the EIC's trade, including export values, import values, and imports sales from 1760 to 1834. Bowen also gives series for imports from various ports in Asia. Many of Bowen's series extend Chaudhuri, which allows us to create long-time series by combining the two. As one detail, Bowen does not provide a series on exports of treasure like Chaudhuri, but has separate series on silver, copper, and coin, which we combine to create a long-run precious metals export series.

As Bowen and Chaudhuri worked independently, it is important to check the comparability of their series. Chaudhuri and Bowen's export series share one observation in 1760. The figures are fortunately close. The import series do not overlap in time, but the numbers in neighboring years are similar. This gives confidence that a combined EIC series on exports and imports is suitable for time-series econometrics. Both authors also adopt the same timing convention. Imports are Asian goods which arrive to Britain between July to June of year t. Exports are British goods which leave from Britain between July to June of year t.

Figure 1 shows the time-series for EIC shipping, import values, and export values from 1664 to 1833. We plot shipping capacity and imports in natural logs. Exports are plotted using the inverse hyperbolic sine (IHS). The IHS approximates the natural log for most values away from zero. All the series fluctuate significantly from 1664 to 1700. These were turbulent times due to war and political events in Britain and Asia. The major outlier in the series is exports in 1691, which was zero. This is not a data error for two reasons. Imports and shipping also decline in the early 1690s. Moreover, 1691 was a year of significant uncertainty for the EIC as the validity of its charter was being debated in parliament. Over the longer-term, all the variables trend upwards peaking in the early 1800s. We can see the effects of the EIC losing its market share in Asia around the time its monopoly over Indian trade ends in 1813. Solar (2013) also documents a shift in shipping at that point. The annual series are all contemporaneously correlated with one another.

Shipping and imports have a 0.91 correlation. Imports and exports have a 0.61 correlation. The same for shipping and exports.

Figure 1: Time series of EIC shipping capacity, EIC imports and exports



Sources: Authors new series on shipping capacity. See text for details. Imports and exports are the combined series from Chaudhuri (1978) and Bowen (2005).

IV. The dynamics of EIC shipping and trade

In this section, we estimate the dynamic relationships between EIC shipping and the EIC's British-Asian trade. As a first step, we establish whether the series are stationary, that is whether we can reject a unit root. The Augmented Dickey Fuller tests in Panel A of Table 1 do not include a time trend and cover the years 1668 to 1833 after incorporating 3 time lags. The test statistics for imports and exports, being smaller than the 5% critical value, indicate that we can reject a unit root for these series at the 5% significance level. However, the higher value of the test statistic for shipping capacity indicates a unit root cannot be rejected, even at the 10% significance level. In panel B, the tests include a time trend, which is our preferred specification as all three variables trend upwards. We now reject the null hypothesis of a unit root for all three variables. Based on these Augmented Dickey Fuller tests, we do not examine cointegration among all the series, as that would require all to be non-stationary. Instead, we study the dynamic relationships of all three series in log levels using Vector Autoregressive Regressions (VARs) and Local Projection models. As a robustness check, we also examine dynamic relationships between detrended variables.

Table 1: Augmented Dickey Fuller test for unit root

Panel A: no trend, 1668-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Shipping capacity (logs)	-2.045	-3.488	-2.886	-2.576
Imports (logs)	-2.949	-3.488	-2.886	-2.576
Exports (Inverse hyperbolic sine)	-4.426	-3.488	-2.886	-2.576
Panel B: trend, 1668-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Shipping capacity (logs)	-3.690	-4.018	-3.441	-3.141
Imports (logs)	-5.715	-4.018	-3.441	-3.141
Exports (Inverse hyperbolic sine)	-5.625	-4.018	-3.441	-3.141

Notes: Dickey Fuller test statistic uses three lags. All variables are annual. We observe shipping capacity from 1600 to 1833 but for these tests it is restricted to 1664 to 1833, when imports are observed. Exports are observed from 1660 to 1833, but for this test they are restricted to 1664 to 1833.

We now model the dynamic relationships between these variables. Let E_t be EIC export values, let I_t be EIC import values, and S_t be shipping capacity all in year t. As a reminder I_t are official/Company values of Asian goods which arrive in Britain between July to June of year t. E_t are the market values of goods which leave from Britain between July to June of year t. S_t is the total tonnage of ships in the British-Asian trade between January and December of year t. It is useful to think about shocks to each which might have effects over a series of years. Let $\epsilon_{s,t}$, $\epsilon_{e,t}$, and $\epsilon_{i,t}$ be shocks to S_t, E_t, and I_t respectively, all in year t. In the description of our model, we assume these shocks are independent of each other. The importance of independence is explained after the model. We also highlight an ordered effect of shocks, which will be important for identification.

Exports are modeled by the function $E_t = f_E(\epsilon_{s,t}, \ldots \epsilon_{s,t-k}, \epsilon_{i,t}, \ldots \epsilon_{i,t-k}, \epsilon_{e,t}, \ldots \epsilon_{e,t-k})$, where the subscripts reflect year of each shock extending backward to t-k. A positive contemporaneous shock to shipping $\epsilon_{s,t}$ should increase E_t as shipping capacity was used to transport precious metals and manufactured goods from Britain to Asia. For example, if a new ship was leased to the EIC in year t it could be immediately used to ship exports in year t. Positive shocks to shipping $\epsilon_{s,t-1}$ could play the same role supposing there are delays in ships being loaded or prepared. Positive shocks to shipping in t-1, t-2, and later could also increase E_t through a different channel by stimulating the supply of exports in Britain. For example, silver supplies might get transferred to Britain over the years t, t-1, and t-2 if the EIC has more shipping capacity in year t-3. We also allow for shocks to imports $\epsilon_{i,t}, \dots \epsilon_{i,t-k}$ to affect exports independently through f_E, as ships from Asia were more or less loaded. Suppose for example, there was a positive supply shock in Asia. If significant it could result in imported goods equaling or exceeding the EIC's shipping capacity in the years that followed. Or, if there was a significant negative supply shock in Asia, EIC ships could have returned with goods far less than capacity. Finally, current and past shocks to exports $\epsilon_{e,t}, \dots \epsilon_{e,t-k}$ will influence E_t.

Imports are modeled as a function of several shocks dating back to t-k through $I_t = f_I(\epsilon_{s,t}, \dots \epsilon_{s,t-k}, \epsilon_{i,t}, \dots \epsilon_{i,t-k}, \epsilon_{e,t-1}, \dots \epsilon_{e,t-k})$. A contemporaneous positive shock to shipping $\epsilon_{s,t}$ should increase I_t as ships were used to transport goods from Asia to Britain. Past positive shocks to shipping, $\epsilon_{s,t-1}, \dots \epsilon_{s,t-k}$ are also likely to increase imports as new ships made in Britain would first go to Asia and then return with imports years later. Longer-term responses could also result if shipping were to stimulate the production of imports in Asia. Mui and Mui (1984)'s study of the tea trade indicates import supplies needed to be developed. Past positive shocks to exports should increase I_t independently as Asian bound ships were more or less loaded. For example, suppose there was a dearth of silver in England. It could mean that ships left for Asia far below capacity. Exports were used to purchase imports in Asia, which then arrived in Britain with several years of delay. Therefore, we expect exports shocks $\epsilon_{e,t-1}, \dots \epsilon_{e,t-k}$ to impact I_t .Importantly, we assume $\epsilon_{e,t}$ cannot affect I_t. Imports arriving in year t were determined by decisions in Asia no less than one year earlier with no immediate communication with the Company directors in Britain. Current and past shocks to imports, $\epsilon_{i,t}, \dots \epsilon_{i,t-k}$, will certainly matter for imports.

Finally, shipping is also modeled as a function of shocks dating back to t-k: $S_t = f_S(\epsilon_{s,t}, \dots \epsilon_{s,t-k}, \epsilon_{i,t-1}, \dots \epsilon_{i,t-k}, \epsilon_{e,t-1}, \dots \epsilon_{e,t-k})$. In this case, one might argue current and past shocks to shipping $\epsilon_{s,t}, \dots \epsilon_{s,t-k}$ will be the most consequential as this activity was largely under the control of the shipping interest. Recall that ships were leased from owners, who had their own agenda as private traders or adventurers. Also, EIC ships regularly sunk or were taken. Nevertheless, it is possible that a positive shock to exports should lead to more demand for shipping capacity. As ship building required construction and negotiation with suppliers, we assume that there is a delay of at least one year, so $\epsilon_{e,t}$ has no effect on S_t, but $\epsilon_{e,t-1}, \dots \epsilon_{e,t-k}$

could positively affect S_t. It is also possible that a surplus of imports arriving from Asia provided revenues, which could then be used to attract ships into the EIC trade. Yet for the same reasons as shocks to exports, such a response should happen with a delay. We assume only import shocks $\epsilon_{i,t-1}, \ldots \epsilon_{i,t-k}$ impact S_t.

IV.A Estimating equations and results

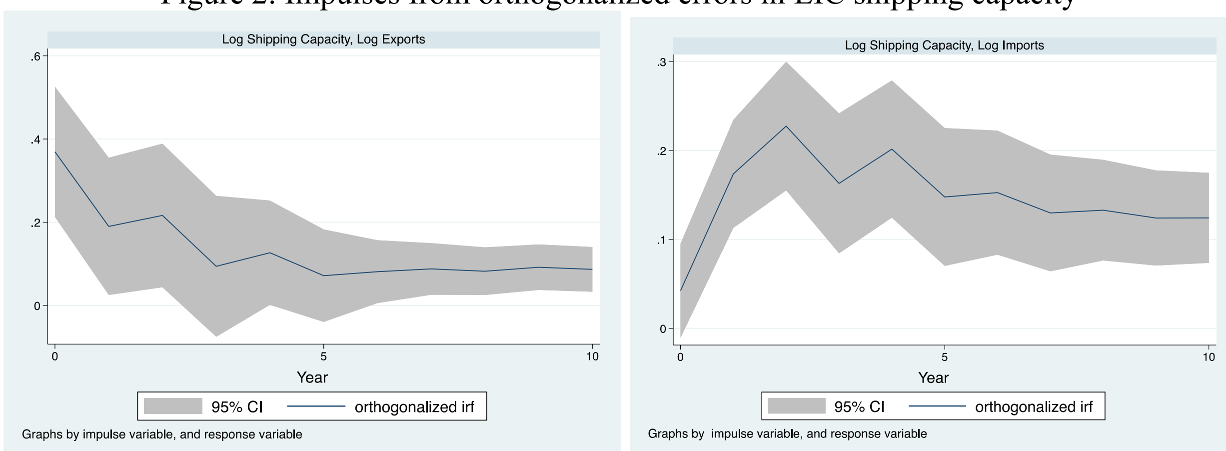
We use a VAR model to estimate the various dynamic effects. Let $x_t{}' = (s_t, i_t, e_t)$, where lower case letters represent variables in logs or inverse hyperbolic sine for exports. The VAR model is:

$$x_t = A_0 + \sum_{k=1}^{K} A_k x_{t-k} + \varepsilon_t \qquad (1)$$

where A_0 is a 3x1 vector of constants, $A_1, \ldots A_K$, are 3 by 3 matrices of parameters, $k \leq K$ indicates the annual time lag, and ε_t is a 3x1 vector of error terms assumed to be distributed as $N(0, \Sigma)$. For identification, we use a lower triangular matrix P defined by the Cholesky decomposition, $\hat{\Sigma} = \mathrm{PP}'$, with $\hat{\Sigma}$ being our estimate of the variance-covariance matrix Σ defined in the VAR model. The Cholesky decomposition uses the ordering of the variables $x_t{}' = (s_t, i_t, e_t)$, which follows our description of the relationship between EIC shipping, imports, and exports and contemporaneous shocks to each. We use P to define an orthogonalized error, $\epsilon_t = P^{-1}\varepsilon_t$, whose variance covariance matrix is I_3. As a result, a change in the orthogonalized error for one variable is not correlated with the others. We then write the moving average as $x_t = P\epsilon_t + \Phi_1 P\epsilon_{t-1} + \cdots + \Phi_m P\epsilon_{t-m} + \cdots \ldots$ noting that $\Phi_m P\epsilon_{t-m} = \Phi_m PP^{-1}\varepsilon_{t-m} = \Phi_m \varepsilon_{t-m}$. Finally, the orthogonalized impulse response function, OIRF, is defined as $\Theta_m = \Phi_m P$, where the i,j element is the impulse response of the i'th variable to a one standard deviation change in the orthogonalized error of the j'th variable after m periods.

The estimates of the baseline VAR model are shown in Table A1 in the appendix. We set K=4 as recommended by the AIC criterion. The data covers the years 1668 to 1833 due to 4 lags. For simplicity, we focus on OIRFs describing between-variable impulses. Figure A.1 in the appendix shows responses of variables to their own shocks. The OIRFs are shown in figures 2-4 with 95% confidence intervals. Figure 2 focuses on impulses from the orthogonalized errors in shipping, which we describe as shocks measured in standard deviation units, SDs. In the left panel, a one SD shock to shipping capacity in t increases exports in t by 36 log points (43% $\approx [\exp\left(\frac{36}{100}\right) - 1] * 100$). The effects of the shock to shipping are significant for two more years before becoming insignificantly different from zero. Our interpretation is that shipping capacity had large positive effects on exports, but only in the short-run. It functionally helped move exports, but it did not stimulate export supply. In the right panel, we find that a one SD shock to shipping capacity increases imports by 22.7 log points (25%) after two years and by 20.1 log points (22%) after four years. The effects get smaller after, but they continue to persist. These results illustrate how new ships added to the EIC fleet returned from Asia with more imports over the course of many years. The longer-term effect suggests shipping stimulated the supply of imports in Asia. However, as we show later, the very long-term effect after 10 years is not as robust.

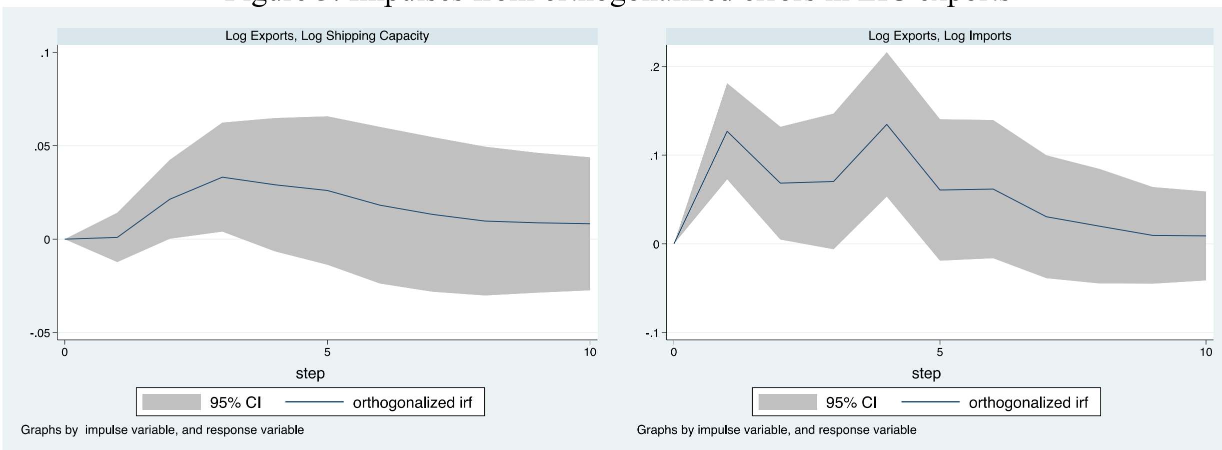
Figure 2: Impulses from orthogonalized errors in EIC shipping capacity



Source: author’s estimates from VAR model (1).

Figure 3 focuses on impulses from shocks to exports. We find some positive short-run effects on imports. In the right panel, a one SD shock to exports increases imports by 12 log points one year later and by 14 log points four years later. A significant rise in imports one year later is a bit surprising as it typically took a year for exports to arrive in Asia before being sold. The positive impact of exports after 2 years is expected following Chaudhuri (1978), who argued that extra shipments of exports allowed more purchases of imports two years later. We find effects extending to 3 and 4 years, but not further. In the left panel, we find that shocks to exports have little impact on shipping. The one exception is after three years, where a one SD shock to exports increases shipping by 3.3 log points. However, this is a relatively small effect. Shipping evolved for reasons largely unrelated to export shocks. We think this is due to control of the shipping interest, which did not drastically change its strategy due to trade shocks.

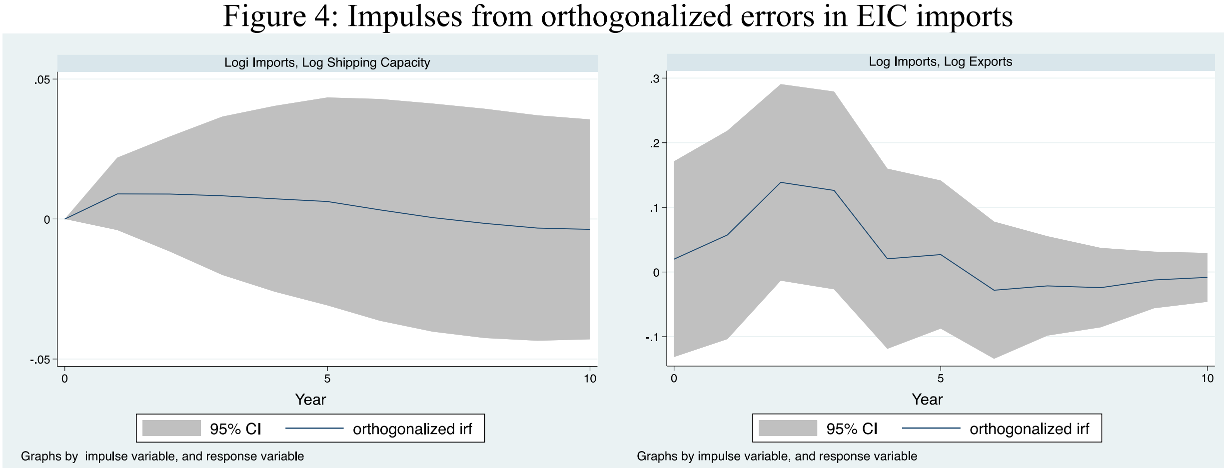
Figure 3: Impulses from orthogonalized errors in EIC exports



Source: author's estimates from VAR model (1).

In figure 4, we focus on impulses from shocks to imports. They are found to have little effect on exports or shipping. The OIRFs are relatively small in magnitude and not precisely estimated. Thus, the effect of import shocks on other variables was surprisingly minimal. It appears that decisions about how much to export and the collective process of determining capacity in the fleet were largely independent of the official value of goods returning from Asia.

Figure 4: Impulses from orthogonalized errors in EIC imports



Source: author's estimates from VAR model (1).

To test the sensitivity of these findings, we performed a series of robustness checks. First, we detrend all three of the baseline series and re-estimate the VAR for the years 1668 to 1833. The impulse response functions of this exercise are reported in Figure A.2 in the appendix.[9] They are similar to the impulses shown in figures 2 to 4. One difference is that greater detrended shipping positively and significantly impacts detrended imports over the horizons t+1 to t+3, at which point they are insignificantly different from zero. Thus, the short-run effects of shipping on imports are robust, while the long-run are less so. Second, we use Broadberry et al.'s (2015) GDP deflator to create a series for 'real' exports. The OIRFs in Figure A.3 in the Appendix are similar to our baseline estimates indicating inflation in the early nineteenth century is not affecting our estimates.

In a third robustness, we restrict estimation to the years 1700 to 1833. We do this to omit the zero value for exports in 1690 and the volatility of EIC trade up to 1700. The responses in the restricted time period, 1700 to 1833, are reported in Figure A.4 in the appendix. Greater shipping is found to have a positive effect on imports, but they are only significantly different from zero at the horizon t, t+1, and t+6. Again, we find the positive effects of shipping on imports are mainly short-run from 1700 to 1833. Another difference is that we find no statistically significant impact of shipping on exports from 1700 to 1833. As we discussed earlier, the period from 1665 to 1699 had some of the largest shocks to shipping capacity and exports. In 1691 there were no exports for example. Part of the large effects of shipping identified overall came from the period 1664 to 1699. We also find imports have a large positive effect on shipping over the long-run from 1700 to 1833. Our interpretation is that over time imports played an increasing role in driving the expansion of shipping capacity.

In a fourth robustness check, we restrict the sample to years from 1757 to 1833, the responses in the restricted time period are reported in Figure A.5. in the appendix. In this period the EIC became a territorial authority in India, which dramatically shifted its business model (Bowen 2005). The conclusions are the same as 1700 to 1833, except here we find that shipping had a large positive and significant effect on exports with the largest impact at the horizon t+6 (a 10% increase in capacity increases exports by 18.4%). Shipping has a similarly large (although less precise) effect on imports over the same long horizon (in t+6 a 10% increase in capacity increases imports by 10.8%). Thus, shipping played a large functional role in driving EIC imports and exports during the key period of territorial rule.

[9] Here we use three lags as recommended by the AIC test.

In sum, the OIRFs imply that shocks to shipping affected imports and exports, with more lasting impacts on imports. Shocks to exports affected imports, mainly in the short-run. Shocks to imports did not have a clear effect on exports. Moreover, we do not find strong evidence that shocks to exports or imports affected shipping. Building on this result, we further examine shipping's effect on trade, including additional outcomes. We will not further consider trade's effect on shipping as the OIRFs imply there was an insignificant or inconsistent effect.

V. Shipping capacity's effects on more trade outcomes: local projections estimates

In this section, we use local projections, which provide a flexible strategy to estimate impulse response functions emphasizing shocks from a single variable (Jordà, 2005). The local projection (LP) estimates should be similar to the impulses from VARs especially in the short-run. They may differ in the longer-run effects. Our baseline local projections equation for imports and exports are the following:

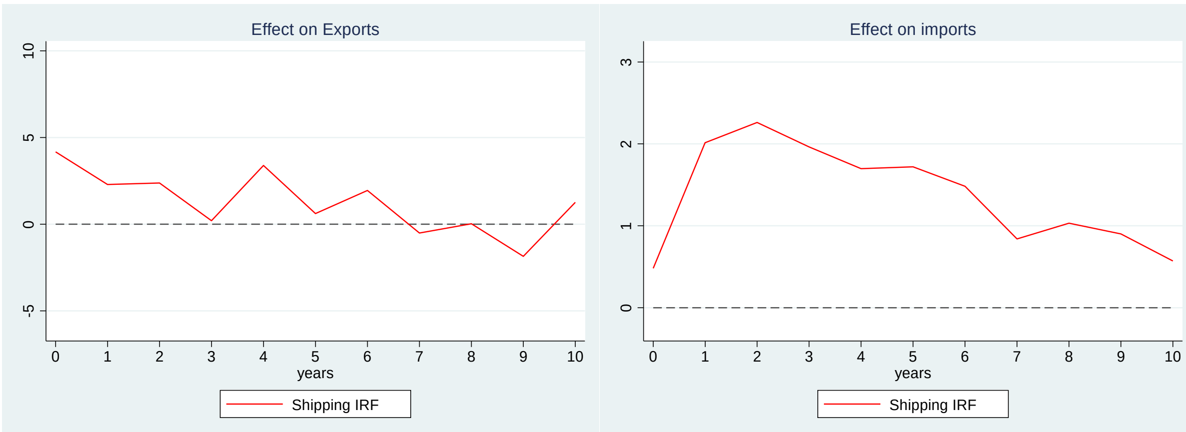
$$e_{t+j} = \beta_{e1} s_t + \sum_{k=1}^{K} \alpha_{eek} e_{t-k} + \sum_{k=1}^{K} \alpha_{esk} s_{t-k} + \sum_{k=1}^{K} \alpha_{eik} i_{t-k} + \varepsilon_{et+j} \qquad (2)$$

$$i_{t+j} = \beta_{i1} s_t + \sum_{k=1}^{K} \alpha_{iek} e_{t-k} + \sum_{k=1}^{K} \alpha_{isk} s_{t-k} + \sum_{k=1}^{K} \alpha_{iik} i_{t-k} + \varepsilon_{it+j} \qquad (3)$$

where j = 0,…,10 . The horizons for responses are all calculated starting at t, t+1, t+2,…In equation (2), our main focus is on the coefficient β_{e1} the effect of an increase in shipping on exports at different horizons. In equation (3), our main focus is on the coefficient β_{i1} the effect of a shipping shock on imports. To identify β_{e1} and β_{i1} we assume shipping is exogenous, which is consistent with the OIRFs. All other right hand side variables are also exogenous because they are lagged one period.

Figure 5 shows the LP impulse response functions from an increase in shipping. The scale of the responses is different from figure 2 because we are not showing an orthogonalized shock calculated from the Cholesky decomposition. The responses are interpreted as elasticities given that our variables are in logs. Red areas are ninety five percent confidence intervals calculated using Newey West standard errors. First, we note that the patterns are similar to the OIRF estimates in figure 2. The effect of shipping on exports is positive and very large in the short-run. However, there is less precision of the estimated impulses of shipping on exports. A null effect is rejected at the 5% confidence level only at the horizon t+2. We also find that shipping has a very large effect on imports at the horizons t+1 through t+6. Thus, the LP estimates confirm that shipping was a fundamental driver of imports and exports.

Figure 5. Baseline Estimates using Local Projections

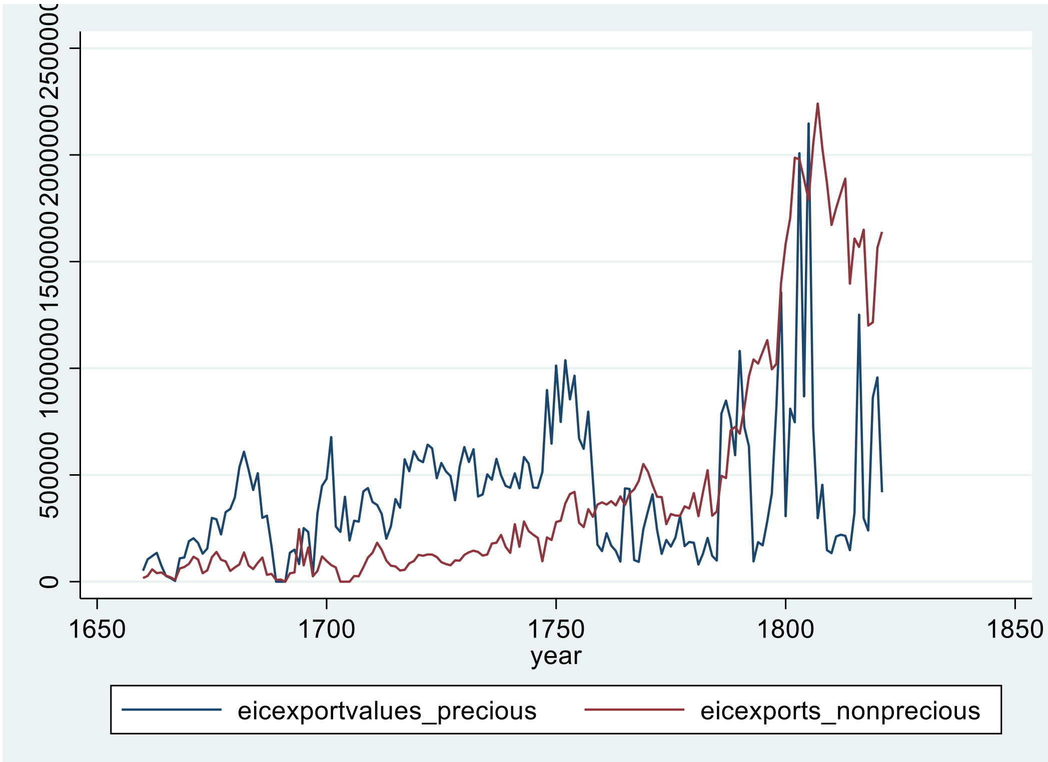


Source: Author's estimates from LP models 2-3. 95% confidence intervals are shown.

We now focus on the effects of shipping on the two main types of exports, precious metals and other goods. To begin, we explain that the composition of EIC exports shifted over time. The EIC largely exported precious metals, like silver, up to 1760. Afterwards, EIC exports increasingly consisted of goods, like cloth and non-precious metals. The shift away from precious metals is much discussed in the literature, as it indicates how the EIC was able to obtain silver and other goods in India, largely through its colonial authority. It then used these Indian goods to purchase imports in China and Asia more broadly. The drain of silver from Britain, which had long been one of the economic drawbacks of EIC trade, became much less significant from 1760.

We use Chaudhuri and Bowen's series for different types of exports. Bowen's series on precious metals ends in 1822, so we only consider different types of exports to that year. Figure 6 confirms the importance of precious metals exports up to 1760. It also confirms that most EIC exports after 1760 consisted of non-precious metals. Notice also that exports of precious metals were zero for several years in the early 1690s. These exports could be very volatile.

Figure 6. Exports of Precious Metals and Other Goods



Sources: Authors calculations from splicing the export series from Chaudhuri (1978) and Bowen (2005).

As above, we establish whether the two separate exports series are stationary in their inverse hyperbolic sine transformation. The Augmented Dickey Fuller tests in Panel A of Table 2 do not include a time trend and cover the years 1668 to 1833 using three time lags. We reject a unit root for both series. In panel B, the Dickey Fuller tests include a time trend. We again reject a unit root. As the export series are stationary, there is no need to consider cointegration with the shipping capacity series.

Table 2: Augmented Dickey Fuller test for unit roots in two export series

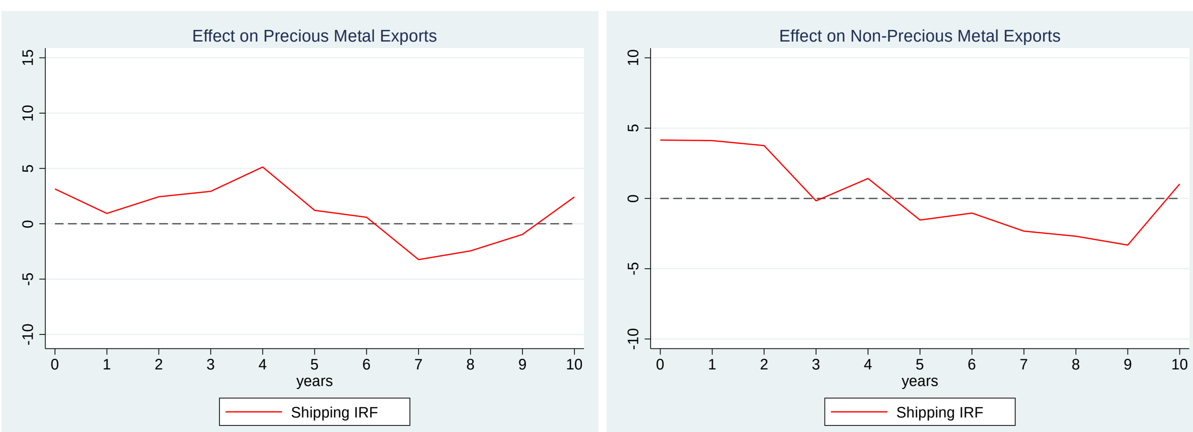
Panel A: no trend, 1668-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Precious metals exports	-4.629	-3.492	-2.886	-2.576
Non-Precious metals exports	-4.208	-3.492	-2.886	-2.576
Panel B: trend, 1668-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Precious metals exports	-4.740	-4.022	-3.443	-3.143
Non-Precious metals exports	-5.608	-4.022	-3.443	-3.143

Notes: Dickey Fuller test statistic uses three lags. All variables are annual. Both series are transformed with the hyperbolic sine function, which approximates a natural log and is defined at values of zero.

Next, we examine the LPs similar to equation (2) where we replace $export_t$ with the series for either precious metals or non-precious metals. Like equation (2), we assume that either export series react to shipping in year t. We set k=3 using the AIC criteria for lag order selection tests for the precious exports and k=4 for the non-precious exports.

Figure 7 gives the LP estimates for shipping capacity with 95% confidence intervals. The left panel shows the results using precious metals as $export_t$. Greater shipping has an immediate positive effect on precious metals exports in t, but it is statistically significant only at the 10% level. For the next five years, precious metal exports are higher, but the longer-term effect is not precisely estimated. Thus, increased shipping did not have clear persistent effects on precious metal exports after the first year. One interpretation is that ships were not filled to capacity with precious metals as they left Britain. Therefore, after a positive shock to shipping capacity, some extra metals were shipped, but mainly existing capacity was more effectively utilized. As shown in the right panel, we find a positive and precisely estimated short run effect of shipping on non-precious metal exports. This would suggest that ship capacity was a constraint perhaps because ships were more likely to be filled to capacity with these other goods. Moreover, regulations especially after 1790, implied that the EIC was forced to use some of its capacity for non-precious metal exports which could also explain this effect.

Figure 7. Local projection responses to shipping capacity shocks using precious metal exports



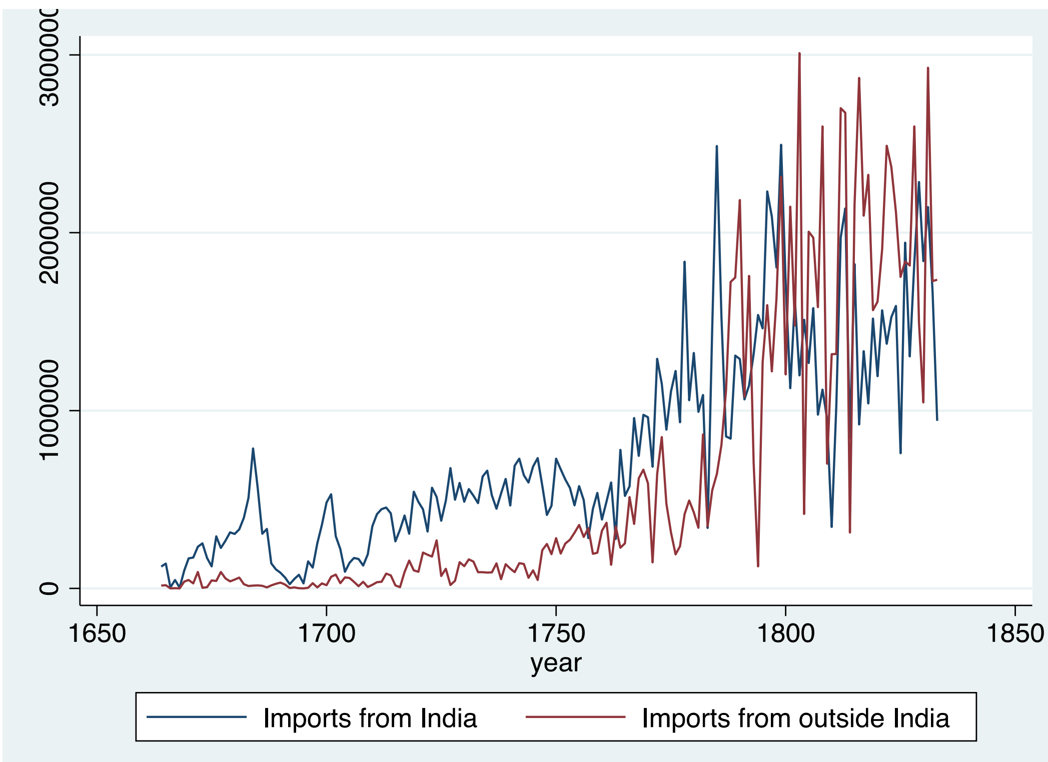
Source: Authors' estimates from LP model 2, modified to use precious metal exports. 95% confidence intervals are shown.

V.A Extensions to imports of Indian and non-Indian goods

We now examine effects of shipping on different types of imports. To begin, most of the EIC's imports came from India starting in the mid-1600s. After the duties on tea imports were reduced in 1784, the EIC's imports increasingly came from China, which was its main supplier of tea (Mui and Mui 1984). The Indian trade was conducted differently from others as the EIC was more involved in Indian politics.

Figure 8 shows a series for the value of Indian and non-Indian imports using the combined data from Chaudhuri and Bowen. The series confirm that Indian imports were larger up to the late 1700s. Afterwards, the value of imports outside of India was larger. Earlier we showed that we can reject a unit root for the imports series. In the appendix, we report in table A.2 that a unit root can be rejected for both the Indian import and non-Indian import series.

Figure 8. EIC imports from India and outside India



Sources: Authors calculations from splicing the import series from Chaudhuri (1978) and Bowen (2005).

Like the previous section, we estimate LPs similar to equation (3) where $import_t$ is replaced with the series for either Indian or non-Indian imports. Like equation (3), we assume that either import series reacts to shipping in year t, but they react to exports with a lag in year t-1. The timing assumptions are the same as in equations (3). Note the results are robust if we allow either imports to react to exports in year t. We set K=3 using the AIC criteria for lag order selection. Figure 9 gives the LP estimates for greater shipping with 95% confidence intervals. On the left, higher shipping significantly increases Indian imports over the horizon from t+1 to t+6, before trending to zero. Thus, shipping stimulates Indian imports, much like we found earlier, but the effect is absent in the longer-term. On the right, we find that shipping increased non-Indian imports, although over a longer time span, including the horizon t+10. The longer-term effect on non-Indian imports suggest that shipping provided a larger stimulative effect on the China trade. Mui and Mui's (1984) summary of the tea trade supports this conclusion.

Figure 9. Local projection responses of Indian and non-Indian to shipping

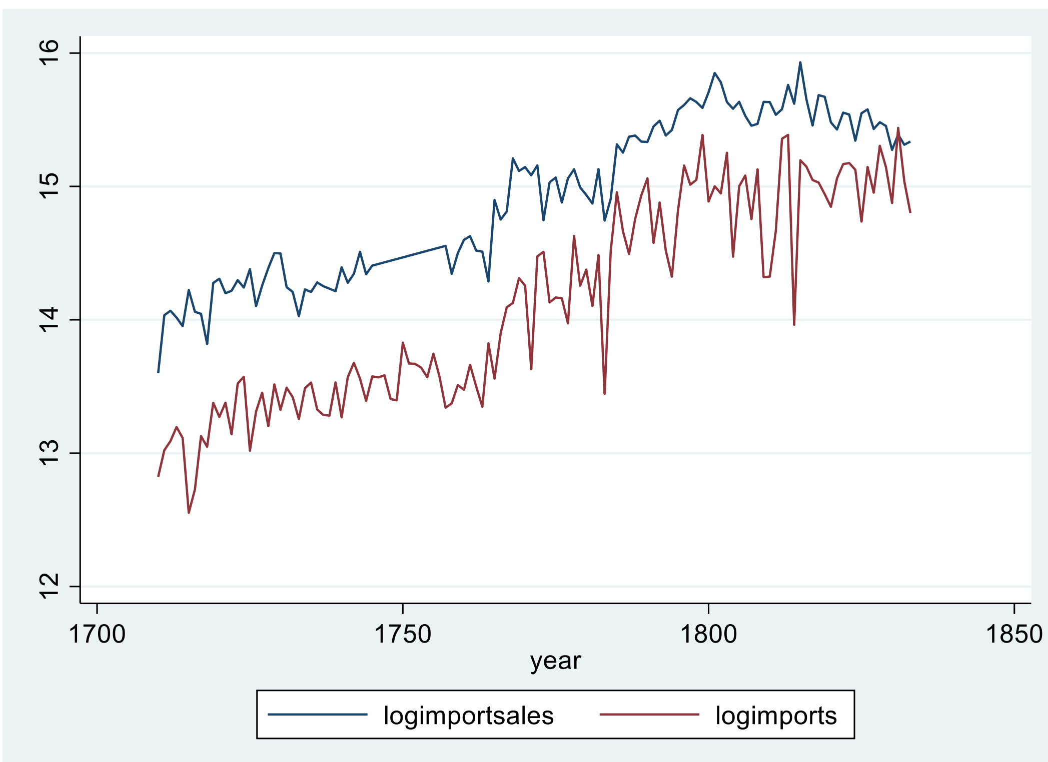
Source: Authors' estimates from LP model 3, modified to use either Indian or non-Indian imports. 95% confidence intervals are shown.

VI. Extensions to imports sales

In this section, we consider the effects of shipping on import sales. The price of goods imported from Asia did not equal the price at which they were sold in Britain. For example, the price of cotton cloth purchased in India was far less than the price it sold for in Britain. In Chaudhuri's framework there was a third system of EIC business, which translated imports into sales in Britain. The effectiveness of this third system was crucial to its financial success or failure. Chaudhuri did not propose a direct effect of shipping on sales, except through its influence on imports available for sale, which is the second system. However, it is possible that greater shipping capacity stimulated a supply of imports which were more valuable to EIC upon sale in Britain. Such an argument has been made by Mui and Mui (1984) for the tea trade. We test for this 'value enhancing' shipping channel by studying import sales and shipping.

The value of import sales is reported from 1710 to 1745 in Chaudhuri (1978) and from 1757 to 1833 in Bowen (2005). We combine these two series and linearly interpolate sales values from 1746 to 1756. Log import sales are shown in figure 10 along with the log value of imports, our earlier variable. The sale value was higher, indicating the mark-up charged by the EIC. Generally, import sales trend upward like the official values. They also exhibit similar fluctuations, although with a lead or lag.

Figure 10. Values of import sales and imports from Asia (in logs)



Sources: Authors calculations from splicing import sales (receipts) series from Chaudhuri (1978) and Bowen (2005).

As above, we first establish whether the imports sales series are stationary. The same for the shipping series from 1714 to 1833, when imports sales are available. The Augmented Dickey Fuller tests in Table 3 indicate we cannot reject a unit root for import sales, regardless of whether a time trend is included. The unit root is also not rejected for shipping.

Table 3: Augmented Dickey Fuller test for unit roots, import sales and shipping 1714-1833

Panel A: no trend, 1714-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Import Sales (logs)	-1.470	3.504	-2.889	-2.579
Shipping capacity (logs)	-1.919	3.504	-2.889	-2.579
Panel B: trend, 1714-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Import Sales (logs)	-1.458	-4.034	-3.447	-3.147
Shipping capacity (logs)	-0.968	-4.034	-3.447	-3.147

Notes: Dickey Fuller test statistic uses three lags. All variables are annual. We observe sales from 1710 to 1833.

Given shipping and imports sales are non-stationary in the 1714 to 1833 time-period, we test whether these variables are cointegrated. Pairwise cointegration implies that a linear combination of two series is stationary. Johansen's trace statistics evaluate hypotheses for the number of linear combinations of the time series that are non-stationary. A rank of 0 implies we cannot reject no cointegration in the linear combination. A rank of 1 implies we can reject no cointegration. The test in table 4 suggests there is pairwise cointegration between shipping and import sales. In other words, there is a long-run relationship between shipping and import sales.

Table 4: Cointegration test shipping and import sales, 1714-1833

Variable	Rank =0 Trace stat.	Rank =1 Trace stat.
Shipping capacity, import sales	37.443	2.867*

Notes: Cointegration test uses two lags. All variables are annual. We observe sales from 1710 to 1833.

It is difficult to establish causation between two cointegrated variables, however, we can document the dynamic relationship between shipping and import sales using either a VAR or LP. For brevity, we report LPs in the text and show OIRFs in the appendix (Figures A.6 and A.7). Our LP models are:

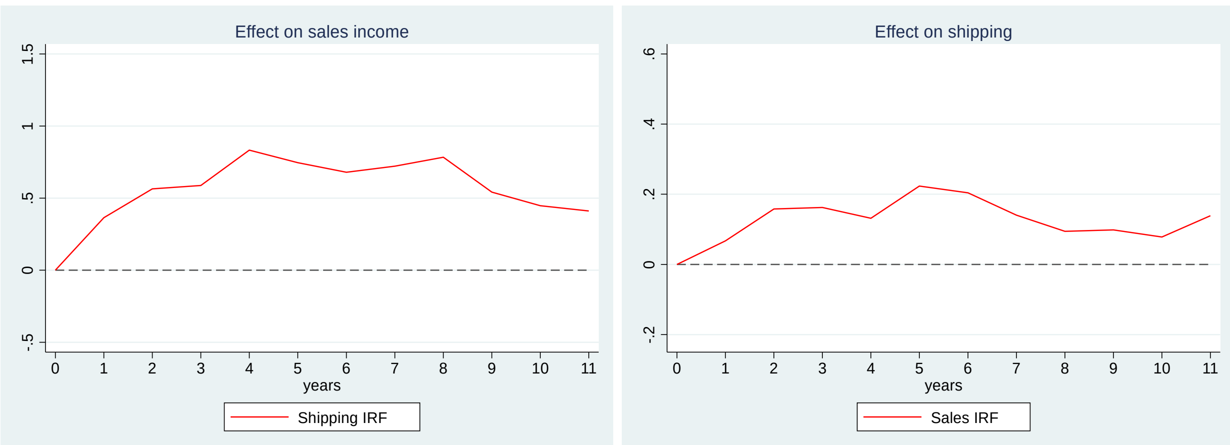
$$r_{t+j} = \beta_1 s_{t-1} + \sum_{k=1}^{K} \alpha_{rrk} r_{t-k} + \sum_{k=2}^{K} \alpha_{rsk} s_{t-k} + \varepsilon_{rt+j} \quad (4)$$

$$s_{t+j} = \beta_2 r_{t-1} + \sum_{k=2}^{K} \alpha_{srk} r_{t-k} + \sum_{k=1}^{K} \alpha_{ssk} s_{t-k} + \varepsilon_{st+j} \quad (5)$$

where j = 0,…,10, r_t is import sales (equivalently import revenues) in year t and s_t is shipping capacity, with both variables in logs. For identification, we assume in (4) that sales in t first reacts to shipping at time t-1, and in (5) shipping in t first reacts to sales at time t-1. We are effectively assuming both sales and shipping are potentially endogenous.

The LP estimate of sales at different horizons are shown in figure 11. We find that greater shipping capacity increased sales. The effect of shipping emerges at the horizon t+2 and persists through t+9. Its effects are longer term. This result suggests that shipping enhanced the value of imports that were brought from Asia and that were sold in Britain. In the right-hand panel, we see import sales increase shipping capacity in the short run, over the horizons t+2 to t+5. There is little effect after. Thus, greater sales only had a short run effect on shipping capacity. Thus, LPs suggest shipping increased sales, while sales had a less clear effect on shipping.

Figure 11. Local projection responses on import sales to shipping and vice versa



Source: Author's estimates from LP models 4 and 5.

VI. Conclusions

The East India Company's trade grew substantially from the mid 1600s to the early 1800s with suppliers and customers spanning multiple continents. The EIC became the major supplier of Asian imports in Britain and throughout Europe. The literature has studied the EIC from many perspectives, often with an emphasis on its colonial role in India. This paper focuses on the EIC's shipping capacity and how it was related to its trade between Britain and Asia. We use a new series on shipping capacity to examine the dynamic relationships with the value of EIC imports and exports from 1664 to 1833. Our paper is the first to analyze shipping and EIC trade using time series methods and the first to examine the long run dynamics of imports and exports overall. We employ local projections and vector autoregression models to estimate the effects of an independent shock to shipping on imports or exports. We also estimate effects of independent shocks to imports and exports on each other and shipping.

The main finding of our study is that shocks to shipping capacity significantly increased the value of the Company's exports and imports over the short and medium run. The effects on imports were larger and more persistent across time, especially imports outside of India. This suggests that shipping helped to stimulate import supply beyond helping to functionally move goods from Asia to Britain. In an extension, we study the value of imports sold in Britain, which exceeded the value of imports purchased in Asia. We find that shipping was positively related to import sales in the long run, and that a shock to shipping increased the value of import sales. This finding suggests that shipping helped to enhance the selection of Asian imports that would have a higher value in Britain. We find less precise effects on exports, especially exports of precious metals like silver. Here we think shipping shocks were less relevant, say compared to the transatlantic silver trade. Overall, our findings show that shipping capacity was one of the quantitively important drivers of EIC trade and its commercial growth.

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Appendix

Table A.1 Baseline VAR model (1)

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
logshippingcapacity						
logshippingcapacity						
L1.	1.229681	0.0814178	15.1	0	1.070105	1.389257
L2.	-0.1477899	0.1255485	-1.18	0.239	-0.3938604	0.0982807
L3.	-0.2296303	0.1233348	-1.86	0.063	-0.4713619	0.0121014
L4.	0.1297713	0.0787667	1.65	0.099	-0.0246086	0.2841513
logimports						
L1.	0.0259057	0.0189966	1.36	0.173	-0.0113269	0.0631383
L2.	-0.0152857	0.0165648	-0.92	0.356	-0.0477522	0.0171808
L3.	-0.0145225	0.0168951	-0.86	0.39	-0.0476362	0.0185912
L4.	-0.0004487	0.0152654	-0.03	0.977	-0.0303683	0.029471
ihsexports						
L1.	0.0008971	0.0067546	0.13	0.894	-0.0123417	0.0141359
L2.	0.0167706	0.007276	2.3	0.021	0.00251	0.0310313
L3.	0.0024816	0.0072794	0.34	0.733	-0.0117857	0.016749
L4.	-0.0130065	0.0070571	-1.84	0.065	-0.026838	0.0008251
_cons	0.1534966	0.0959571	1.6	0.11	-0.0345758	0.341569
logimports						
logshippingcapacity						

L1.	1.295517	0.3234131	4.01	0	0.6616391	1.929395
L2.	-0.0312654	0.498712	-0.06	0.95	-1.008723	0.9461922
L3.	-1.502596	0.4899185	-3.07	0.002	-2.462819	-0.5423738
L4.	0.7544207	0.3128824	2.41	0.016	0.1411824	1.367659
logimports						
L1.	0.3020506	0.0754595	4	0	0.1541528	0.4499485
L2.	0.3209338	0.0658	4.88	0	0.1919682	0.4498993
L3.	-0.071638	0.0671117	-1.07	0.286	-0.2031745	0.0598985
L4.	-0.0641364	0.0606383	-1.06	0.29	-0.1829852	0.0547124
ihsexports						
L1.	0.1275372	0.0268311	4.75	0	0.0749492	0.1801253
L2.	-0.0054986	0.0289021	-0.19	0.849	-0.0621457	0.0511485
L3.	-0.0549999	0.0289158	-1.9	0.057	-0.1116738	0.0016739
L4.	0.0664943	0.0280325	2.37	0.018	0.0115515	0.121437
_cons	-0.1968492	0.381167	-0.52	0.606	-0.9439229	0.5502244
ihsexports						
logshippingcapacity						
L1.	0.9505181	0.983085	0.97	0.334	-0.9762932	2.877329
L2.	-0.5879304	1.515945	-0.39	0.698	-3.559127	2.383267
L3.	-1.17297	1.489215	-0.79	0.431	-4.091778	1.745837
L4.	1.143373	0.9510749	1.2	0.229	-0.7206997	3.007445
logimports						
L1.	0.1499708	0.2293756	0.65	0.513	-0.2995972	0.5995387
L2.	0.2724356	0.2000134	1.36	0.173	-0.1195835	0.6644547
L3.	0.0655771	0.2040007	0.32	0.748	-0.334257	0.4654112

L4.	-0.2588451	0.1843233	-1.4	0.16	-0.6201122	0.1024219
ihsexports						
L1.	0.2708151	0.0815591	3.32	0.001	0.1109623	0.430668
L2.	0.2024817	0.0878544	2.3	0.021	0.0302903	0.3746732
L3.	-0.1220713	0.0878958	-1.39	0.165	-0.2943439	0.0502012
L4.	-0.0727791	0.085211	-0.85	0.393	-0.2397896	0.0942313
_cons	3.602226	1.158641	3.11	0.002	1.331332	5.873121

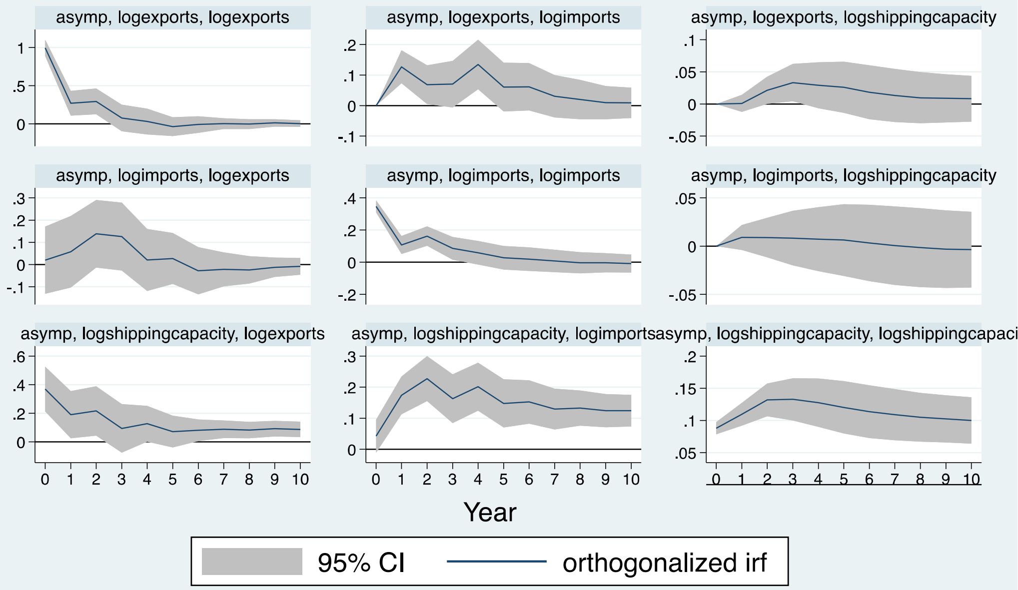
Table A.2: Augmented Dickey Fuller test for unit roots in two subperiods

Panel A: no trend, 1668-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Indian imports (in logs)	-3.505	-3.488	-2.886	-2.576
Non Indian imports (in logs)	-2.766	-3.488	-2.886	-2.576
Panel B: trend, 1668-1833		Critical value		
Variable	Test Stat.	1%	5%	10%
Indian imports (in logs)	-5.508	-4.018	-3.441	-3.141
Non Indian imports (in logs)	-6.678	-4.018	-3.441	-3.141

Notes: Dickey Fuller test statistic uses three lags. All variables are annual.

Figure A.1

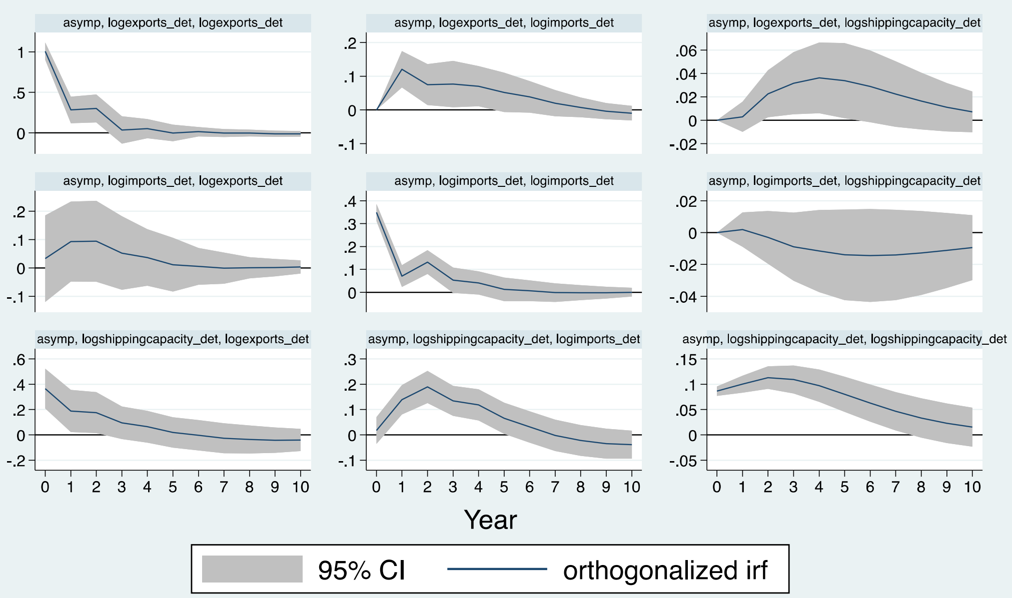
Baseline Estimates



Graphs by irfname, impulse variable, and response variable

Figure A.2

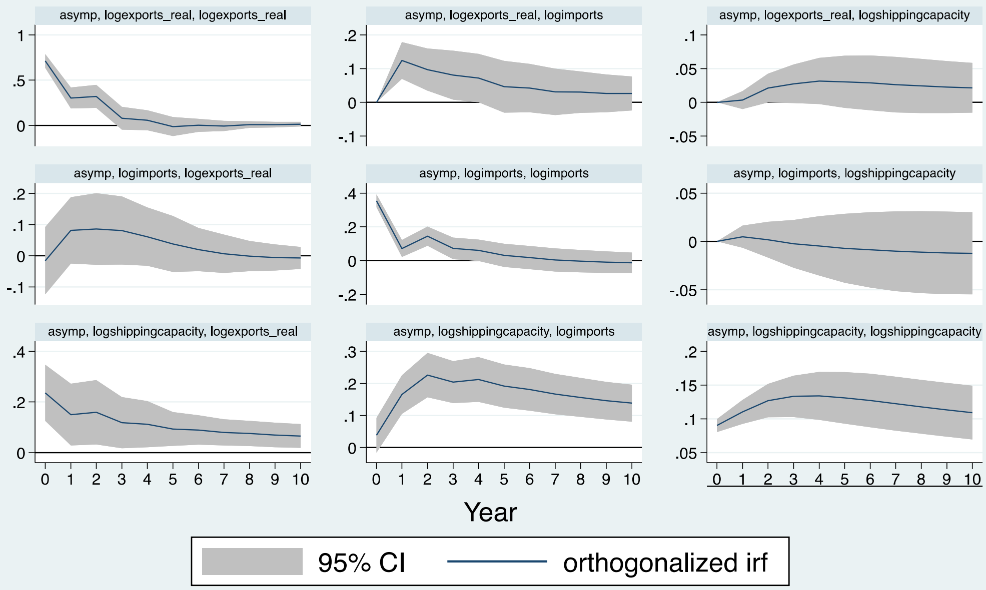
Detrended Variables



Graphs by irfname, impulse variable, and response variable

Figure A.3

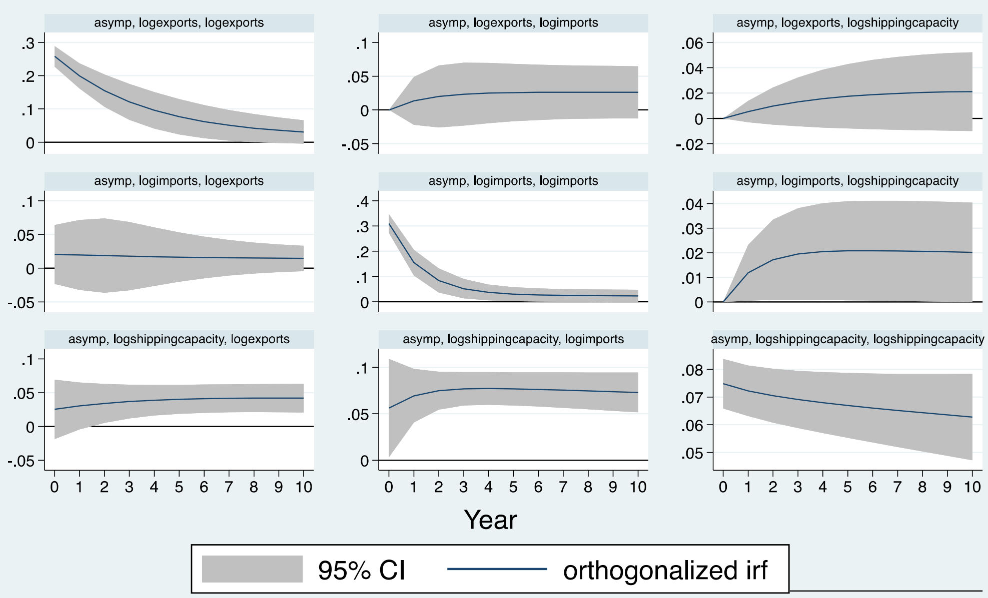
Using Real Exports



Graphs by irfname, impulse variable, and response variable

Figure A.4

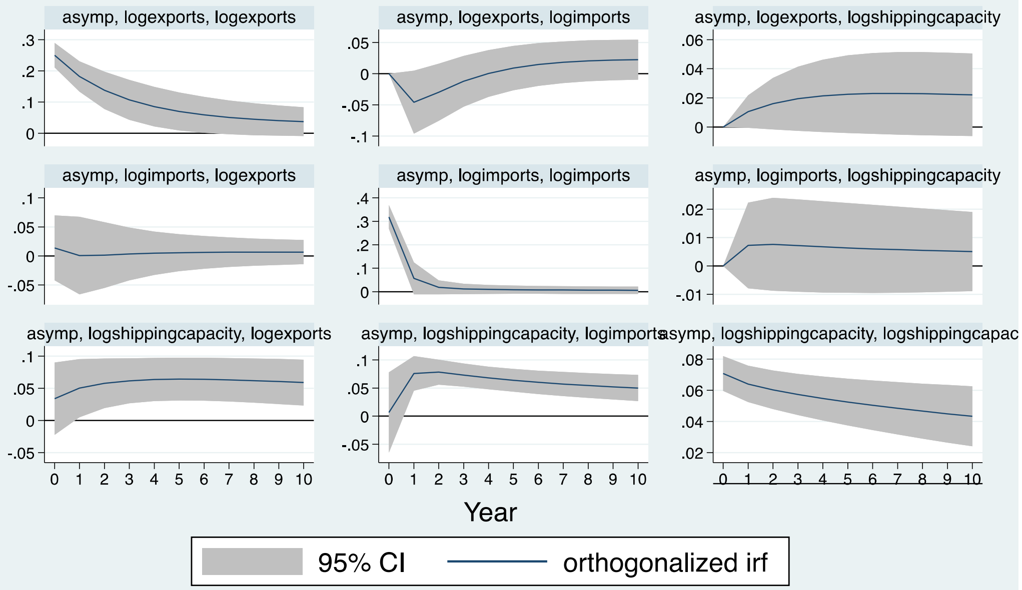
1700-1833



Graphs by irfname, impulse variable, and response variable

Figure A.5

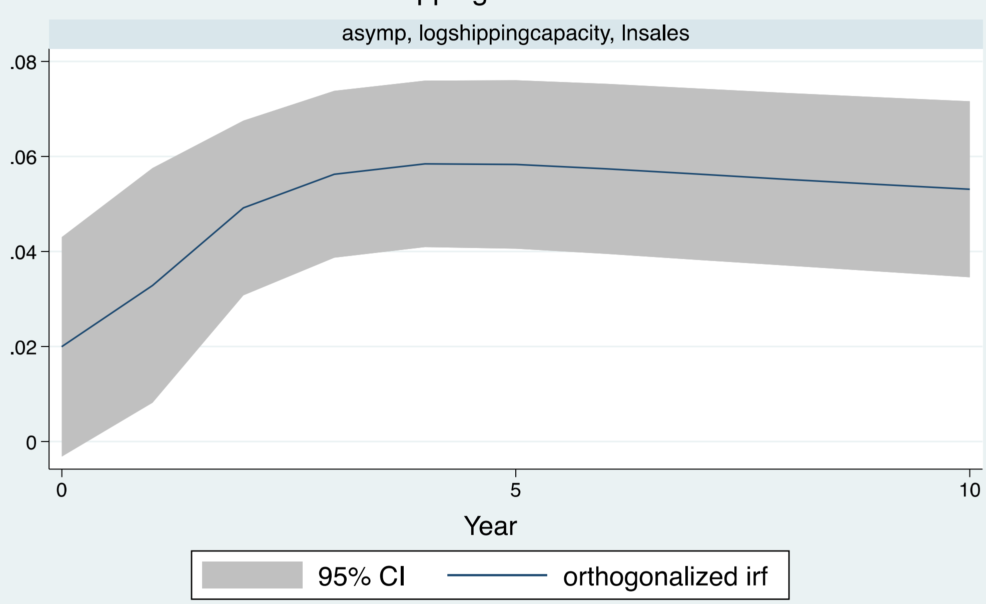
1757-1833



Graphs by irfname, impulse variable, and response variable

Figure A.6

Effect of shipping on sales income



Graphs by irfname, impulse variable, and response variable

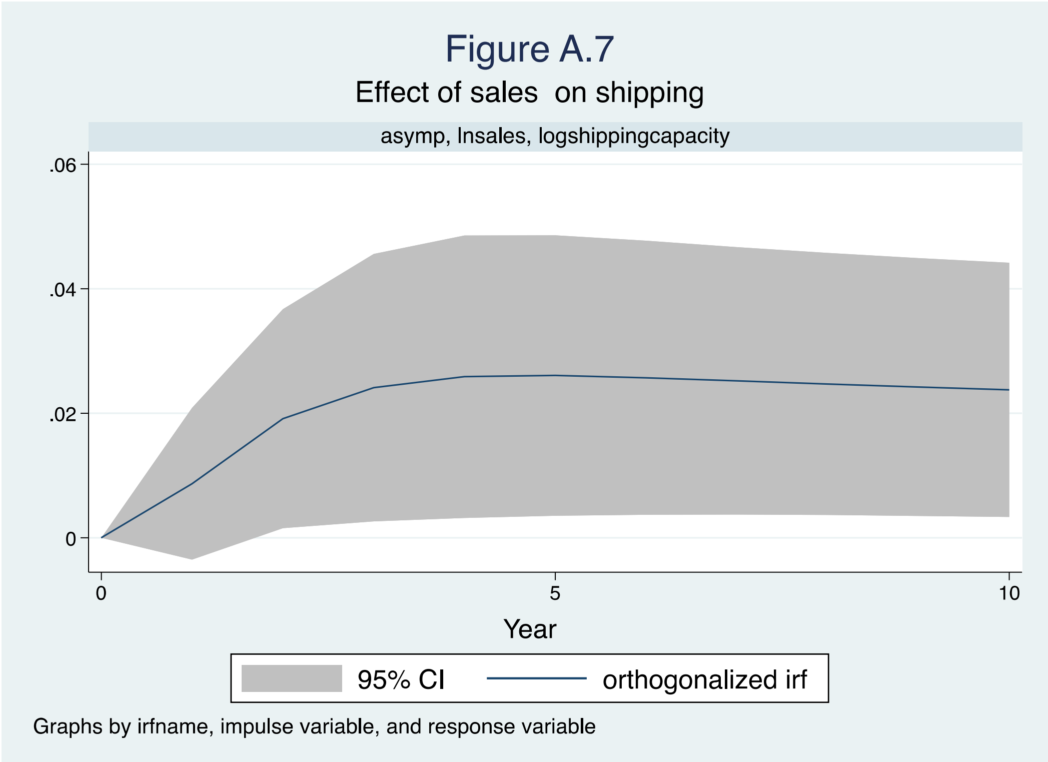


Figure A.7
Effect of sales on shipping
asymp, lnsales, logshippingcapacity
.06
.04
.02
0
0
5
10
Year
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable