

The World after the ‘Spanish Dollar’.

Spanish American Silver after Independence, the ‘First Global Crisis’ in the 1820s and its mechanisms of international transmission.

III Seminar in Economic History

Bank of Spain

October 5th, Madrid

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Very preliminary version²

¹ We appreciate comments and suggestions made by Jeremy Ducros, Elena Martínez and Pilar Nogués-Marco.

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I. Introduction

The main goal of this research report consists of testing the hypothesis that silver production in New Spain/Mexico (before and after 1821, respectively) had a significant influence on the evolution of prices across the world. Silver played a protagonist role in a bimetallic international monetary system and circulated across the global economy of the eighteenth and nineteenth centuries. In particular, the *reales de a ocho* (Spanish pesos or dollars) massively coined in the mints of the silver-producing territories of Hispanic America became the international currency from the first half of the 16th century until the post-independence decades (Cipolla, 1999). Circa 1800, New Spain was by far the largest world producer of silver and reached historical records. After 1821, Mexican production fell dramatically. Similarly, it also intensely declined in other independent Hispanic American republics. Previous abundance of silver, then, turned into relative scarcity. Notwithstanding, Mexico continued being the world leader in silver production.

Any version of the quantitative theory of money will predict that world prices in terms of silver should change in response to the developments observed in silver supply, of which New/Spain production represents an acceptable proxy. Long-run dynamics of international prices moved along the path that might be expected: somehow replicating what happened in 16th and 17th centuries in Europe (Revolution of Prices followed by a downward trend), inflation characterizes the second half of the 18th and the beginning of the 19th centuries as opposed to the deflation or stagnation that started in the mid-1810s.

Given the similarity observed between the two phases of the international economic history phases mentioned above, our approach to the study of the period 1770-1848 draws on Martín Aceña (1992). We firstly analyze quantitatively the co-movements of prices in silver terms throughout the East (China) and the West (the US, New Spain/Mexico, the UK and continental Europe). The peculiar Japanese case, a country that remained more isolated than other large economies from global flows of goods and silver, is also considered. Next, we make a sept forward by proceeding with an attempt of statistically examine the relationship between prices and production of silver in New Spain/Mexico. At this stage of the research, our preliminary results offer evidence in favor of our hypothesis.

The present report is organized as follows. After this succinct introduction, in Section II we provide a general overview of the period and focus on the causes and consequences of the fall in silver production in New Spain/Mexico and the rest of Hispanic America from the 1810s to the 1840s, with a particular focus on the 1820s. In Section III we deal with the unprecedented silver scarcity, as well as with the coincident international

deflation that started in the mid-1810s. Section IV shows a description of the co-movements of prices across a significant number of western and eastern countries –including the “Japanese exception”- and some insights regarding the century-long importance of the Hispanic American silver –in the form of *reales de a ocho*- as internationally accepted and valued means of payments. Section V consists of a statistical analysis of those co-movements and their correlation with silver production in New Spain/Mexico. In Section VI we propose some preliminary conclusions and outline some potentially promising and complementary avenues for further research.

II. An overall picture of the period: rise and fall of silver production

The last decades of the eighteenth century and the first of the nineteenth constitute an interesting period of the world economic history. In our view, nevertheless, it has not attracted so far as much attention as it deserves from economic historians. Why is this period so interesting? A satisfactory answer to this question ought to contemplate several factors. Only those factors more closely related to our research, which are those related with the geopolitical factors that affected the long-established economic ties across the world, will be considered.

To begin with, certain historical events (i.e., French revolution, Napoleonic empire and Hispanic America independence) decisively influenced economic outcomes. As shown in Dobado et al. (2012), the long process of grain markets integration across the West initiated in the first half of the eighteenth century experienced a sharp reversal in 1792-1825. In other words, a process of globalization was on its way by the early 1790's. The impact of the French Revolutionary and Napoleonic Wars on the international economy –on foreign trade, especially, including not only the North Atlantic and Continental Europe, but also Hispanic America and Asia- had been previously highlighted by O'Rourke (2006).³

A major event taking place in this period was the fragmentation of the American territories of the Hispanic Monarchy after their independence had unexpected, negative effects at least on the pre-existing monetary and commercial integration within the region because of: a) the rapid breaking of the continental monetary union based on the silver peso standard that started at the very beginning of the wars between independentists and

³ Crouzet (1964) explored, as O'Rourke (2006) reckons, the dramatic disruption of international commerce caused by the wars of 1792-1815. In particular, the French economic historian deals with the long term, far reaching economic consequences of the British maritime blockade, the “*self-blockade*” of the continent imposed by the French and the drastic territorial changes in Germany and Italy.

loyalists (Irigoien, 2009); b) the generalized adoption of extremely protectionist policies from independence to WWI by the new republics (Coatsworth and Williamson, 2004).

One of the most relevant consequences for the global economy related with this event was the collapse of precious metals production in New Spain and the Andes. During the pre-independence period, global trade was largely built upon the voluminous and continuous exports of Hispanic American silver pesos throughout the Early Modern Era. In the years preceding the upheaval that would end in the independence, Hispanic America had reached an all-time record in silver production.⁴ In the 1790s main producers (i.e., Viceroyalties of New Spain, Peru and Upper Peru) as a whole were producing silver as never before. In the 1800s, production slightly decreased albeit staying at nearly historical maxima. By then, New Spain was by far the world leader in silver production: 178 million of fine ounces out of a world total of 286 million.⁵ In other words, more than 60 per cent of total world silver production was obtained in New Spain. Therefore whatever happened to silver production in that Viceroyalty exerted a global influence. In the 1810s silver production in both New Spain and the rest of Hispanic America substantially decreased (100 and 48 millions of fine ounces in 1811-1820, respectively)⁶. It further declined in the 1830s –see Table 1.

INSERT TABLE 1 ABOUT HERE

O'Rourke (2006) attributes the fall in New Spain and Hispanic America silver production to "*wartime blockades*" and "*political disorder*". In this respect, some clarification is needed. As to the negative effects of the maritime blockades conducted by the Royal Navy on Spanish shipping across the Atlantic and Caribbean, its importance as a short-termed shock was recognized by Humboldt (1814). To him, the causal relationship between blockade and silver production relied on mercury supply to the mining centers. Mercury was the main input in Hispanic American silver production, being Almadén, in central Spain, the chief supplier. Thus, as noticed shortages of mercury in New Spain caused by "*maritime war*" were registered between before 1810.⁷ However, the fall in silver production – measured in this by coining in Mexico City mint on a yearly base- in the 1800s was far from important because of the counterbalancing factors such as the building of stocks of mercury in years of high imports that were available at the mining centers in years of scarcity or the substitution of

⁴ We draw on data collected by John Garner (<http://www.insidemydesk.com/hdd.html>, website frequently visited during 2016 and 2017).

⁵ White (1930a and b). This is a source that, to the best of our knowledge, has scarcely been mentioned in the specialized literature despite its richness in data.

⁶ Ibidem.

⁷ See Dobado and Marrero (2014).

smelting for amalgamation in the treatment of certain types of silver ore - see Figure 1.⁸

INSERT FIGURE 1 ABOUT HERE

In fact, it is true that the registered outflow of silver from New Spain (remittances abroad by private individuals through the ports in the Caribbean including relatively amounts of coined gold) show a high inter-annual variability in response to changes in the relevant circumstances, among them the maritime blockades. Thus, for instance, in 1797, 1801 and 1805 they did not reach one million pesos, far below the average of the years 1796-1815. However, silver exports from New Spain also showed impressive recoveries in "normal" years: e.g., 29.3, 16.9, 19.3 and 21.8 in, respectively, 1802, 1804, 1807 and 1809. Actual exports of silver to Asia from Acapulco via the *Galeón de Manila* are unknown for most of this period. However, it is safe to assume that, at least, after 1785 they never reached the volume corresponding to the outflow through the Caribbean and that diminished from 1785 until the last voyage of the *Galeón of Manila* in 1815. Smuggling of silver certainly existed, albeit in quantities difficult to estimate. In any case, it is unlikely that they significantly altered the general picture depicted by the figures of the legal trade.

Total registered exports of silver from Mexico between 1825 and 1849 remained almost constant at a yearly average of nine million pesos. This figure is not only lower than that of 1766-1789 (more than fourteen million pesos) but also even that of the "abnormal" 1800s (nearly twelve million) (Lerdo, 1853:1967; Romero, 1997).

The spectacular fall in silver production occurred in 1810 and is directly related to the civil war -commonly known as *Insurgencia*- that started in that year. Its effects on silver production were simply devastating. They was accompanied by the ceasing of mining activities in Almadén as a result of the French invasion of Spain in 1808 and by the practical disappearance of the Spanish State in the Peninsula, at least as far as mercury production and commercialization -a royal monopoly- are concerned.

The setback experienced by the silver production proved to be long lasting. The decrease in the 1820 exceeded that of previous decade. The recovery in the 1830s and 1840s was not fast enough as to permit reaching the levels of the 1790s and 1800s. In sum, the long-term fall in silver production in Mexico during most of the first half of the nineteenth century was a conspicuous result of post-1810 developments. As a result, estimates of total Mexican foreign trade by Cárdenas (2003) show a significant fall between the 1800s and the 1830s: 304.3 million pesos compared to 182.3,

⁸ Ibidem.

respectively. Notwithstanding, Mexico was still producing more than 50 per cent of total world silver production.

Significantly enough, similar dynamics are observed in the other silver-producing territories in Hispanic America. As a consequence, world silver production in 1841-1850 still was less than 90 per cent that of 1801-1810. Therefore, the first half of the 19th century appears to be clearly different to the second half of the 18th century in terms of the supply of silver to the world economy. Thus, it is unlikely that these developments did not affect an international monetary system strongly dependent on silver. In this respect, the pre-1810 global monetary context contrasts with the one that emerged after the beginning of the independence in Hispanic America. Moreover, the deterioration of the quality (weight and purity) of the new pesos further rarified global markets for silver (Irigoin, 2009a and b).

At a national level, the disruption of silver production triggered different consequences that depended on the type and intensity of commercial and financial connections with silver-producing countries and on each country's monetary regime. Several countries worldwide depended more or less on silver as a local means of payment and considered this metal as legal tender (France, China, and most countries in Latin America). In those cases, an exogenous supply shock on silver would immediately affect the monetary base, which could lead to different reactions by monetary authorities depending on the extent and nature of the shocks.

As a departing point of our analysis, we explore the links connecting a world economy in which silver was utilized as any other commodity. O'Rourke (2006) rightly points out that the disruption caused to the functioning of the international economy by the war cycle of 1792-1815 in the West also affected to the East. In particular, the decrease in silver production in Hispanic America implied a dramatic fall in British shipments of silver to India and China. Cheung (2013) shows the significant decrease in the silver shipped to Guangzhou by the *British India Company* during the 1790s: from almost 80 metric tons in 1790 to nil in 1793-1795 and less than usual quantities in other years.⁹

In fact, the rise in opium trade might have been favored by the new conditions reigning over silver production in Hispanic America and its worldwide circulation.¹⁰ Irigoin (2013) seems to agree with this claim for

⁹ "The scarcity of silver caused the British East India Company serious difficulties in its China trade." (Cheung, 2013, p. 128).

¹⁰ "Before 1800, the tea trade was, at least in the terms of the mercantilist ideology of the day, grossly favorable to the Chinese. The EIC's [East India Company] records pinpoint 1806 as the year when silver flow reversed. After that date, the value of opium imports exceeded that of tea exports, and Chinese silver began flowing out [author's stress] of the Celestial Empire for the first time. After 1818,

somewhat later in the 19th century.¹¹ Whether this hypothesis is valid turns out to be difficult to test.¹² However, it finds support in the change found by Permanyer (2014) in the traditional pattern of trade between the Philippines and China from 1815 –precisely the year in which the *Galeón of Manila* and its cargo of highly appreciated *reales de a ocho* vanished- to 1830. “*Lack of liquidity*” after the interruption of the trans-Pacific silver flows between Hispanic America –from New Spain mainly- and the Philippines even before 1815 was behind the reorientation towards opium by the employees of the *Real Compañía de Filipinas* (RCF), in collaboration with the British.¹³

This historical fact complements O’Rourke’s (2006) view on the effects of the years 1792-1815. It is our contention that the significant, long-lasting fall in silver production in the 1810s and 1820s, and its incomplete recovery afterwards, had further pervasive effects on the international monetary system.

Such a claim should first of all consider the dynamics of the silver market in London and Paris, two major markets for silver. In fact, in the late 18th and early 19th century, major economic actors could influence the flows of metals and manage the shocks accordingly. In the case of Great Britain, both the Central Bank and the Mint relied on pre-established mechanisms that would rebalance the supply shocks through the official mint price and by direct interventions of the Bank of England. While Great Britain experienced different monetary regimes since the 18th century, including a period of inconvertibility that began with the Bank Restriction Act in 1797, it only gradually returned to gold after 1816, before which the silver coins had remained in circulation. During the whole period, it acted as a major market for gold and silver, whose supply and demand depended upon a set of factors, such as the British balance of trade, the supply of bullion from the Americas and Africa, the demand from Asia and Europe, credit and financial shocks and geopolitical events (Hotson and Mills 2015).

silver constituted fully one-fifth of the value of Chinese export goods.” (Berstein, 2008, p. 290).

¹¹ “*The rise in Opium imports into China, which took off after the silver trade had plummeted suggests, that merchants turned to Opium as a substitute for pesos [reales de a ocho], or that Opium was an alternative source of sycee [silver ingots used in China as money].*” (Irigoien, 2013, p. 27).

¹² Von Glahn (2016) disagrees “*on the role of opium as the principal cause in the reversal of the flow of silver.*” (Von Glahn, 2016, p. 367).

¹³ “*At the end of the 1810s and during the succeeding decade, the RCF employees in Calcutta and Canton reoriented their private business (...), in the opium sector. This concurred with two fundamental factors: the end of the Manila Galleon in 1815 on the one hand, and the opium boom in the first half of the 1820s on the other. In Canton, together with the main British firms of Charles Magniac and Co. and W.S. Davidson and Co. –precursors of Jardine, Matheson and Co. and of Dent and Co., respectively- houses like the Spanish Lorenzo Calvo y Cia and the Hispano-British of Ysarrri y Cia. [author’s stress], both made up of RCF employees, will have a prominent role in this rise.*” (Permanyer, 1814, pp. 156-157).

The Bank of England could consequently participate in the bullion and specie markets, and the Royal mint defined a mint price for gold and silver —silver coins continued to circulate and be used so settle sterling debts — which effectively acted as an anchor to the market price of both metals, leading to a strikingly stable ratio of gold to silver since at least the late 18th century.

This did not mean, nevertheless, that central banks could always efficiently intervene in the bullion market, whose occasional shocks could lead to major volatility and economic disruptions, ultimately leading to a change in the monetary regime. Flandreau (1996) provides a general account on the theories explaining how these shocks could have led to the emergence of the gold standard in the 1870s, though he concludes that an international bimetallic standard could have survived with more international cooperation. Moreover, countries under a silver standard (or whose monetary base contained a major proportion of silver) experienced in the 19th century the direct impact from changes in the price of silver, which were largely driven by that metal's production. The mechanism, largely described in the gold-standard literature (Eichengreen and Mclean, 1994; Rush, 1985) links the production of the metal (silver in our case) with the level of prices. An increase in silver supply caused by silver mining could lead to an increase in silver reserves, which in turn increased the money supply and the price level.

Whether this mechanism was relevant for the period under study is an open question. In certain cases, the immediate effects from a sudden change in silver production could be limited in terms of monetary supply as production was only small proportion of the money stock. Mertens (1944) for instance estimates that in France the new production of gold and silver represented about five percent of the monetary base (Mertens, 1944). Moreover, during those years in which war finance was recurrent, Central Banks utilized paper money to face the shortage of specie. Resort to exceptional measures could be also caused by financial crises. During the crisis of 1825, Kindleberger (1984) reports that the Bank of France shipped gold to Great Britain in exchange of which the Bank of England sent silver. Within these two cases, the first half of the 19th century has been qualified as one in which the gold-silver exchange rate operated within narrow margins, albeit with imperfections. While London treated gold as money, in Paris it was rather considered as an asset, while the opposite held for silver (Flandreau 1997).

The crisis of 1825 also serves to illustrate the understudied role of silver in the deflation that followed the Napoleonic wars. Neal (1998) highlights the deflationary policies introduced by the British government and the Bank of England. However, the availability and prices of gold and silver have been reported to be correlated by the end of the 18th century —with the price of silver first affecting the price of gold— and there is no reason to

believe that this was not the case after the wars (Hotson and Mills 2015). Moreover, Salvucci (2013) has recently speculated, based on contemporary sources, that the deflation in Great Britain could have been a direct consequence from the decline in specie production from the Americas. Salvucci (2013) also observes that the highest volatility of the silver price in London in terms of gold coincides with the period of inconvertibility. This volatility could have had an incidence on real activity, on the exchange rate Mexican peso –sterling pound or both, with lasting effects on the British monetary regime.

In the case of China, some authors attribute *“the net outflow of silver from China to the rising value of silver in the international markets”*, instead of blaming the opium imports ¹⁴ According to Lin (1991), *“falling global production of silver”*, along with a weak demand for tea and silk in Europe, are the reasons why China experienced a net outflow of silver during the first half of the nineteenth century.¹⁵ Von Glahn (2016) disagrees with Lin as to the relevance of the two factors proposed by her to explain the shortage of silver in China. Part of evidence upon which Von Glahn (2016) builds his argument is empirically flawed as he clearly underestimates the real fall in Mexico during the first decades of the 19th century.¹⁶ However, he offers a convincing monetary argument: *“The principal evidence for a shortage of silver in China during the first half of the nineteenth century is the sharp appreciation of silver (relative to bronze coin) beginning in the mid-1830s.”*¹⁷ Contrary to Von Glahn (2016) assertion, the exchange ratio between silver and bronze started to rise before than as late as in the 1830s. Reinforcing our conclusion drawn from Von Glahn’s own figures, Chen (1975) shows clearly that depreciation of copper begun early in the 19th century –see Figure 2.¹⁸

INSERT FIGURE 2 ABOUT HERE

¹⁴ Demigny (1964), referred by Von Glahn (2016, p. 367).

¹⁵ Lin (1991), referred by Von Glahn (2016, p. 367).

¹⁶ It is a common limitation in some works dealing with money and prices in China the lack of careful attention paid to the pre-1810 years in New Spain. Thus, it may seem that growing production in Mexico after 1821 implied a certain return to normal, which is clearly untrue, as the accumulated silver produced was clearly lower than before 1810. Between 1790 and 1809, the accumulated production of silver in Mexico nearly amounted 450 million pesos compared with the 300 million total of 1810-1839. A similar fall in other Hispanic American producers significantly changed the world supply of silver. In this new playground, the USA outperformed European countries as carrier of silver to China.

¹⁷ Von Glahn, 2016, p. 368.

¹⁸ Both Von Glahn (2016) and Chen (1975) suggest that other factor might contribute to the explanation of the increase in rate of exchange between silver and bronze (i.e, debasement of bronze coin by the state and changes in the price of agricultural products). However, we find that their reasoning is somehow contradictory and/or unconvincing.

This evidence for China is consistent with our hypothesis that the pervasive reduction of silver production in Hispanic America from 1810 somehow created a new monetary world in which silver became less abundant and more expensive in terms of other goods.

These global interactions can be established through an initial observations on the relationship between silver production and prices of silver in (the West? London?). This is shown in Figure 3, where we report the price of silver in the West, which clearly reflects the change in the supply of silver after 1810 –see Figure 3.¹⁹

INSERT FIGURE 3 ABOUT HERE

III. Silver scarcity and the fall in prices' levels

During the two last decades of the 18th, the price of gold in terms of silver increased. Interestingly enough, it experienced a significant fall in 1810 and from 1814 to 1820. Until the 1820s, the evolution of the gold/silver ratio is compatible with the hypothesis that it reflects the ups and downs of silver production. From the 1820s on, the said ratio remained rather stable within bands of variation not far from the average values reached before 1810. Certainly, it reaches beyond the objectives of this research report to propose an explanatory formal model of the long run behavior of the gold/silver ratio in a period of increasing monetary and financial complexity such as the one we are dealing with. In any case, for the whole first part of the 19th century the respective production of gold and silver do not seem to capture the dynamics of their relative prices see Table 2. Likely, changes in the demand for the two precious metals in response to the diverse and important economic developments in the real and monetary sector, and their interactions-, of this period should be considered in our future research.²⁰

INSERT TABLE 2 ABOUT HERE

The link between the levels of prices and the production of gold and silver mines was reported by contemporaries (Ricardo 1811; Tooke 1838). These observations were later analyzed and named as the “price revolution”, which described the economic effects in Europe from the specie flow stemming from the Spanish colonies (Clark and Hamilton 1934).

¹⁹ Details on the methodology used to construct this series are offered at <https://measuringworth.com/docs/GoldInterpretation.pdf>.

²⁰ A skyrocketing rise in manufactures exports from Britain to Hispanic America occurred between the 1780s and the 1820s (O'Rourke, 2006). The new trade resulting from the Napoleonic Wars and, especially, from the independence of the American territories of the Hispanic Monarchy forcedly increased the inflow of silver into the UK and reduced that with Spain as destination.

(Bordo 1984) provides a general overview of the classical economists, all of which emphasized the role of bullion —whether quantity theories of money such as the one raised by Richard Cantillon or the more elaborated international specie standard analyzed by David Hume which emphasized the role of the balance of trade on the determination of prices and wages.

These authors raised already the law of one price or today's theory of purchase power parity (Rogoff, 1996). Accordingly, prices in open economies should behave similarly once the effects of the exchange rates are taken into account. This reasoning justifies why authors such as McCloskey and Zecher (1984) and Flandreau (1996) have estimated that, regardless of the monetary regime blocks to which open economies participated, the correlation in prices series during the 19th century (since around 1840) are high and positive and show no difference between blocks. To our view, we have reasons to believe that these forces were already in place since at least the late 18th century. The fall in prices that we report in Section III has also been taken as evidence in favor of the existence of common business cycles in Europe and as part of in the national historiographies of different countries. Regarding the former, Silbering (1923) reports different indexes of prices of international traded commodities [provide different definitions] and shows that they experience a general fall during the 1810s (starting in 1810). Craig and García Iglesias (2010) report a downward cycle in Europe's economic activity around 1810-1811, though they insist that price expectation may vary according to an economic shock, while this relationship may be dissociated from the cycles in the real activity. They nevertheless recognized that the specie flows had an important effect on business cycles in Europe.

Salvucci (1987, 1994) reports such a mechanism in the case of Mexico's bilateral trade. While increased production of silver allowed for more import capacity for British cottons, Salvucci (1994) identifies a real exchange rate mechanism, in which an overvaluation of the Mexican peso in the late 18th century and the early 19th century also contributed to the fall of local woolen production. This overvaluation can be directly attributed by an increase in the price levels in Mexico which were a byproduct of increased silver stock. Given the prices and exchange rates with Great Britain, bilateral trade (and smuggling) led to an increase of imports of British cottons and substitution of Mexican woolen.

Following the same reasoning, the fall of silver production may have led to the reverse mechanism. The deflation reported in Mexico could have been accompanied by this same process in other countries in South America. Moreover, the interruption of silver imports to Great Britain could have other, international trade effect as Great Britain was a major player in the world's silver market. In the case of Asia, Bowen (2010) argues that in the late 18th century silver was exported from Britain to Asia, but that these

flows reversed precisely after 1810. Most of this silver was in fact re-exported from Spanish America. Again, London emerged as a major place in which the Bank of England and the English East India Company participated in the market of “silver bullion for good”. He provides figures for the period 1802-1811, in which 43.8% of silver imported to India arrived from Great Britain, 16% from Europe (other) and 40.2% from America. Bhattacharya (2008) reports that China absorbed 18% of the New World’s silver output; silver deflation was also due to the trade deficits.

IV. Co-movements of prices and the role of silver as an international means of payments

A close inspection of series (i.e., grain prices and Consumer Price Indexes) for a relevant group of countries shows more than superficial similarities over the period under consideration. Those countries may be included in a “silver world” increasingly integrated by the intra- and intercontinental trade in goods and *reales de a ocho* over the Early Modern Era. In this respect, Flynn and Giráldez (2004) “propose [critiquing O’Rourke and Williamson (2002)] that globalization began when the Old World became directly connected with the Americas in 1571 via Manila.”²¹ We agree with this claim. Departing from Acapulco, in the Pacific coast of New Spain, the *Galeón de Manila* was loaded with important quantities of silver that redirect to China and other countries of the region. For some time, Peru was also permitted to export silver to the Philippines in exchange for luxury goods.. Trade between Veracruz and Spain had very much in common with the *Galeón de Manila* in that it consisted basically in silver. Once arrived to Seville (16th and 17th centuries) or Cadiz Atlantic trade Lead by Portugal, the Netherlands, Britain and even Demark and Sweden successively joined the new commercial route through the Cape of Good Hope to the Indic and the China Sea, with an active participation of merchants from the East, where silver was very much appreciated as to permit the appearance of a market for arbitrage of precious metals. After the independence, the USA rapidly developed a fruitful trade with China. For the first time in history, trade was practically global.

The role played by the flexible supply of reliable, worldwide accepted, silver *reales de a ocho* minted in Hispanic America was indispensable. During some decades of the 16th and 17th centuries, Japan became an important silver producer whose exports had Korea and, mainly, China as destination, and kept alive a significant trade between the three countries

²¹ Most estimates of silver exported, between 1550 and 1645, from Japan to China exceed to those of the silver coming from America through the Pacific and the Atlantic routes. (Von Glahn, 2013, p. 32).

(Flynn and Lee, 2013). The seclusion of Japan in the 1630s very much reduced its participation in international markets.

According to de Vries (2003), in 1725-1750, intercontinental silver flows were as follows: slightly more than three quarters of the Hispanic American silver production (nearly 50 per cent higher than in 1600-1650) were sent to Europe, while direct exports across the Pacific route to Asia amounted to between 2.5 and 8 per cent; from Europe roughly 8 and 10 per cent were, respectively, exported to the Baltic and the Levant; and between an quarter and a third makes its way Asia by the Cape.

Therefore, we contend that the inclusion into this expanding “silver world” should have certainly affected the dynamics of prices across continents.

Albeit some country-specific or more general circumstances (i.e., bad harvests, military invasions, maritime blockades, war effort and its financial requirements) might cause the appearance of influent observations in the series, an underlying common trend becomes apparent. It adopts the shape of an inverted U centered sometime in the 1810s. This trend is shared by countries with different economies and varied historical trajectories across continents. This nearly global behavior of prices –inflation in the second half of the 18th century and the early 19th century followed by deflation and/or stagnation of prices in the rest of the first half of the 19th century–resembles that of the European countries in the 16th and 17th centuries studied by Martín Aceña (1992). Might the ascend part of the inverted U be considered a peculiar form of price revolution? Behind these two developments we find a huge increase in silver flows from Hispanic America to most of the rest of the world

In the case of Spain, the main gate of entry of silver from Hispanic America into Europe until 1821, the series of consumption baskets for Barcelona (a coastal, grain-importing, commercial and manufacturing town that pioneered Spanish industrialization) and Palencia (a distant from the sea, wheat producing, second-rate location in the peninsular urban hierarchy) follow the trajectories depicted in Figure 4.²²

INSERT FIGURE 4 ABOUT HERE

The existence of two clearly different periods in terms of the rate of growth in prices is more evident in Figure 5.

²² Details on the construction of the series may be found in Moreno (2001) and Nogués (2005). The choice of representative consumption baskets constitutes the starting point of the CPIs series. The similarity between the two series, despite the fact that the one for Barcelona is built upon prices in silver *pesetas* while that for Palencia prices are denominated in *reales de vellón*, is somewhat striking. Our research agenda will include the attempt to find an explanation for this close coevolution.

INSERT FIGURE 5 ABOUT HERE

The usual explanation for the Spanish inflation looks at the problems posed by the agrarian sector. Technically and institutionally traditional, especially inner Spain, it could not increase its supply at the pace required for matching the growing demand from an increasing population. Bad or very bad harvests at the end of the 18th and the beginning of the 19th century can be seen as an extreme manifestation of the structural difficulties experienced in the previous years. The Napoleonic invasion came to distort even further the instability of the market for agrarian products.²³

As to the inflationary effect resulting from the supposedly mismanagement of public finances, more particularly regarding the "excessive" issuing of *vales reales*, White (1987) finds a "lack of reaction of prices to the variations in the circulation of vales" [our translation], except after the financial collapse of the Hispanic Monarchy at the end of the 18th century. Tedde (1987) proposed a monetary causation for the inflation, in the absence of an increase in the circulation of *vales*, of the years 1784-1788: a huge increase in the inflow of American silver.²⁴ Thus, he considers that the inflationary effect of the pre-1793 issues of *vales reales* was "moderate". By that year, prices in Barcelona and Palencia had been already growing at historically high rates. Thus, other factors might be in operation.

The effects of Latin America's independence were recently summarized and reported by Tedde de Lorca (2009). He argues that the fall in specie inflows from the Americas led to demonetization, further aggravated by the deficits in the Spanish balance of trade. According to Tortella and García (2013), Spanish deflation was especially intense between 1815 and 1830. From around 1830 to the mid-1850s, prices "steadied", "although with ups and downs around a horizontal trend."²⁵ Their explanation of the Spanish deflation points out to the outflow of coins because of its high content in silver and the chronic trade deficit and also to hoarding. These might well be the main problems confronted by the Spanish monetary system but it is not necessarily true regarding other countries that were experiencing deflation as well. In this respect, Nogués (2005) finds that deflation is not a Spanish peculiarity as it was shared with other Western countries (Germany, the USA, France and Great Britain).

INSERT FIGURE 6 ABOUT HERE

²³ However, it should be noticed that the yearly average rate of growth in prices in Palencia between 1752 and 1789 was 2,6 per cent. These rates exceed those of the two Castilles and Valencia during the Revolution of prices of the 16th century (Martin Aceña, 1992, Table 3, p. 367).

²⁴ Tedde, 1987, p. 547.

²⁵ Tortella and García, 1813, p. 29.

In this respect, Mexico City features an interesting case (Figure 6). Despite certain, contrasting features behind the Mexican series, they do not set apart Mexico City from the basic sequence of inflation-deflation observed in Spain.²⁶ These differences include those stemming from consumption patterns (corn as main staple in the “barbebones low” basket and some wheat and much more meat in the “respectable low” one”), along with especially meagre harvests in a non-negligible number of years, plus years of civil war after 1810. However, deflation is more intense in the “respectable low” basket since it was less sensible to the fall in corn harvests repeatedly suffered by the traditional Mexican agrarian sector after the independence. Nonetheless, the two-phase cycle of prices between 1760 and 1849 is perceptible, albeit somewhat less than in Spain, where intense fluctuations of the agrarian production were not anymore as frequent as before the 1810s –see Figure 7.

INSERT FIGURE 7 ABOUT HERE

The inverted-U shape of prices is also perceptible in two well-integrated and relatively rich Atlantic economies, such as the USA and the UK –see Figure 8.²⁷

INSERT FIGURE 8 ABOUT HERE

Once again, similarities between the two countries and their consistency with international norm are noticeable. However, in the USA, both inflation before 1814 and deflation afterwards were somewhat more intense. As to the inflationary phase, the effects of the War of Independence (1775-1783) –among them intense monetary instability- and the “Panic of 1796-1797” –in which the UK was involved- further increased the growth in prices in the US.²⁸

²⁶ The “barebones” or subsistence baskets are similar to that of Allen et al. (2012) for Milan. In turn, the “respectable” basket attempts to capture the more complex diet of the urban workers and is comparable to others estimated for Beijing and London (Challú and Gómez-Galvarriato, 2005, p. 91). These two basic types of baskets are then divided into “low” and “high” versions. Our choice of the “low” levels of the two baskets likely represents better the real consumption of a larger share of the population. In any case, only minor dissimilarities in levels and trends may be observed between the “low” and “high” versions of the two baskets.

²⁷ Details on the building of the Consumer Price Index (USA) and the Retail Price Index (UK) may be found in <https://www.measuringworth.com/inflation/#>.

²⁸ The crisis started when the bubble resulting from land speculation burst in 1796. It was worsened by Bank Restriction Act was passed, in 1797, by the Parliament of Great Britain. The long-lasting convertibility into gold was suspended until 1821. The controversy on the suspension of specie payments took the following factors into consideration. *“the unbalancing of the budget and is possibly inflationary results; the premium on gold in Paris that accompanied the destruction of the assignats; abnormal imports of grain necessitated by inadequate British harvests; and large imports, at extremely high prices, of naval stores.”* (Rostow and Jacobson, 1953, vol 1, p. 47).

The similitude in prices dynamics between these two countries during the period of deflation is striking, what reinforced the idea of a highly integrated Atlantic economy before the canonical time span of globalization (that proposed by O'Rourke and Williamson in a series of works)-see Figure 9.

INSERT FIGURE 9 ABOUT HERE

Our attempt to present a global picture of the intercontinental flows of silver of the "early globalization" and of price co-movements during the period 1770-1848 needs to complement developments in the West with those in East, especially as China, the largest economy until the 19th century, remained on a silver standard until 1935. The trade of Western countries with China enormously grew during the 18th century and was basically based on the exchange of silk, porcelain and, increasingly, tea for silver.

It is not surprising, then, that, given the parallel with 16th-century Europe, a debate on the effect of the huge amount of silver inflows on Chinese prices has arisen. From a monetary point of view, China is particularly interesting since the *"Chinese imperial government did not issue a silver currency before 1889."*²⁹

As to the 16th century, Flynn and Giráldez (1995) propose that inflation "was a global phenomenon."³⁰ Moreover, they claim that, instead of main protagonists, Europeans were just *"intermediaries in the trade [in silver] between the New World and China."*³¹ Be it true or not –at least a similar quantity of silver remained in the West (Hispanic American and Europe), China acted for centuries as the final destination of a significant part of the world production of this precious metal.

But what can be safely proposed about prices and silver in the eighteenth-century China? Von Glahn (2013) reckons that imports of silver –mostly from New Spain- into China reached historical maxima in the last quarter of that century.³² Cheung (2013) discusses whether the concept of "price revolution" is appropriate for eighteenth-century China. For this author, the still very influential idea that the enormous inflow of silver into China was followed by a high inflation is still widely influential among specialists. The evidence in favor of this idea is shown in Figure 10.

INSERT FIGURE 10 ABOUT HERE

²⁹ Von Glahn, 2013, p. 17.

³⁰ Flynn and Giráldez, 1995, p. 203.

³¹ Ibidem.

³² Von Glahn, 2013, p. 44. "Carolus pesos", after Carlos III, and "budha-head", issued during the reign of Carlos IV, were highly appreciated since 1790s -Irigoin (2009b) is cited by Von Glahn- and valued at an increasing premium during the first half of the nineteenth century.

A first problem with this source is recognized by Wang (1992) himself. The series for the Suzhou Prefecture, including Suzhou City, “*the largest grain market in the country*”, are based on the reports submitted by the provincial authorities to Beijing. The “other series” has been assembled with shorter series for Xiaoshan, Changshu and Shanghai. Until 1785-1787, the two series components basically co-move together. However, afterwards they clearly diverge. For Wang (1992), this divergence might response to errors in the reports from Suzhou Prefecture. In any case, rice prices in silver increased at an average yearly rate of growth of 2.7 per cent between 1711 and 1786, which is higher than that estimated by Martín Aceña (1992) for Spain during the 16th century. This evidence favors the notion of a “prince revolution” in eighteenth-century China. An alternative explanation is proposed by Cheung (2013). The decline in silver imports – see footnote 7- “*would have led to a fall in commodity prices in terms of silver.*”³³ In turn, the same factor might contribute to the increased value of silver in term of copper cash. At this stage of the research we cannot go further with respect to the assessment of Chinese price evolution before 1815. Less arguable is the fall in prices between that year and 1848.

Within the East, the contrast between China and Japan is apparent – see Figure 11.

INSERT FIGURE 11 ABOUT HERE

Neither in Osaka, the main and highly sophisticated Japanese market for rice, nor in Edo and Hiroshima, prices show the inverted-U shape that may be seen in the cases considered so far. We consider China and Japan because of two main reasons.³⁴ On the one hand, they were two big economies, especially the former.³⁵ On the other hand, they represent polar cases in terms of their economic openness. This difference between China and Japan is important to understand the dynamics of prices during the period under study. Thus, while China played an active role in the flows of silver and goods of the increasing global economy from the second half of the sixteenth century –especially from mid-eighteenth century-, Japan remained comparatively closed from the adoption of the *sakoku* policy in 1633-1639 by Tokugawa Iemitsu until the openness of the country forced

³³ Cheung, 2013, p. 128.

³⁴ India has not been included in our discussion. Following Studer (2008): “*Prior to the mid-nineteenth century, the grain trade in India was essentially local, while more distant markets remained fragmented.*” (p. 424). A visual inspection of grain prices in India reveals the existence of several well-differentiated regions. On the contrary, grain markets in China and Japan were well-integrated since the eighteenth century (Bassino, 2006; Shiue and Keller, 2007; Dobado et al., 2015). On the contrary, no statistical evidence of trade in grain between China and Japan is found by Dobado et al. (2015) in spite of the existing differential in prices.

³⁵ According to Maddison estimates, China GDP was still at the top of the world ranking by 1820, while Japan occupied the seventh position, well ahead of the USA and Spain.

by the arrival, in 1853, of the “black boats” of the US Navy commanded by Commodore Perry and the subsequent treaties with Western powers.³⁶ The rationale behind the divergent paths of foreign trade followed by China and Japan from mid-seventeenth century is exposed by Miyamoto and Shikano (2003).³⁷ Rice prices movement over the long term reveals the implications of the contrasting policies chosen in the two countries.

As a summary of the evidence regarding price dynamics during the period under consideration we present Table 3.1 and Table 3.2.

INSERT TABLE 3.1 AND TABLE 3.2 ABOUT HERE

Table 3.1 shows the average yearly rate of growth of prices between 1774 or 1775 and the year in which the maximum of the inflationary phase is reached. Table 3.2 depicts inter-decennial rates of growth in order to avoid the effect of a possible selection bias. The two estimates reflect a similar prices dynamics. The long run evolution –Japan excepted- of prices very much resembles that of Europe in the 16th and 17th centuries (Martín Aceña, 1992). In some cases, both inflation and deflation are even more intense.

These basic findings are complemented with an econometric analysis in the next section.

V. Econometric analysis of price series and New Spain/Mexico silver production

This section uses some findings from Dobado et al. (2012) for the Atlantic grain prices obtained with series that cover the second part of the eighteenth and first half of the nineteenth Century. The previous work finds pairwise co-integration relationships between series from Amsterdam and Holland, Arévalo (inner Spain), London and Southern England, Gdansk, Milan, Strasbourg and Vienna, in Europe, and Pennsylvania, in North America. On the other hand, by using rice prices, the same authors reveal

³⁶ The isolation was incomplete since China and the Netherlands were allowed by the Shogunate to conduct trade under very restrictive conditions.

³⁷ *“After the second half of the seventeenth century, rice prices in both countries began to diverge, and the synchronized movement was completely lost by the eighteenth century. The crucial period was the second half of the seventeenth century. Both countries suffered from shortages of silver, in Japan because of the outflow of silver and the growth of demand for money, in China because of the government’s isolationist policy. However, the two countries came up with different solutions. Japan reacted by withdrawing from the international system, while China responded by re-entering it. Thus the two economies took different paths in the eighteenth century and after.”* (Miyamoto and Shikano (2003, p. 185).

in a different paper that China and Japan were disconnected during the same period (see, Dobado et al., 2015).

Bearing these results in mind, we use these and other eighteenth-nineteenth centuries price series (grain prices, consumer price indexes, etc) with a twofold aim: 1) studying the behavior of worldwide prices and statistical similarities compatible with our hypotheses; and 2) looking for relational patterns between worldwide prices and the production of silver in New Spain.

To achieve our first objective, we first analyze the price series and find that all of them are $I(1)$, meaning that they all need one difference (i.e., $p_t - p_{t-1}$) to be transformed into a stationary series. The results of the stationarity analysis, by means of the Augmented Dickey Fuller (ADF) test, are shown in Table 4.

INSERT TABLE 4 ABOUT HERE

As said in previous sections, most of price series show an inverted U-shape during the period of the analysis. To determine whether there is a long-run relationship between the prices, we perform a cointegration analysis using the Engle–Granger two-step method, which consists of regressing the two cointegrated candidate prices and testing for a unit root in the residuals obtained from the regression. Table 5 shows the results of this unit root tests using the ADF.

INSERT TABLE 5 ABOUT HERE

The statistical test rejects the null hypothesis of unit root in most of the cases, evidencing, in such cases, the existence of a long-run relationship of prices. Interestingly enough, the only relationships that do reject the cointegration hypothesis are those involved with Osaka rice prices. This result was somehow expected due to the isolationist foreign policy of the Japanese Tokugawa Shogunate carried out up to circa 1850. Charts included in Figure 12 depict the evolution of pairs of prices and the residuals of regressing one onto the other. Notice that only the residuals from pairs including Osaka rice prices do not present a stable mean.

INSERT FIGURES 12 ABOUT HERE

Building on those results, we next investigate what could have been the cause of this long-run relation of prices in these, in many cases, quite different economies. As previously said, our hypothesis is that New Spain silver production could have been behind the common trends drawn by most of these prices. A preliminary visual inspection does not reject this hypothesis, as the evolution in time of silver production also draws a similar inverted U-shape. Figure 13 presents some charts that jointly depict silver production in New Spain and some grain prices. Price series are now named

with a “C” at the end because they include a dummy correction for removing the impact of the so-called year without summer.³⁸ In most of the cases, the dramatic reduction of silver production suffered in 1810-12 seems to have some effect in price series, generally around three years latter or so. Unfortunately, we do not find a clear statistical effect in all the cases, probably due to the instability of the relationship. In such a long period, we think that the relation between the production of silver and prices could certainly vary in time and intensity, which violates the assumption of constant parameters.

INSERT FIGURES 13 ABOUT HERE

In order to avoid the possible variability of the parameters, we try to test the hypothesis that the strong reduction in New Spain silver production negatively affected the prices from a different perspective. We calculate the average annual increase for all the price series ($\Pi_{i,t}$) from 1751 to 1811 and we do so for the average annual increase in the cumulated New Spain silver production (S_t) during the same time span. We do the same calculations for the series and the period that goes from 1812 to 1860 –or to the last year available for each series. We then run a static regression for prices registered in different periods:

$$\Pi_{i,t} = \beta_0 + \beta_1 S_t + \varepsilon_{i,t}, \quad (1)$$

where $i = \{\text{London, Pennsylvania, Vienna ...}\}$ and $t = \{1751-1811, 1812-1860\}$.

Notice that Osaka has been deliberately not used in the regression. Regression (1) returns an estimated value for β_1 equal to 0.35 with a p-value of 0.001 for the null hypothesis of $\beta_1 = 0$, meaning that there is evidence of a positive correlation between the average annual increase in the (cumulated) New Spain silver production and the average annual increase in prices, at least, in these two different periods. Figure 14 illustrates the regression presented in (1).

VI. Preliminary conclusions and further research.

This report is a first attempt to provide historical, quantitative and statistical evidence on the role played by the production –largely exported- of silver in New Spain/Mexico in the world’s commercial and monetary systems between, roughly, 1770 and 1849. In those years, New Spain/Mexico was

³⁸ The year 1816 is known as the Year Without a Summer (also the Poverty Year, the Summer that Never Was, Year There Was No Summer, or Eighteen Hundred and Froze to Death) because of severe climate abnormalities that caused average global temperatures to decrease by 0.4–0.7°C. This resulted in major food shortages and dramatic increases in prices across the Northern Hemisphere.

by far the main world silver producer. In 1810, after several decades of growth, its production suffered a significant decrease to which an incomplete recovery followed after 1821. This change, from abundance to scarcity, could not but have far-reaching consequences on an international monetary system in which silver played a decisive role. Those consequences were reinforced by the similar trend registered in the other Hispanic American silver-producing countries.

Our research confirms previous claims on the extent and intensity of the economic integration across distant parts of the world long before the beginning of the –canonical- globalization of the 19th century. Hispanic American silver –mainly in the form of reliable, worldwide-accepted *reales de a ocho*- was indispensable for the continuity of the complex and fascinating inter- and intra-continental economic ties that were developed during almost three centuries.

Thus, a major finding in this paper is that, despite differences in consumption patterns, trade policy, economic development and monetary regimes, the correlation of prices within the West –or at least an important part of it- and between West and East –including China but not Japan- emerged before what we had initially previously assumed. An international prices dynamics divided by the 1810s into a phase of inflation and another of deflation is clearly perceptible in the West and the East, albeit not in the secluded Japan. The inflation is generally observable in the decades preceding the “abnormal” conditions resulting from the military conflicts of 1792-1815 and their monetary and financial consequences on prices. Admittedly, while major economic actors undertook fiscal and monetary policies that led to deflation in the post-Napoleonic Wars period, the price movements that followed cannot be solely attributed to these factors. As we have shown, other, major events led to monetary disruptions in America and Asia.

Varied evidence provided by this research report suggests that changes in silver supply have some non-minor explanatory likelihood regarding our finding of generalized co-movements of prices that adopt the shape of and inverted-U centered in the 1810s.

Only very recently we have been able to start building a reliable series of legal silver exports from New Spain/Mexico. While similarities with the series of production may be observed, differences also exist. At first sight, it seems that it might correlate even better, especially after 1810, with the evolution of international prices. Thus, a statistical analysis will be conducted in order to test the robustness of our hypothesis and to compare its results with those presented in this report.

At this stage of our research, we have developed other, complementary, aspects of this period. One of these are the interactions between the flows of silver into and out of London and its effects on the commercial and monetary regimes in regions other than Europe. To our view, further research is needed as to the role of the Bank of England and the Royal mint and their reactions to events in silver producing countries. We may for instance speculate whether a parallel, global factor is also driving interest rates in different countries. Finally, and if our initial research hypothesis is correct, the history of the 1825 needs to be rewritten at the very least, to take into account for this and other, global factors previously underestimated.

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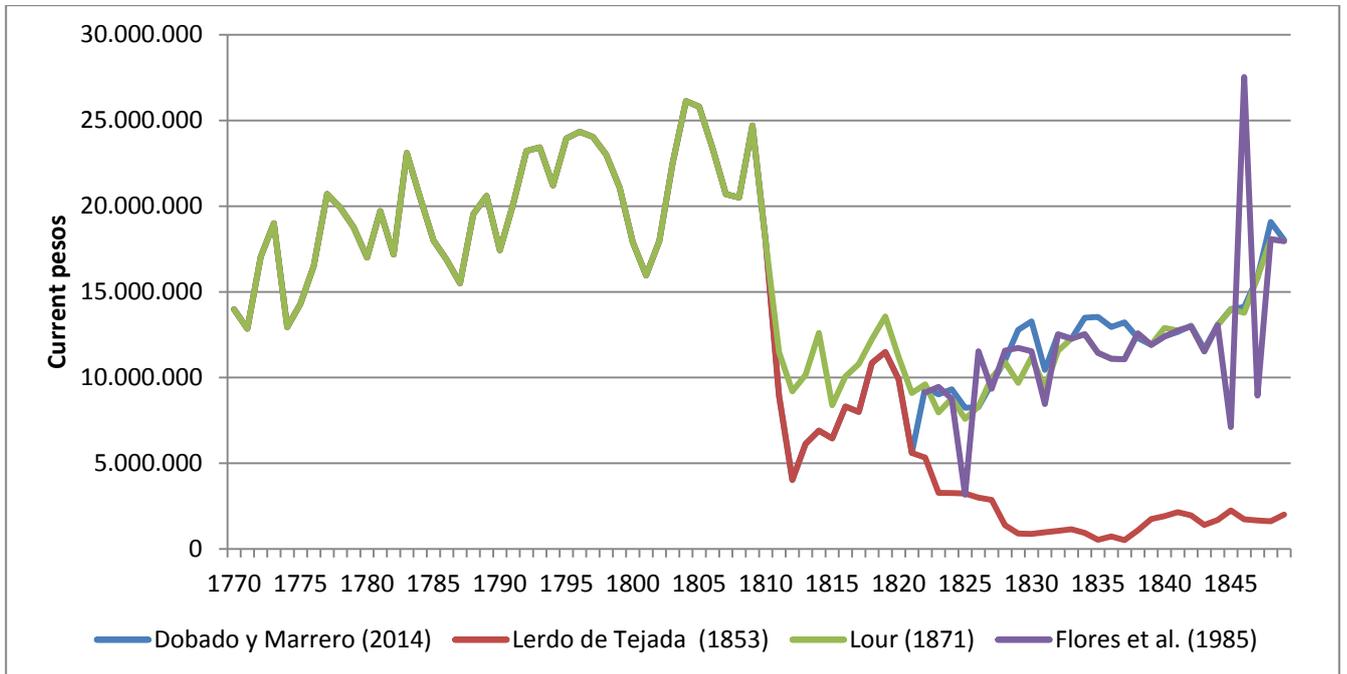
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Figures and tables

Figure 1: Estimates of silver production in New Spain/Mexico, 1770-1848.



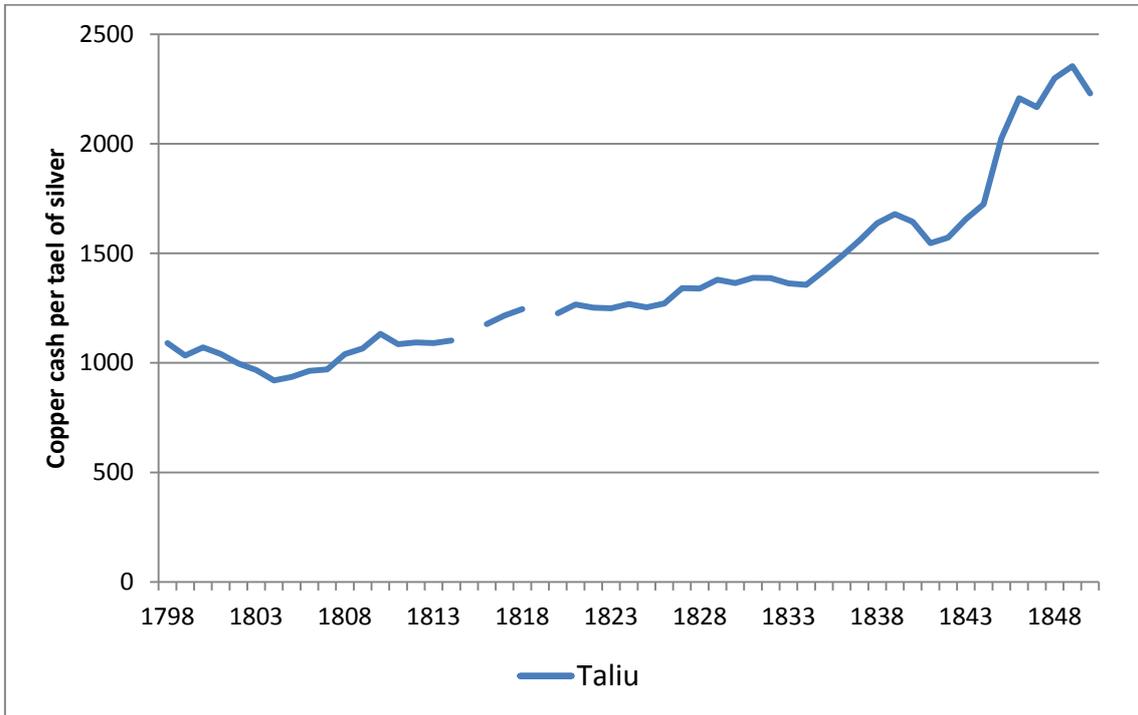
Sources: See references.

Table 1: Production of silver, 1601-1850.

	New Spain/Mexico	%/World	South America	%/World	Hispanic America	%/World	World total
1601-1700	306,6	24,1	800,6	62,9	1107,2	87,0	1271,9
1701-1800	1044,5	57,0	598	32,6	1642,5	89,6	1832,8
1801-1810	178	62,1	83,6	29,2	261,6	91,3	286,6
1811-1820	100,3	57,8	48,4	27,9	148,7	85,7	173,4
1821-1830	85,1	55,4	39,7	25,9	124,8	81,3	153,5
1831-1840	106,5	54,0	60,3	30,6	166,8	84,5	197,3
1841-1850	135,4	53,4	72,6	28,6	208	82,1	253,4
1811-1850	427,5	55,0	221,1	28,4	648,6	83,4	777,7

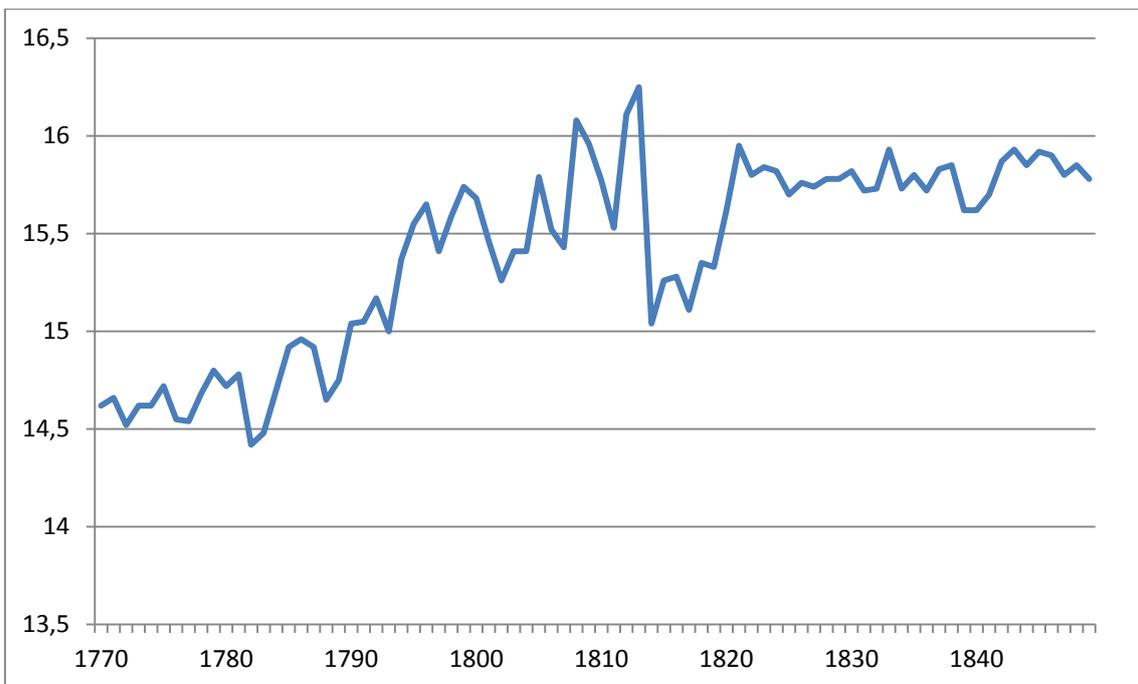
Source: White (1930a)

Figure 2: Cash-silver bimetallic rates, 1798-1850.



Source: Chang (1975).

Figure 3: Gold/silver ratio, 1770-1849.



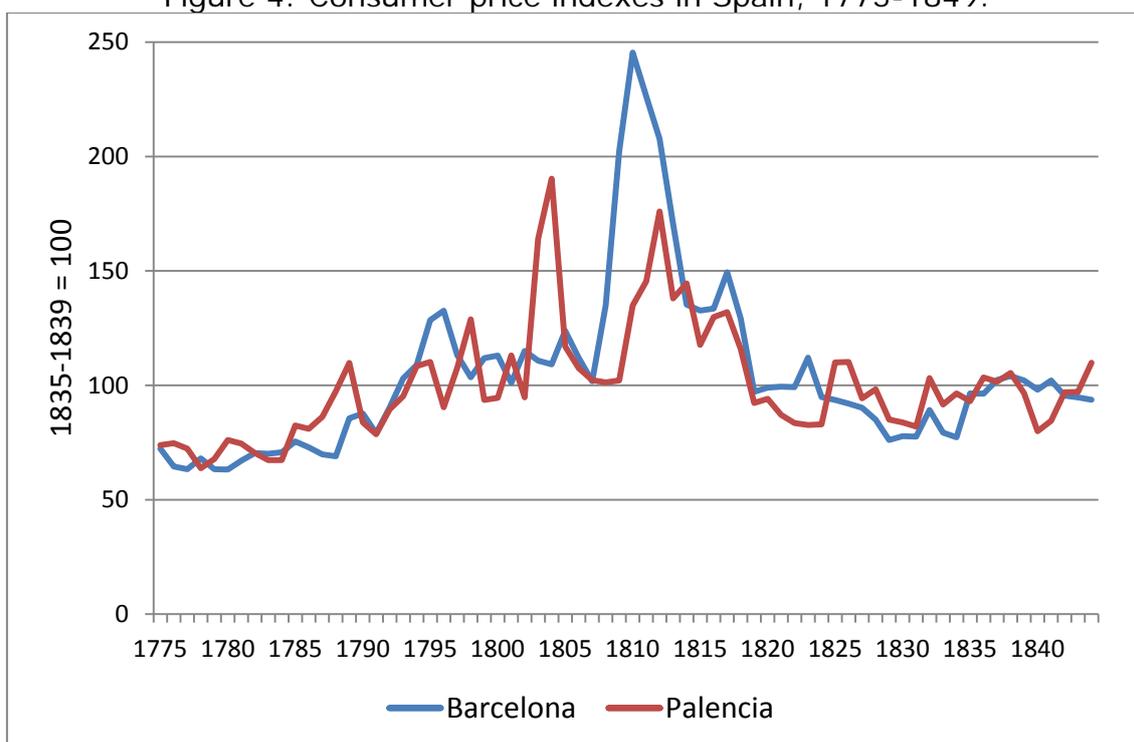
Source: Officer and Williamson (2017).

Table 2: World production of silver and gold, 1801-1850.
(Metric tons)

	Ag	%Δ	Au	%Δ	Ag/Au
1801-1810	286,6		5,8		49,4
1811-1820	173,4	-39,5	3,8	-34,5	45,6
1821-1830	153,5	-11,5	4,7	23,7	32,7
1831-1840	197,4	28,6	6,6	40,4	29,9
1841-1850	253,4	28,4	17,1	159,1	14,8

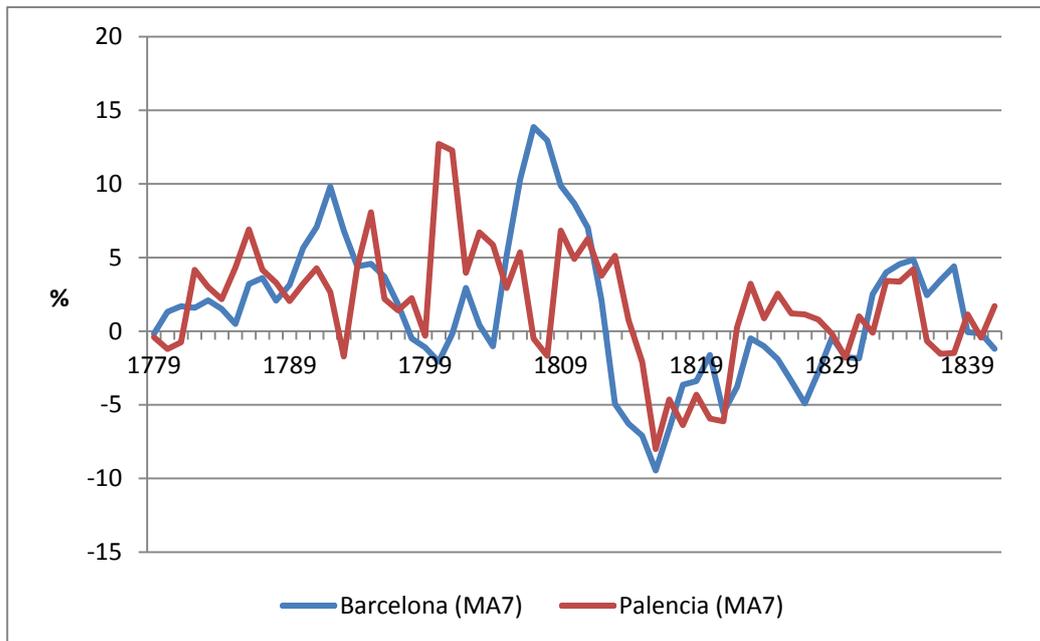
Source: White (1930a and b).

Figure 4: Consumer price indexes in Spain, 1775-1849.



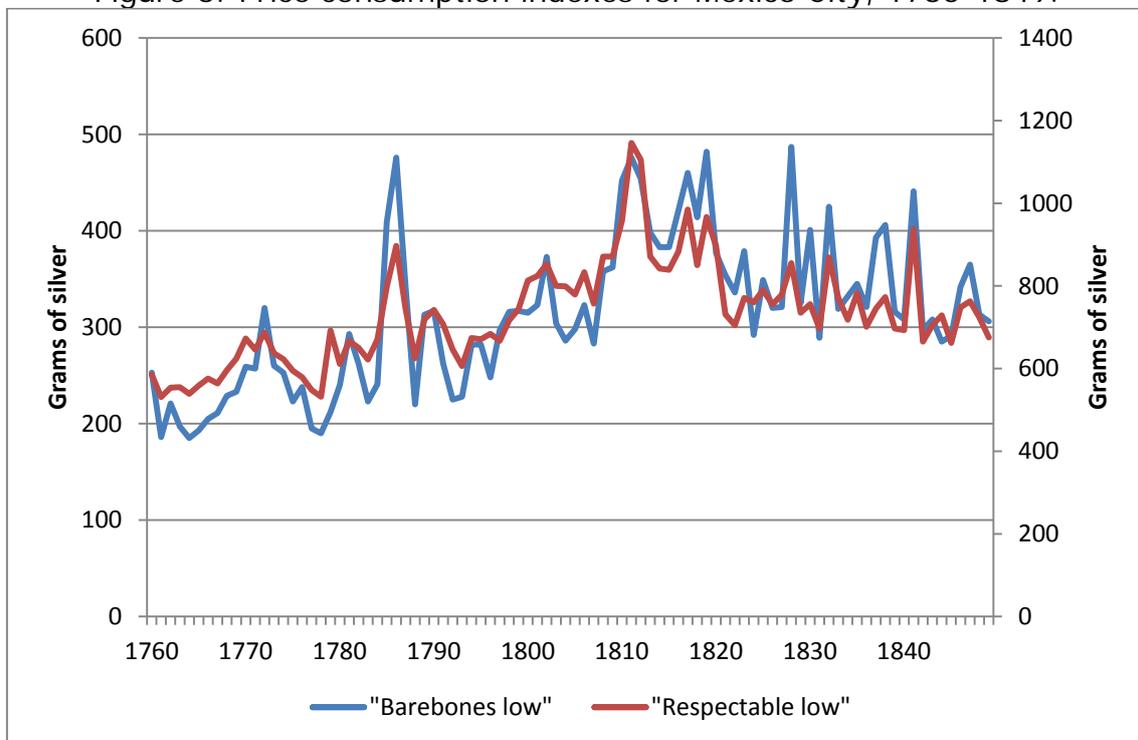
Source: Moreno (2001) and Nogués (2005)

Figure 5: Rates of growth of the Spanish CPIs, 1779-1841.



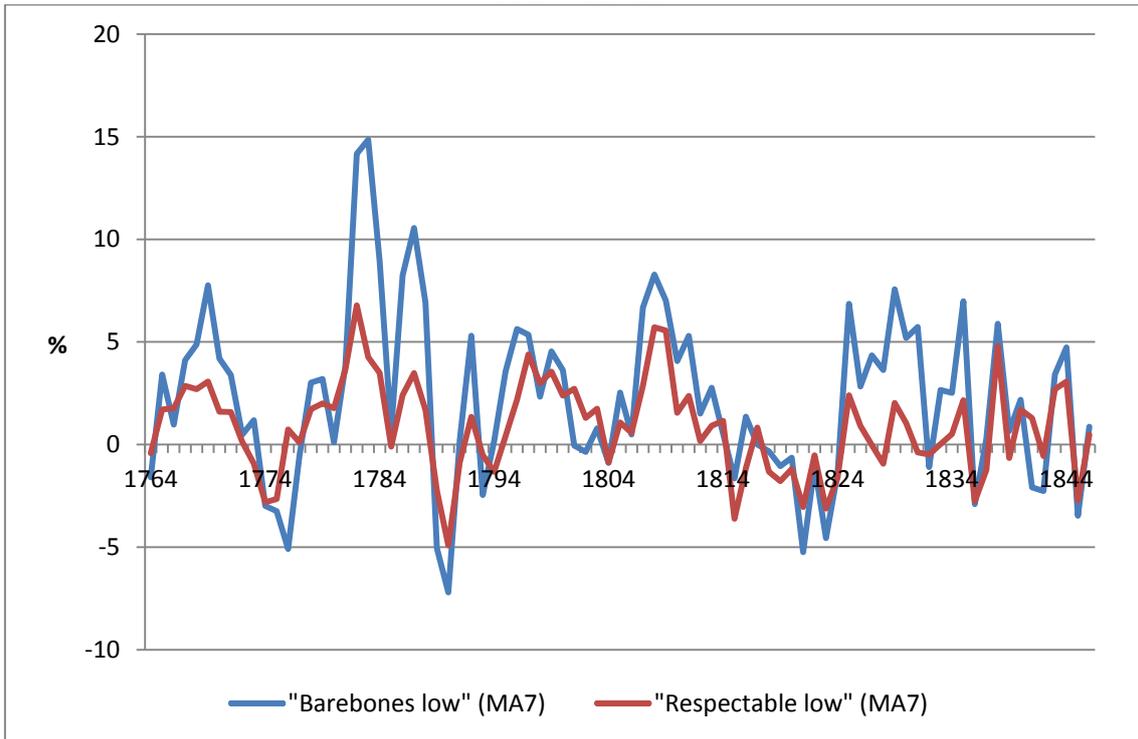
Source: See Figure 4.

Figure 6: Price consumption indexes for Mexico City, 1760-1849.



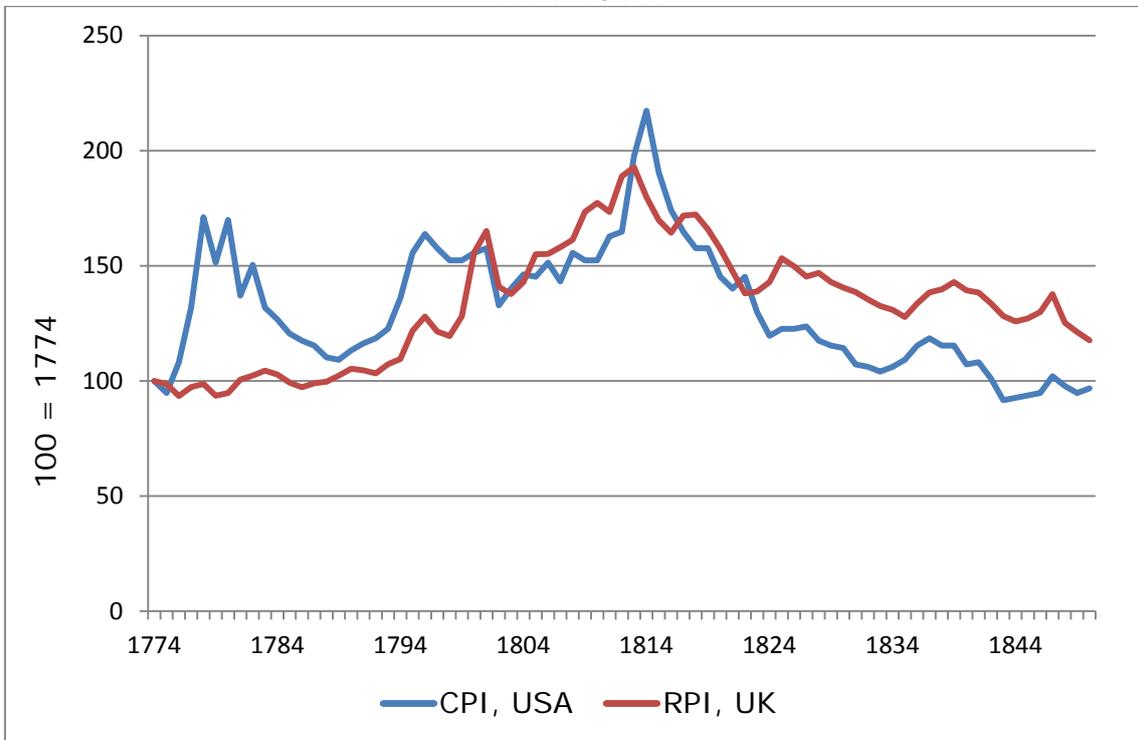
Source: Challú and Gómez-Galvarriato (2015).

Figure 7: Yearly rates of growth of Mexico City CPIs, 1764-1846.



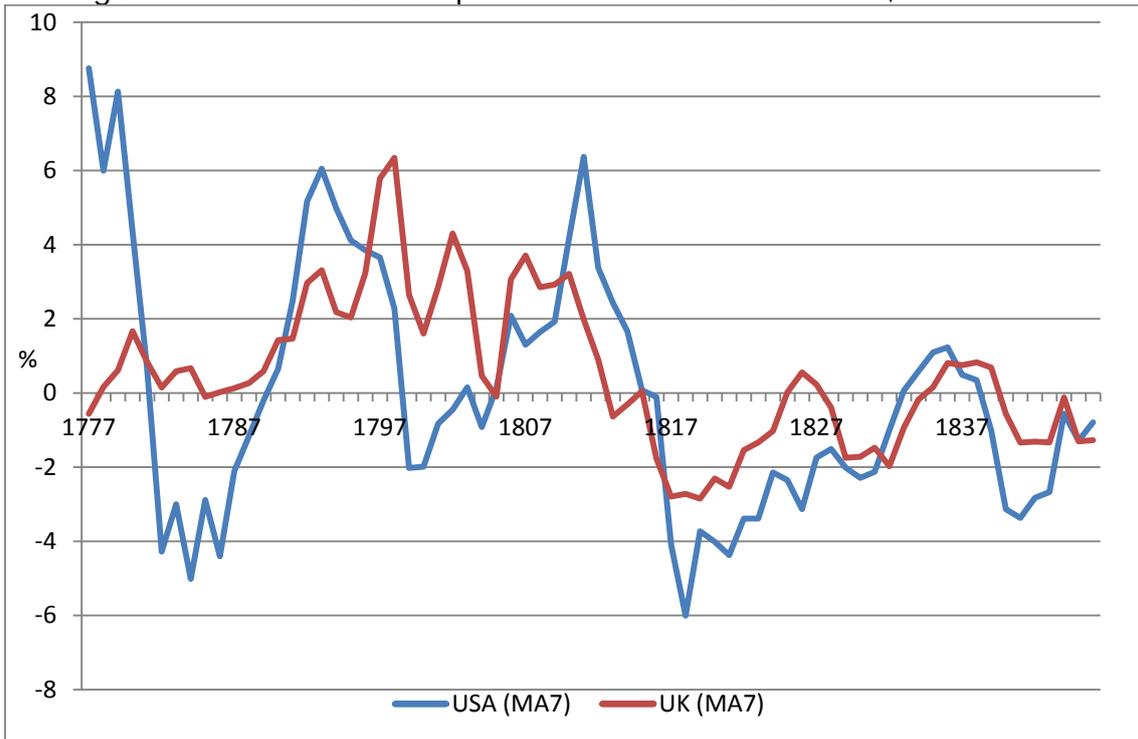
Source: See Figure 6.

Figure 8: Consumer price index (USA) and Retail price index (UK), 1774-1849.



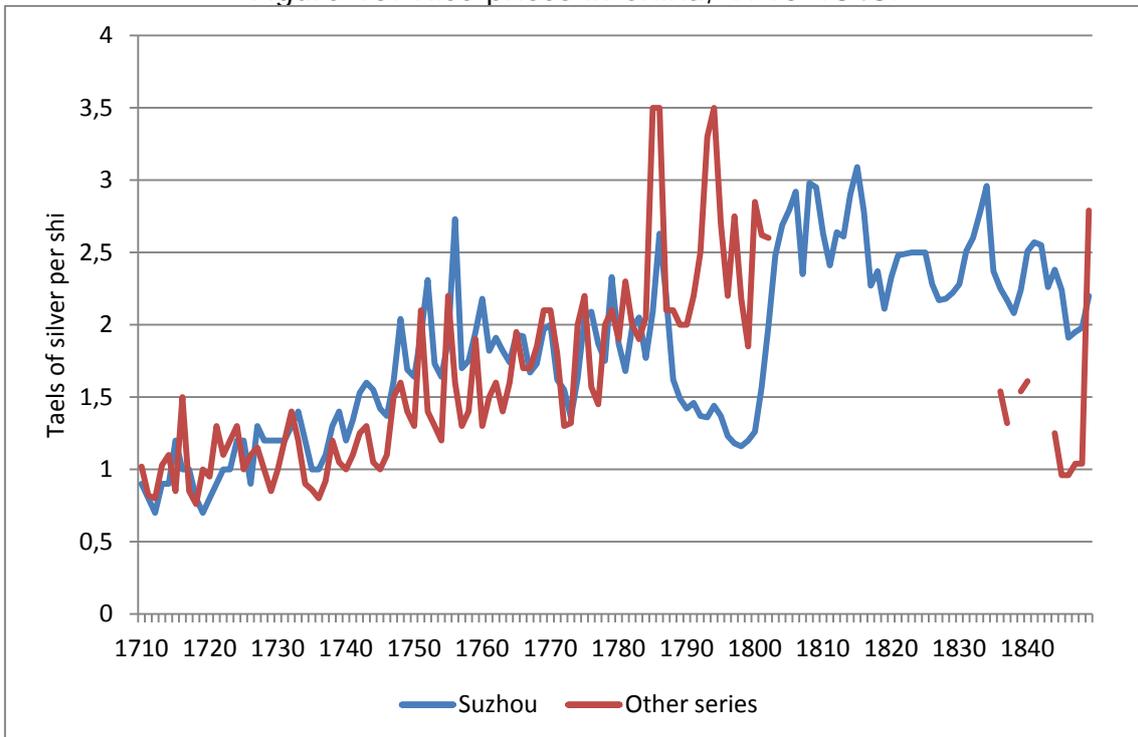
Source: Officer and Williamson (2017) and Clark (2017).

Figure 9: Growth rates of prices in the USA and the UK, 1774-1846.



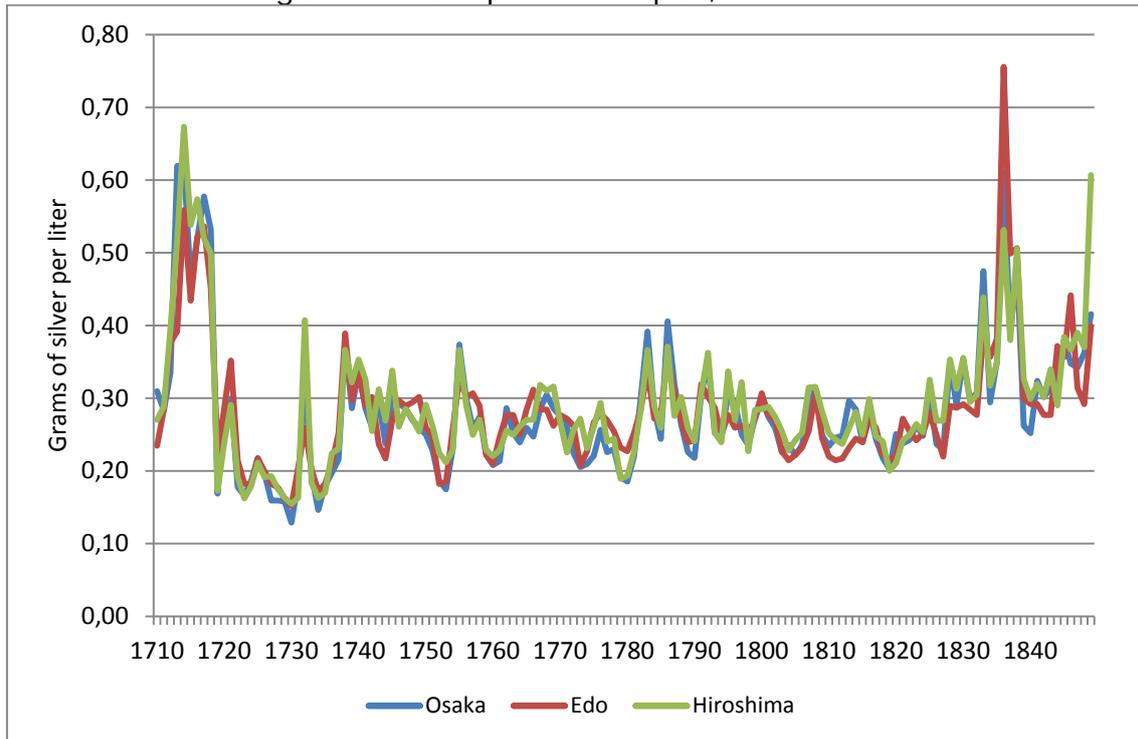
Source: Williamson (2016).

Figure 10: Rice prices in China, 1710-1848.



Source: Wang (1992).

Figure 11: Rice prices in Japan, 1710-1848.



Source: Source: <http://www.iisg.nl/hpw/data.php#japan>.

Table 3.1: Rates of growth of prices, 1775-1849.

USA (CPI)		UK (RPI)		Japan (Rice price in silver grams)			
1775-1814	2,4	1775-1813	1,9	Osaka			
1814-1849	-1,9	1813-1849	-1,1	1775-1808	3,1	1808-1849	3,5
Mexico City (CPIs)				China (Rice price in silver grams)			
BL		RL		Yangzi delta (1)		Yangzi delta (2)	
1775-1811	3,5	1775-1811	2,1	1776-1802	1,0	1776-1802	3,28
1811-1849	0,9	1811-1849	-0,1	1776-1815	2,0	n.a.	-
Spain (CPIs)				1815-1849	-0,4	n.a.	-
Barcelona		Palencia		(1) Suzhou prefecture.			
1776-1810	4,3	1776-1812	4,0	(2) Other series.			
1810-1844	-1,6	1812-1844	-0,1				

Source: See text.

Table 3.2: Rates of growth of prices, 1775-1849.

	USA (CPI)		UK (RPI)		
	Index	%Δ	Index	%Δ	
1774-1779	81,7		97,0		
1810-1819	174,0	113,1	175,7	81,2	
1840-1849	98,4	-43,5	130,7	-25,6	
	Mexico City (CPIs)				
	BL		RL		
	Index	%Δ	Index	%Δ	
1774-1779	211,6		589,2		
1810-1819	432,3	104,3	944,5	60,3	
1840-1849	325,6	-24,7	730,2	-22,7	
	Spain				
	Barcelona		Palencia		
	Index	%Δ	Index	%Δ	
1775-1779	66,3		70,5		
1810-1819	162,7	145,4	132,7	88,2	
1840-1844	96,8	-40,5	93,7	-29,4	
	Japan (Rice price in silver grams)				
	Osaka				
	Price	%Δ			
1774-1779	0,29				
1810-1819	0,33	15,0			
1840-1849	0,45	34,6			
	China (Rice price in silver grams)				
	Yangzi delta (1)		Yangzi delta (2)		
	Price	%Δ	Price	%Δ	
1774-1779	1,95		1774-1779	1,89	
1810-1819	2,58	32,1	1800-1802 (3)	2,69	42,6
1840-1849	2,26	-12,6	1840-1849 (4)	1,41	-47,7
<p>(1) Suzhou prefecture. (2) Other series. (3) 1803-1819 are not available. (4) 1841 and 1843 not available.</p>					

Source: See text.

Table 4: Unit root test for the (logarithm of) price series

Series	Sample	# obs	ADF-stat	# lags AIC	p-value	Decision
<i>Barcelona</i>	1775 - 1844	70	-1.996	2	0.2882	Unit root
<i>CPIMexResHi</i>	1760 - 1868	109	-2.321	1	0.1654	Unit root
<i>CPIMexResLow</i>	1760 - 1868	109	-2.561	3	0.1014	Unit root
<i>CPIUsa</i>	1774 - 1850	77	-2.175	2	0.2153	Unit root
<i>France</i>	1726 - 1868	143	-2.020	4	0.2779	Unit root
<i>Holland*</i>	1720 - 1868	149	-2.321	3	0.1653	Unit root
<i>London*</i>	1700 - 1868	169	-1.941	4	0.3132	Unit root
<i>Milan*</i>	1701 - 1860	160	-2.365	4	0.1519	Unit root
<i>Osaka**</i>	1710 - 1864	155	-1.866	2	0.3484	Unit root
<i>Palencia</i>	1775 - 1844	70	-2.517	2	0.1115	Unit root
<i>Pennsylvania*</i>	1720 - 1868	149	-0.719	4	0.8418	Unit root
<i>RPIUK</i>	1680 - 1860	181	-1.014	3	0.7481	Unit root
<i>Strasbourg*</i>	1700 - 1868	169	-2.000	3	0.2864	Unit root
<i>Vienna*</i>	1700 - 1868	169	-1.953	4	0.3075	Unit root
<i>YangziRev**</i>	1680 - 1868	189	-1.686	5	0.4382	Unit root

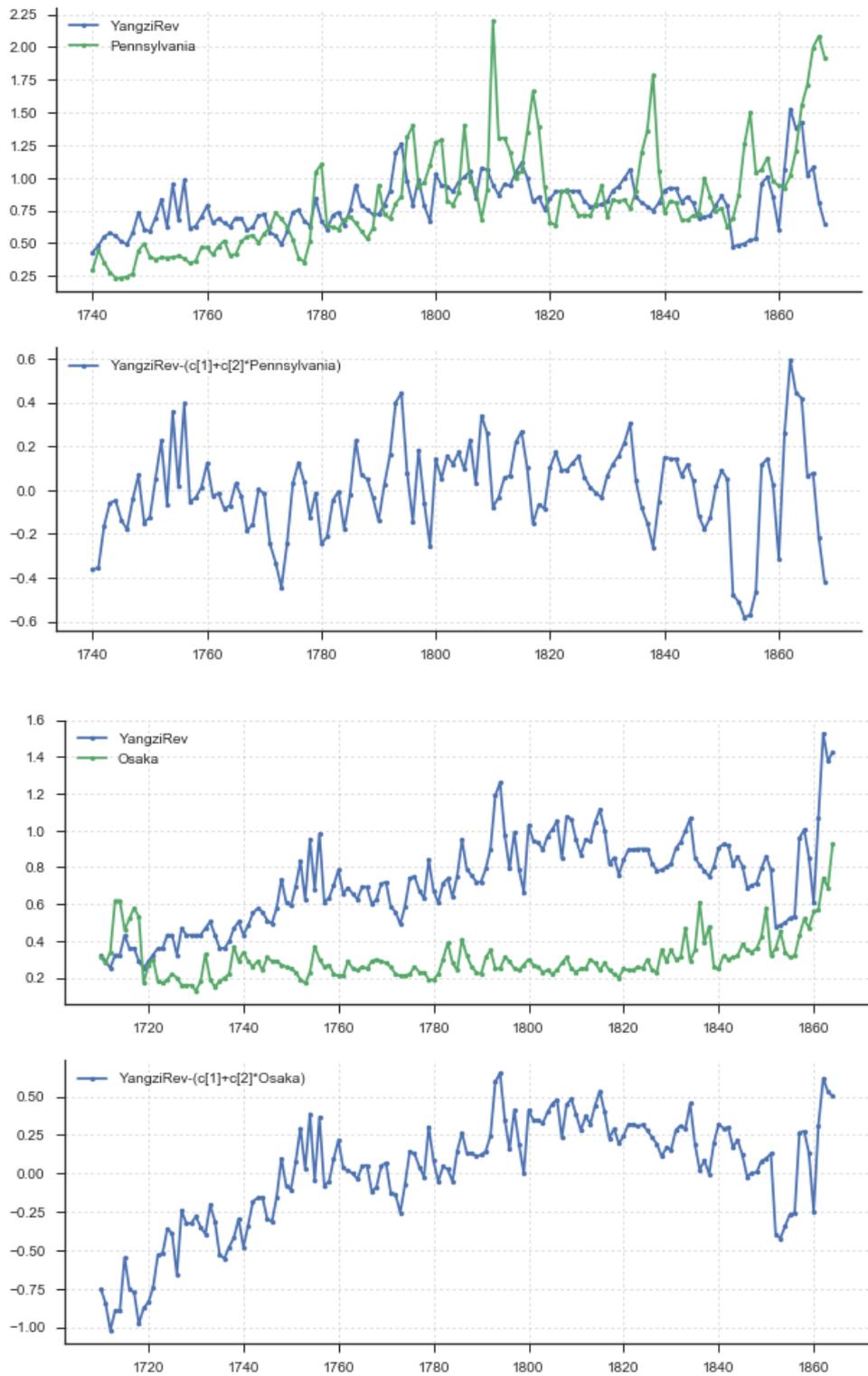
* Series already analyzed in Dobado et al. (2012); ** Already analyzed in Dobado et al. (2015).
The source of the rest of the series is given in previous figures and the text.

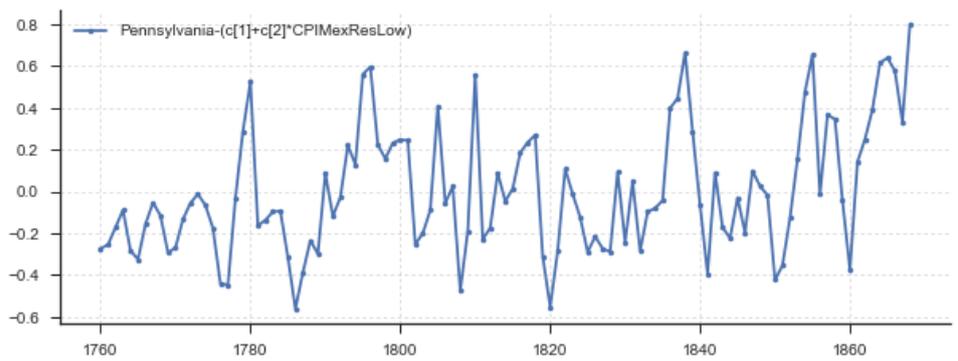
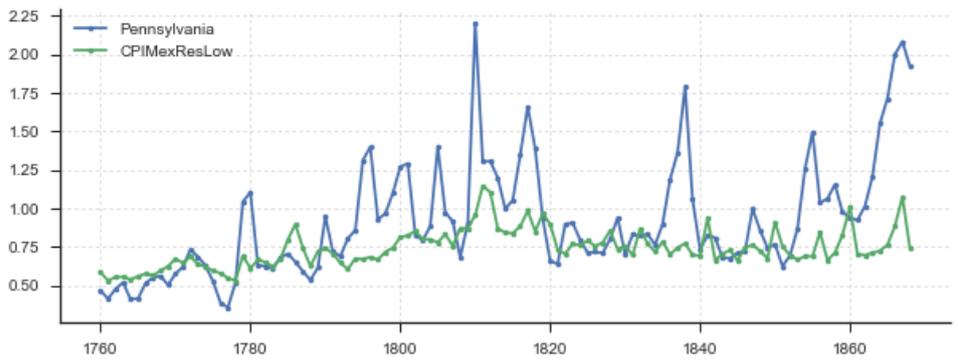
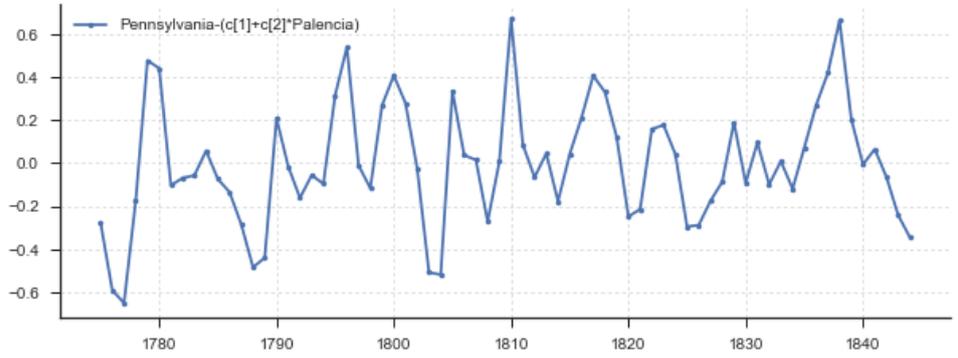
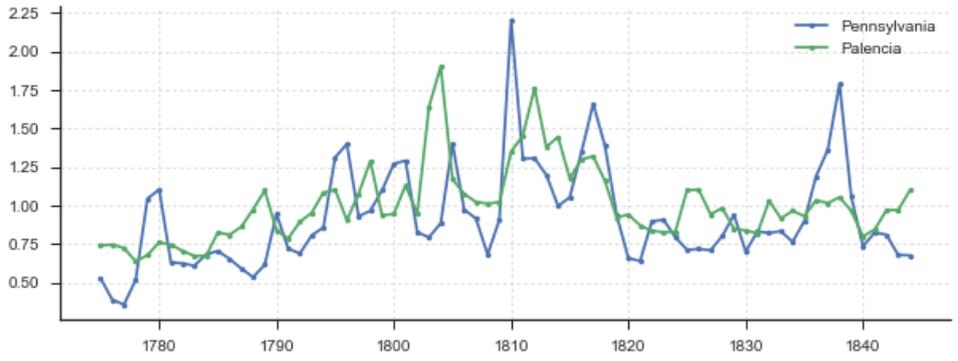
Table 5: Cointegration in the (logarithm of) price series

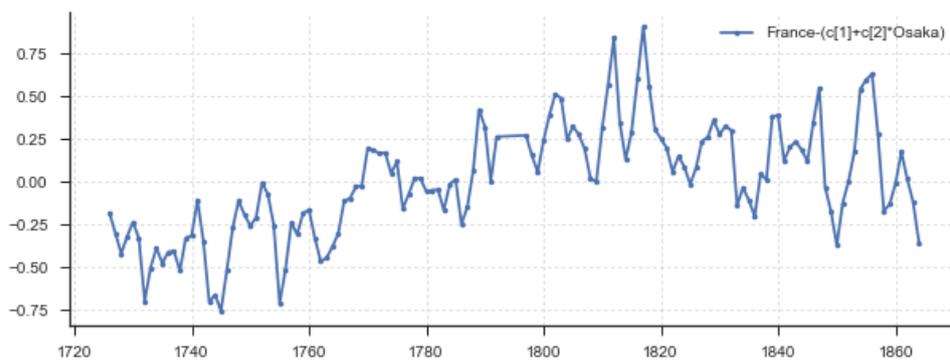
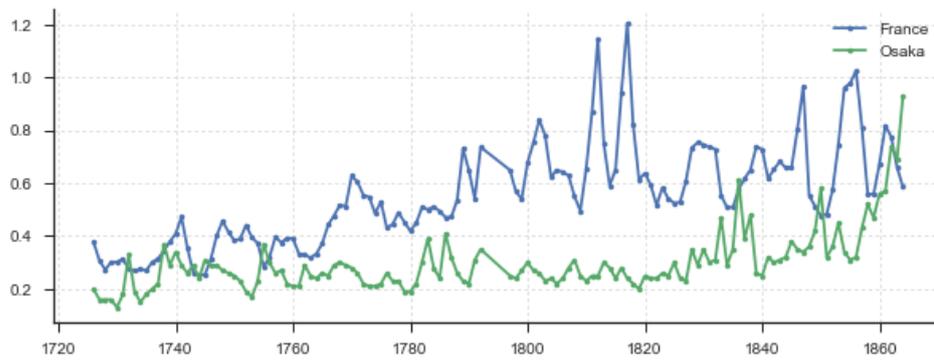
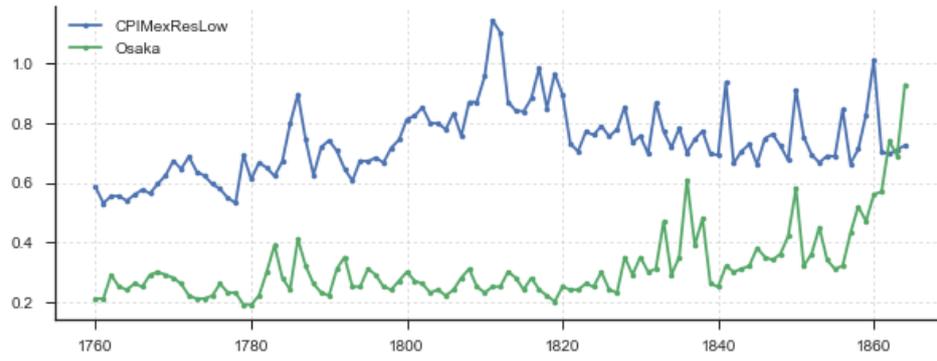
Pair of Series	# obs	ADF-stat	# lags AIC	p-value	Decision
<i>Pennsylvania - CPIMexResHi</i>	107	-4.493	1	0.000	Cointegrated
<i>Pennsylvania - CPIMexResLow</i>	107	-4.641	1	0.000	Cointegrated
<i>YangziRev - CPIMexResLow</i>	106	-4.401	2	0.000	Cointegrated
<i>YangziRev - CPIMexResHi</i>	106	-4.019	2	0.001	Cointegrated
<i>YangziRev - Pennsylvania</i>	127	-5.626	1	0.000	Cointegrated
<i>Pennsylvania - Barcelona</i>	68	-5.909	1	0.000	Cointegrated
<i>Holland - YangziRev</i>	146	-4.662	2	0.000	Cointegrated
<i>Pennsylvania - Palencia</i>	67	-5.512	2	0.000	Cointegrated
<i>Pennsylvania - France</i>	135	-4.333	3	0.000	Cointegrated
<i>YangziRev - Osaka</i>	149	-2.076	5	0.254	Not cointegrated
<i>Pennsylvania - Osaka</i>	139	-1.799	5	0.381	Not cointegrated
<i>CPIMexResLow - Osaka</i>	100	-2.461	4	0.125	Not cointegrated
<i>France - Osaka</i>	130	-2.211	4	0.202	Not cointegrated

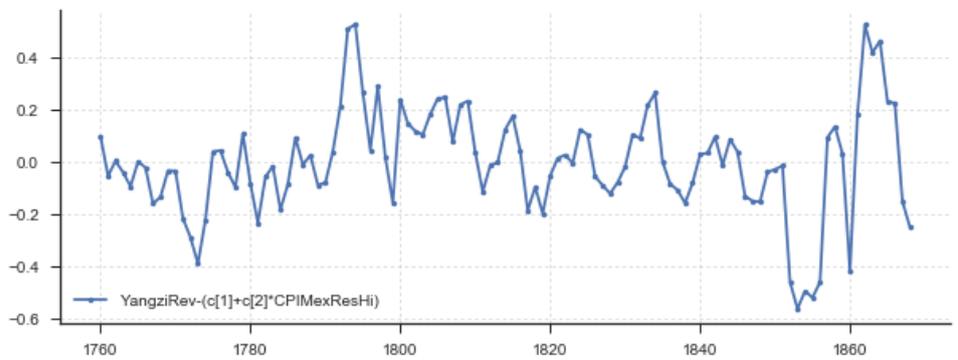
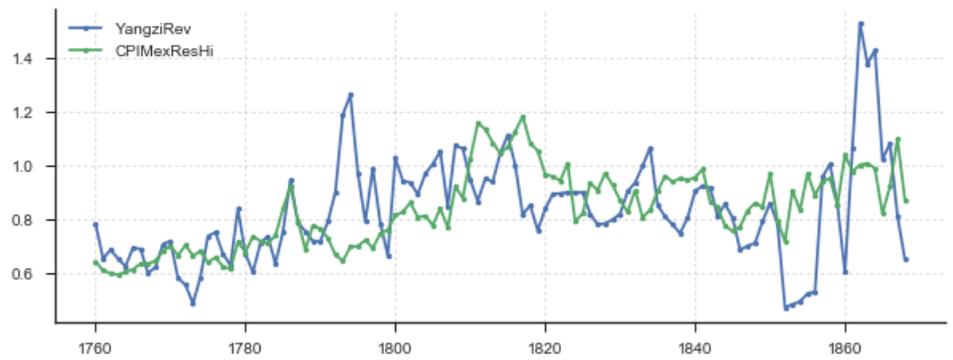
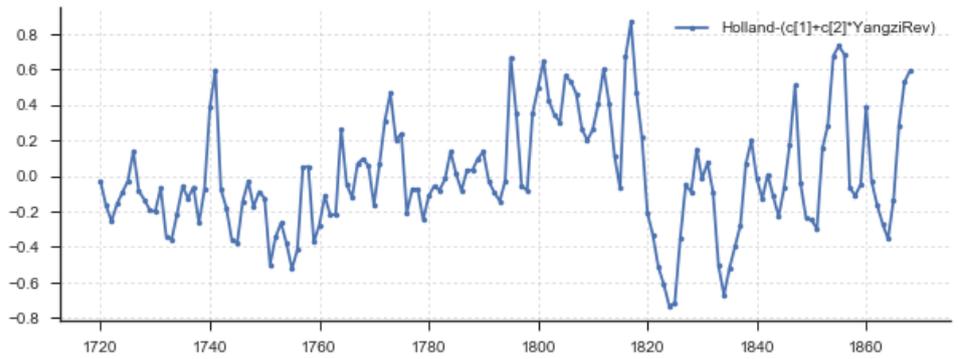
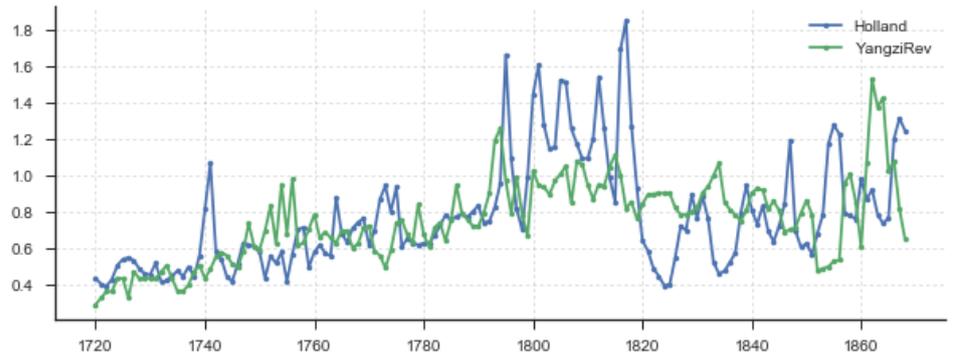
Source: See Table 4.

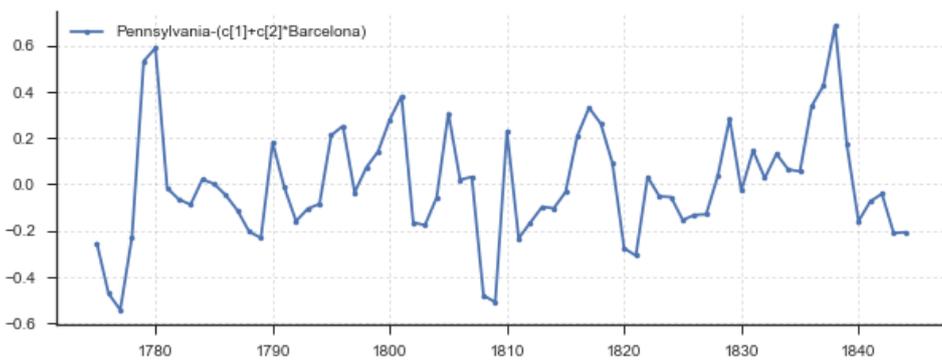
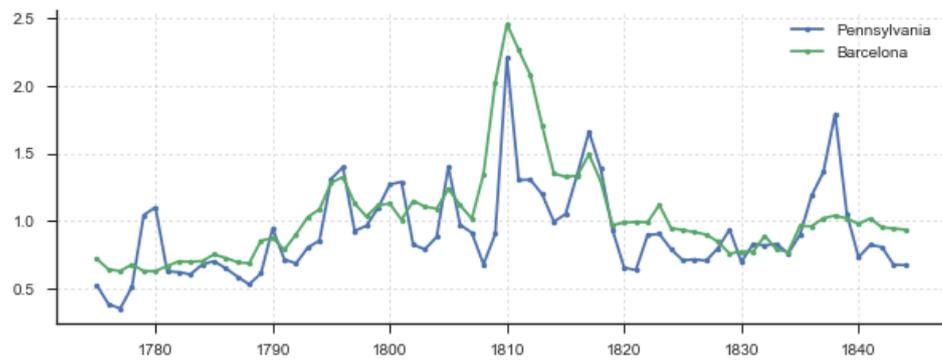
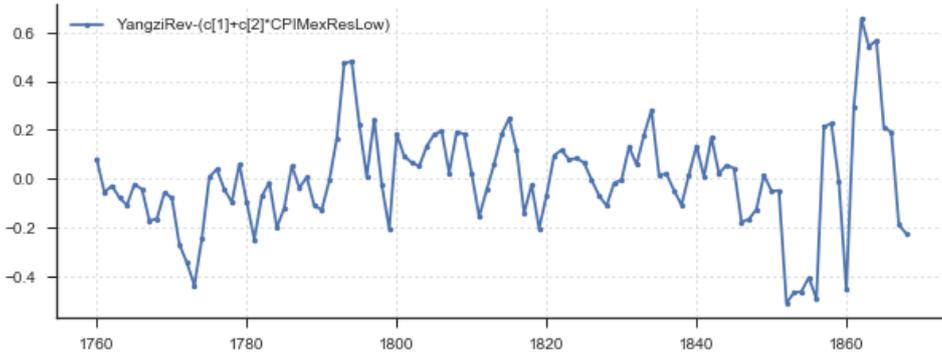
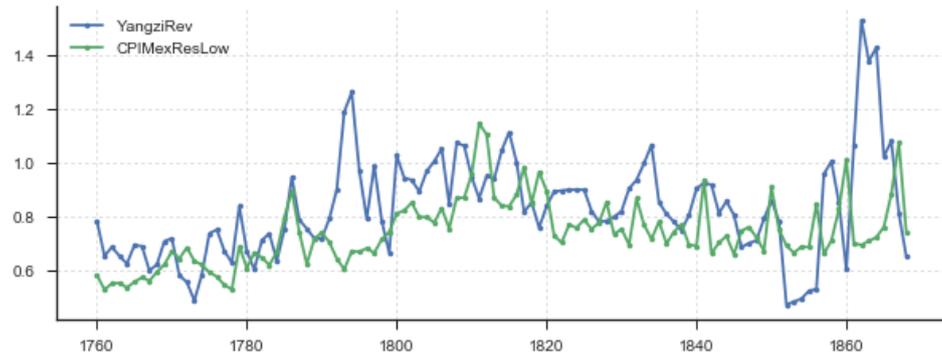
Figures 12: Pairwise relationships of some worldwide prices. Top: price levels. Bottom: residuals from the regression of one price on the other.

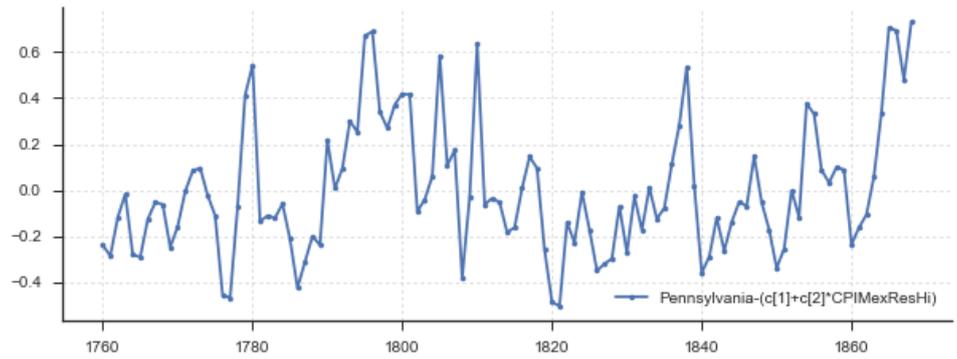
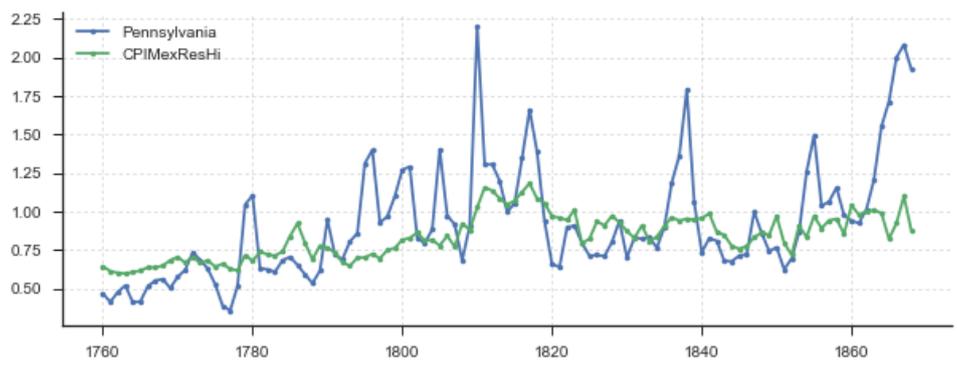
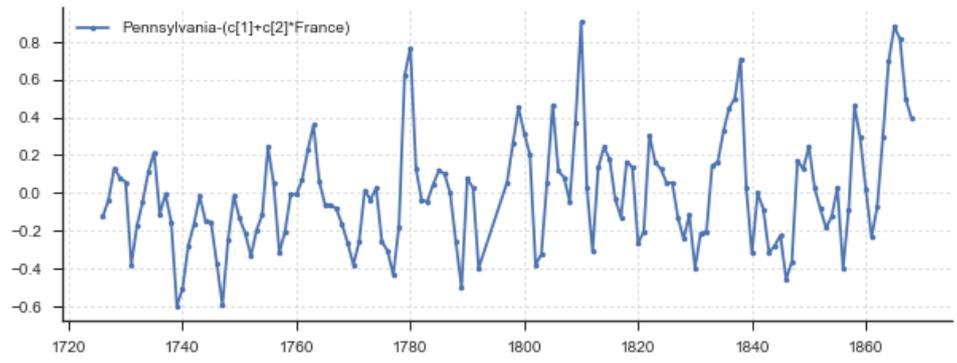
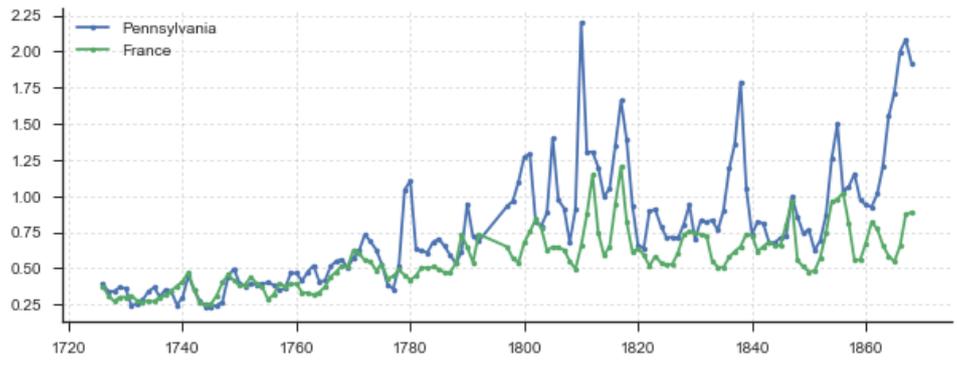






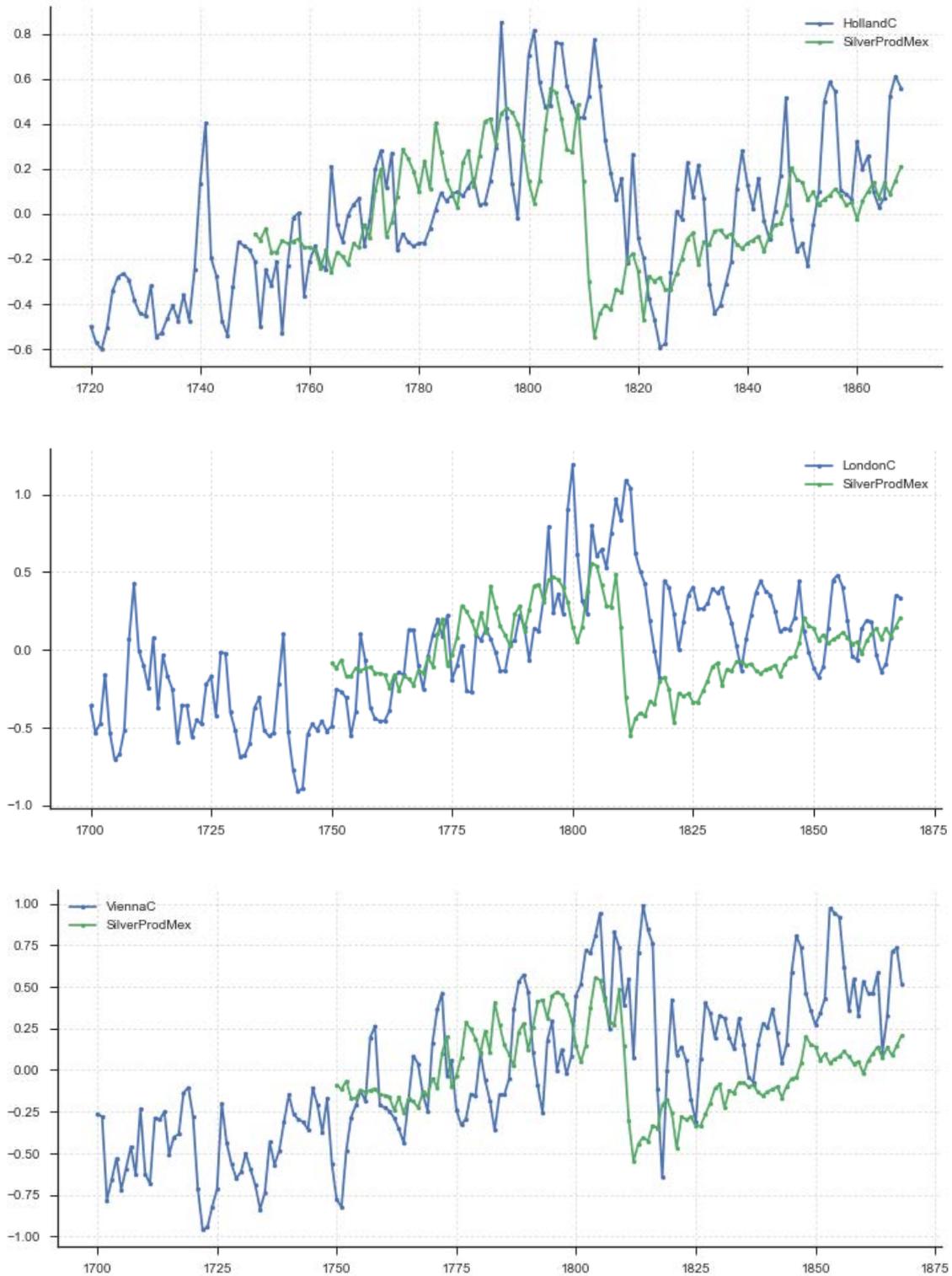


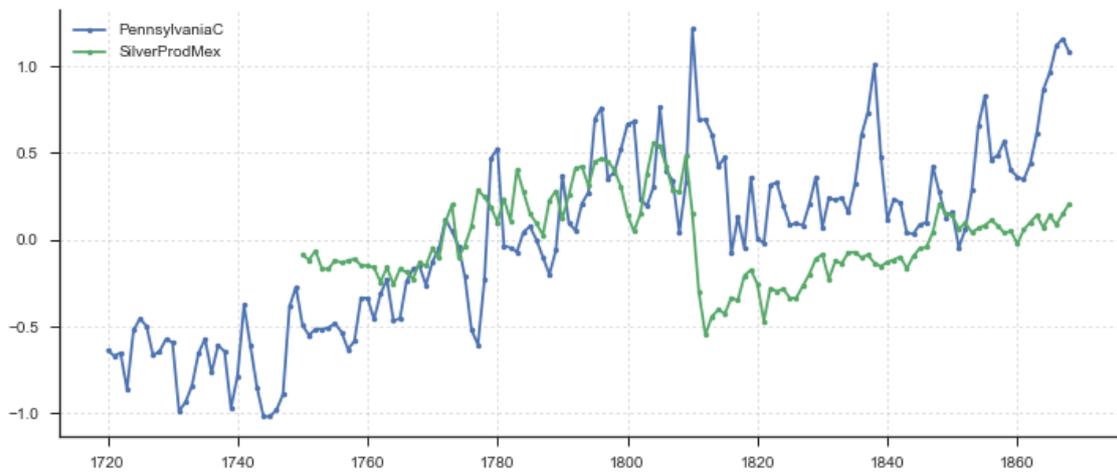
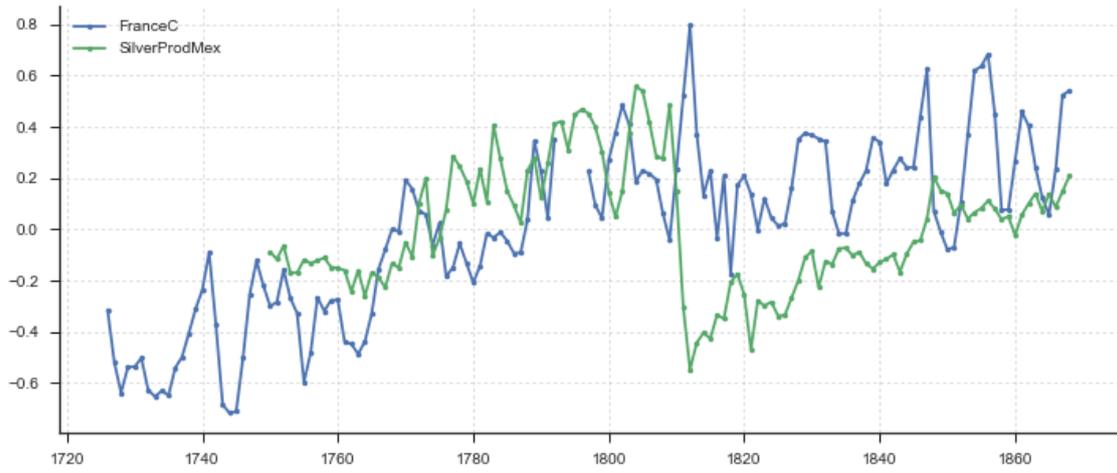




Source: see Table 4.

Figure 13: Evolution of the (logs of) grain prices in different cities and the (log of) silver production in New Spain and Mexico.





Source: see Table 4.

Figure 14: New Spain/Mexico silver stock and Prices relation in different periods

