IRENE Working Paper 21-07

UNIVERSITÉ DE NEUCHÂTEL

Institut de
recherches économiques

Commodity prices and global inflation, 1851-1913

Stefan Gerlach and Rebecca Stuart

COMMODITY PRICES AND GLOBAL INFLATION, 1851-1913

Stefan Gerlach
EFG Bank and CEPR

Rebecca Stuart
Université de Neuchâtel
and
Queen's University Belfast

7 September 2021

Abstract

This paper uses annual data to study the interaction of consumer and commodity prices in 15 economies over the period 1850-1913. We find that consumer price inflation in all 15 countries co-moves with a broad measure of changes in commodity prices. Consumer prices comove most strongly with changes in metal prices, in particular pig iron prices. Furthermore, changes in pig iron prices and production, which have attracted much attention in the literature on 19th century US business cycles, co-move with the international business cycle, suggesting that pig iron prices offer a transmission channel through which international business cycle movements affect inflation.

Keywords: Commodity prices, Gold standard, global inflation, pig iron.
JEL Number: E31, F40, N10

We are grateful to Sakari Heikkinen and Vincent Geloso for data, to Juha Tarkka for locating the Finnish CPI data, and to Daniel Kaufmann for helpful comments. Contact information : Rebecca Stuart (corresponding author), email: rebecca.j.stuart@gmail.com, website: rebeccastuart.net, address: Université de Neuchâtel, Institut de recherches économiques, Rue A.-L. Breguet 2, CH-2000, Neuchâtel, Switzerland.

1. Introduction

This paper studies the interaction of consumer and commodity prices in 15 economies in the period 1850-1913. To our knowledge, the role of commodity prices in inflation fluctuations before 1913 has not previously been studied in the literature.

Existing studies on commodity prices from a historical perspective generally focuses on the question of whether commodity markets were integrated internationally.[1] For instance, Klovland (2005) examined integration in Britain and German commodity markets over the period 1850-1913. Studying prices in both markets for 39 different commodities, he found that most price series were cointegrated although the level of integration was not uniform across all products. Moreover, absolute price variability generally decreased over the period, indicating that markets became more integrated. Jacks (2005) examines the integration of commodity markets in the Americas and Europe, using commodity prices for the period 1800-1913. Studying 10 countries and focusing on the intra- and international integration of the markets, he argues that there were dramatic improvements in market integration in the first half of the century.

A second strand of the literature studies the long run cycles in commodity prices. For instance, Erten and Ocampo (2013) decompose commodity prices using filtering techniques to obtain low frequency cycles over the period since the mid-nineteenth century. Jacks (2019) carries out a similar analysis, using a band pass filter to obtain long-, short- and medium-run cycles in commodity prices since 1900. The author finds that historical episodes of mass industrialization and urbanization often interact with supply constraints to generate above-trend real commodity prices in markets such as energy, metals, and minerals for several years at a time. However, these demand shocks are usually offset by a supply response as formerly dormant exploration and extraction activities take off, and induced technological change takes hold, to reduce supply constraints and eventually bring prices back to trend.

In this paper we turn to a third set of questions, focusing on the role of commodity prices in the international transmission of inflation. In modern economies, fluctuations in

---

[1] See also Findlay and O'Rourke (2001) for an overview of the literature.

commodity prices, in particular oil prices, have played a key role in triggering swings in inflation. Indeed, the lack of literature on the historic relationship is somewhat surprising since the interaction between commodity prices and consumer prices in recent data is well studied in the literature.

Since the oil crises of the 1970s, the importance of oil prices for consumer price inflation has been the focus of many studies (see, for instance, Darby (1982), Beckerman and Jenkinson (1986), Bomberger and Makinen (1993), Adams and Ichino (1995)). Choi et al., (2018) and De Gregorio et al. (2007) both study the transmission of oil prices to consumer inflation since the 1970s using data from several countries and find that the impact of oil price shocks has declined over time. This is attributed to more credible monetary policy, less reliance on energy imports, and less reliance on oil per unit of GDP. Furlong and Igenito (1996) find that the leading indicator properties of non-oil commodity prices for inflation also declined since the 1970s. They propose several potential explanations for this finding, including a reduction in commodities' share of overall output, less use of commodities for inflation hedging, an offsetting response from monetary policy and a change in the mix of shocks affecting inflation over time.[2]

The fact that commodity prices have played an important role in the inflation process in recent decades raises the question of whether this was so also in the past. Indeed, since we know from Klovland (2005) and Jacks (2005) that international commodity markets were integrated, it seems likely that commodity price increases would have impacted on import prices across the world.[3] This will lead to a positive correlation of inflation in individual economies.

---

[2] In addition, the role of commodities as an inflation hedge in investment portfolios has been studied in the finance literature by, for instance, Gorton and Rouwenhorst (2006), Gorton et al., (2007), Cao et al., (2010) and Crawford et al., (2006). These papers consider whether the positive correlation between inflation and commodity prices can be exploited to hedge against the negative correlation usually observed between inflation and other portfolio assets such as stocks and bonds. Zaremba et al., (2019) apply wavelet analysis to commodity prices and inflation data from the United Kingdom for the years 1265 through 2017, and find robust inflation hedging properties of agricultural, energy, and industrial commodities for the 4- to 8-year horizon over most of the sample period.

[3] It is also well established that capital flowed freely across international borders. See for instance Obstfeld and Taylor (2005).

In this paper we use annual data on UK commodity prices in sterling and consumer prices in local currency in 15 economies to study this question over the period 1850-1913. During this period many exchange rates were fixed and, perhaps unsurprisingly, we find that our results are not sensitive to whether changes in the exchange rate are included in the econometric analysis. We first discuss our commodity price data and calculate a common component intended to capture broad commodity price movements. One issue with historical consumer price series is that often wholesale prices are used as proxies for retail prices. We therefore restrict our analysis to metals and other industrial products that we believe would neither enter the consumer basket, nor be used as proxies for items in the consumer basket. This makes finding co-movement between changes in commodity and consumer prices much less likely.

To see this, Cavallo (2008) notes that oil prices can affect consumer prices directly through prices of motor fuels and home heating products, and indirectly by raising the cost of production and transportation of goods that households consume. Since we exclude all commodities that might be used as proxies in the consumer basket, we exclude the direct channel identified by Cavallo, making our test for the relationship between commodity prices and consumer prices between 1851 and 1913 much more stringent. Nevertheless, we find that consumer price inflation and our measure of broad commodity price inflation co-move in all 15 economies that we study.

We then ask which commodity prices were particularly important for consumer price movements and why this was. In this part of the paper there are a further three findings. First, searching across the individual commodity prices in our sample, we find that changes in metal prices, and in particular pig iron prices, are generally most strongly correlated with consumer price inflation. Second, we show that these findings, which rely on pig iron prices in the UK denominated in sterling, are broadly unchanged if we instead use US prices and German prices denominated in local currency. Third, we show that changes in pig iron prices and pig iron production are positively and significantly correlated with a measure of the international business cycle given by the median growth rate in GDP per capita in the economies we study. The relationship between pig iron and the US business cycle during this period has been studied extensively in the literature (e.g., Miron and Romer (1990)). However, much less attention has been paid to the potential importance of pig iron prices for a broader set of countries, which is the focus in this paper. We also show that a simple measure of international inflation is not correlated with the international business cycle. It therefore appears that pig iron prices may be a transmission channel through which international business cycle movements affect inflation in the economies in the sample.

The rest of the paper is organised as follows. In the next section we turn to the data. Section 3 presents a broad measure of commodity price inflation and discusses how it co-moves with inflation in the 15 economies in our sample. Section 4 presents our strategy to identify the individual commodities whose price changes are most strongly correlated with inflation in the economies in our sample. Having shown that changes in pig iron prices have the most explanatory power, in Section 5 we discuss why this might be, and draw some tentative conclusions about the role of business cycles in inflation. Section 6 concludes.

2. The data

2.1 Consumer and commodity price data

The data on consumer price inflation used in this study are drawn from a variety of sources, which are discussed in detail in Gerlach and Stuart (2021). Table 1 provides the sources and descriptive statistics of the various measures of inflation used here. The median and average annual inflation rates are both around 0.5%, and the interquartile range and the standard deviation of inflation are around 4%. Interestingly, the behaviour of inflation in this period is broadly similar across countries, and no country is an obvious outlier.

Our commodity price data are sourced from a series of papers written by Augustus Sauerbeck (1886, 1893, 1908 and 1917).[4] Sauerbeck (1886) first compiled data on commodities in sterling in the United Kingdom for the period from 1846 to 1885, while subsequent publications added additional years of data to the original series. The data

[4] The 1917 publication is technically written by an anonymous editor of the Statist but is referred to as being "in continuation of Mr A. Sauerbeck's figures". As such, for simplicity we refer to this as Sauerbeck (1917).

were collected directly from private firms, as well as publications such as *The Economist*, and are generally for average prices during the year.

In total, Sauerbeck collected 43 data series for the period 1850-1913.[5] In several instances, Sauerbeck included the prices for two or more varieties of a product, for instance, 'prime' beef and 'middling' beef or 'merino wool' and 'English wool'. We follow Sauerbeck in taking the simple average of series such as these to obtain overall categories, such as 'beef' and 'wool.'[6] This reduces the number of time series to 33.

Table 2 shows the median, mean, interquartile range and standard deviation of annual percentage changes of the price series. Sauerbeck groups the data into six categories: corn or grains, meat and animal products, 'sugar, tea and coffee', minerals, textiles and sundry materials. While most commodity prices increased over the sample period, it is evident that some commodity prices declined. In particular, the prices of grains such as wheat, barley, maize and potatoes all fell over the sample period. In addition, some consumer goods declined in price over the period. In some cases this was due to an increase in supply, and in others to a decline in demand. Products such as sugar and tea had experienced an increase in demand in the early part of the century as income growth enabled more consumers to afford them. However, in the second half of the century, expanding production led to an overall decline in their prices. Other products fell out of favour over the course of the sample period. Tallow is an example: as alternative products for making candles became available, tallow was less in demand.

Table 2 also shows that there are large differences in the variance of price changes between commodities. In particular, the prices of the grains and textiles categories – crops for which fickle weather can affect harvests – had the highest variance, while prices meat and animal products – farm products that were much less dependent on the weather – had the lowest variance.

Sauerbeck discusses some weaknesses in his data. As with all price data, changes in quality over time are difficult to capture. Moreover, he notes that prices of some commodities such

---

[5] Sauerbeck provides price levels for each series. Rates of change are calculated as log differences.

[6] The exception is pig iron and iron bar prices, which we do not combine, as we find that pig iron prices are particularly important in our later analysis.

as sugar, coffee and flax, must be considered as only approximately showing the course of prices, although 'the greatest pains have been taken to maintain their standard as near as possible' (Sauerbeck (1886, p. 632)). However, one significant advantage of using these data is that they reflect commodities that were considered important at the time.[7] Sauerbeck (1886) notes that except for wine, spirits and tobacco, for which reliable information could not be found, all commodities selected are those in which a substantial amount of trade took place. This suggests that this dataset identifies the commodities most likely to affect consumer prices.

2.2 Wholesale and retail prices

Kaufmann (2020) identifies several reasons why price levels and therefore inflation rates may be measured by error.[8] Of particular relevance is the fact that wholesale prices are sometimes used as a proxy for missing retail prices in historical price indices. Kaufmann (2020) refers to the US, for which wholesale prices are used in place of retail prices for the period from 1774 to 1851 implying that there is essentially no overlap with the period studied here.

However, an investigation of the UK price series suggests that this may be a serious problem. For the period under review, UK cost of living is measured by an index compiled by Feinstein (1998) for the period 1770-1882, spliced together with another index compiled by Feinstein (1991) for the period 1882-1914.[9] In the absence of retail prices, Feinstein uses wholesale prices for several series. Specifically, he uses Sauerbeck's commodity prices as proxies for the retail prices of flour (in combination with another series for the period 1846-1870), pork and bacon (1850-1870), potatoes (1846-1870) and tallow (as a proxy for candles,

---

[7] In contrast, for instance, Jacks (2019) uses a sample of commodity prices based on production in the US in 2011. It is more difficult to see how some of these commodities would co-move with inflation in the nineteenth century. For instance, petroleum prices first appear in Sauerbeck's data in 1873, presumably because it was not commonly used prior to this.

[8] These include the use of data from major cities to represent the economy more broadly, relatively narrow baskets of retail goods, limited coverage of services and often missing data on rents and housing, and the interpolation of some prices when data are collected at too low frequency.

[9] Less detail is available on the Feinstein (1991) series. However, the author notes: "For years in which retail prices were not available, wholesale prices (Sauerbeck 1886) or average import values were used. The main items for which this was necessary were meat (beef, mutton and pork), eggs and cheese, in each case for the years before 1886; and potatoes, for all years from 1870."

1860-1870).[10] In total, Feinstein uses data on 11 food items, in addition to information on fuel, light, clothing, drink, and rent. Overall, these four items make up just over 20% of the index, during the period that all are used (1860-1870).[11] More generally, it is likely that in several countries wholesale prices are used to proxy retail prices, at least for earlier parts of the sample. Kaufmann (2019) notes that Swiss CPI data uses wholesale prices as proxies during the period under review.

We therefore select a set of commodity prices which we believe could not be used as a proxy for any retail prices. In the first instance, we exclude all series that could be used to proxy for food prices. This includes Sauerbeck's 'grains', 'meat and animal products' and 'sugar, tea and coffee' categories. In addition, we exclude most of the 'textiles' category, as these could perhaps be used to proxy for the price of clothing. We also exclude coal from the 'minerals' category since that might be used to proxy for heating costs. Finally, we remove several 'sundries' including tallow, palm oil and olive oil since these were often used for lighting, and leather and hides since they might proxy for clothing and shoes.

We are left with nine commodity prices: five metals (copper, lead, pig iron, iron bars and tin), timber[12], linseed, indigo and jute. Jute is included in Sauerbeck's 'textile' category. As an exceptionally strong material, it was used for sacking, ropes, and similar products, rather than clothing.[13] Indigo, was primarily used as a textile dye, and while it may have been used in the production of clothing, indigo prices would be a poor proxy for retail clothing prices.[14] Finally, linseed oil was used as a resin and a varnish, and later for making linoleum.

In Table 3, we show the pairwise correlations of percentage changes of the prices for these nine commodities and the other, excluded, commodities. The bottom row shows the

---

[10] See Appendix to Feinstein (1995) for details.

[11] Based on 1858/62 base year weights. See Table 1 in Feinstein (1998).

[12] Timber was a construction material and some price indices proxy housing with a construction cost index. One example is the US series for 1860-1880, where construction costs are calculated based on the price of pine boards, bricks and labour (Lebergott (1964, pp. 348-349)). However, we consider this to be such a small potential part of a consumer price index that we include timber in our analysis. Moreover, removing timber prices from our set of commodity prices does not significantly affect the overall results.

[13] It appears that jute was used in India (where it is primarily produced) as a textile for clothing, however, there is no evidence of this being the case in any of the countries studied here.

[14] See Alden (1965) for a discussion of indigo production during this period.

average pairwise correlation for each of the nine commodities. The prices of three metals (pig iron, iron bars and lead) as well as timber, have the highest overall correlations with the other commodity prices (average correlation coefficients of 0.2-0.3). Indigo has the lowest average correlation at just 0.01, while the price of jute also has a low average correlation at 0.10.

Some of the highest correlations are between the metal prices, in particular, for pig iron, iron bars, lead and tin, and the prices for textiles, hemp, silk and wool, as well as hides and leather. Metals and timber prices are also generally highly correlated with coal prices, and to a lesser extent with the prices of some of the grains and meat and animal products. Indigo prices have negative correlations with the prices of several of the meat and animal products, textiles and hides and leather, however, its overall highest pairwise correlations are with silk and butter prices. Perhaps unsurprisingly, jute prices are relatively highly correlated with other textile prices, but negatively correlated with the prices of many of the grains. Linseed prices also have relatively high correlations with textile prices and particularly low correlations with meat and animal product prices.

3. Commodity prices and inflation

To explore whether world commodity prices impact on consumer prices, we need to summarise the behaviour of commodity price inflation in a single series. However, it is unclear what weighting might be given to each commodity, especially as production and use would vary across the fifteen economies in our sample.[15] We therefore follow Ciccarelli and Mojon (2010) and Gerlach and Stuart (2021) and consider four measures of the common component of commodity price changes: the cross-sectional average, the cross-sectional median, the first principal component and a single factor from a factor model of the nine commodity prices.[16] Overall, these measures move similarly, with correlations between 0.87 and 0.97 (see Figure 1).

---

[15] See Jacks (2019) for a discussion of calculating historical weighted indices.
[16] For a discussion of the differences between principal components analysis and factor analysis, see Mardia, Kent and Bibby (2003).

There is therefore no obvious reason to choose between measures on empirical grounds. However, the mean is a poor measure of the central tendency of a distribution if that is asymmetric. To explore the potential importance of this, we compute the cross-sectional skew of the commodity prices for each year in the sample. While the mean of the cross-sectional skew over the full period 1851-1913 is 0.05, which suggests that the distribution in not asymmetric, looking at the distribution for individual years we note that it ranges from -2.2 in 1903 to 2.7 in 1888. Overall, it appears that in a given year one or a few commodities experience price changes far below or above the other commodities. We therefore follow Gerlach and Stuart (2021) and select the cross-sectional median since it is robust to outliers.

Having computed a measure of global commodity prices, which are all measured in pound Sterling, we next turn to their relationship with inflation in the 15 economies that we study.

Figure 2 shows the median international inflation rate alongside the median commodity price inflation. The two series move together; indeed, the correlation coefficient is 0.54. Nonetheless, there are periods with deviations, particularly in the 1860s and the early 1900s.

To consider this relationship more formally, we next estimate a simple reduced-form inflation equation in which we regress inflation in country *i* on the lagged inflation rate and the median of commodity price growth. Using obvious notation, we have that:

$$\pi_{i,t} = \alpha_i + \beta_i \pi_{i,t-1} + \gamma_i \pi_{c,t} + \varepsilon_{i,t} \qquad (1)$$

The results are presented in Table 4. We find that commodity prices are significant in all regressions. This result is striking when one recalls that these are primarily industrial goods which we deem very unlikely to be included in the consumer basket, and which thus are unlikely to have any direct channel through which they can impact consumer prices. The estimated coefficients range between 0.075 in France and 0.535 in Sweden, and are 0.221 on average, suggesting that over 20% of any change in commodity prices passes through to inflation within a year. The proportion of inflation explained by the model ranges from 8% in Australia to 47% in the US and is 23% on average.

3.1 Exchange rates

The data used above are for commodity prices in pound Sterling in UK markets. Since consumer price inflation is measured in national currency units, the question of what consequences exchange rate changes might have for our results arises. Therefore, we next extend the analysis using data on the exchange rate against pound Sterling. In total, we have data for the full sample period for 11 of the economies in our sample.[17]

Most of the countries in our sample were on the gold standard from the 1870s, and often were on silver and bimetallism standards before.[18] As a result, the exchange rates generally evolve as step functions whereby there are long periods of exchange rate stability with, typically, one devaluation during the sample period.[19] This suggests that the exchange rate is unlikely to play an important role in the inflation process.

Re-estimating equation (1) but adding the percentage change in the exchange rate as a regressor confirms this hypothesis. In the interest of brevity, the results are not tabulated here, however, we find that the exchange rate is significant in six countries, but that the parameter is small, typically around 0.4.[20] The estimates of the parameter on the change of commodity prices, γ, are broadly unchanged by the inclusion of the change in the exchange rate, indeed the correlation between these estimates and those in Table 4 is 0.96. In what follows we therefore present results with the exchange rate omitted from the regressions.

4. Which commodity prices are most important?

Next, we consider which individual commodity price changes are most strongly correlated with inflation. To do so, we estimate the effect of changes in each of our nine commodity

[17] Data for Canada, Finland and Iceland were not available for the full sample and so are not included here. The UK is not included for obvious reasons. Data on ten of the exchange rates were obtained from the Clio infra project (https://clio-infra.eu/Indicators/ExchangeRatestoUKPound.html), while the eleventh, Norway, was obtained from Eitrheim et al., (2004).

[18] Indeed, floating exchange rates were considered a 'radical departure from fiscal and monetary stability' and viewed with disfavour (Bordo (2003, p. 5)).

[19] Thus, in log first-difference form, the exchange rate change is typically "small" with one very large outlier, making the series look much like a dummy variable.

[20] The exception is Australia, where the parameter estimate is in excess of two.

prices on inflation in separate regressions. That is, we estimate the following equation for the change in each commodity price, $\pi_{j,t}$:

$$\pi_{i,t} = \alpha_i + \beta_i \pi_{i,t-1} + \gamma_{i,j} \pi_{j,t} + \varepsilon_t \qquad (2)$$

In the interest of brevity, we only report the estimates of the parameter γ and the r-squared from the regressions in Table 5. It should be kept in mind that the changes in the different commodity prices are often strongly correlated.[21]

No individual commodity price inflation series is significant in Australia. In Iceland (copper) and Denmark (lead) changes in only one of the commodity prices is significant, and in the other 12 countries, changes in at least two commodity prices are significant. Indeed, in the US, changes in seven of the nine commodity prices are significant.

Overall, three of the changes in prices of minerals are significant in most countries: pig iron (significant for 10 countries), and iron bars and lead (both nine countries). In contrast, tin and copper prices are significant much less frequently. Of the non-metal prices, changes in linseed and timber prices are significant in eight and eleven countries, respectively, while changes in indigo prices are significant in just two (France and Canada) but with a negative sign in the Canadian equation. The price of jute is not significant in any equation.

To consider which commodity prices explain most of the variation in consumer prices, we look at the r-squareds from our regressions. The average r-squared across all the country equations is highest for pig iron (0.23), followed by timber (0.19). Indeed, pig iron prices have the highest r-squared in nine countries, far more than any other commodity price.

4.1 A search algorithm to identify important commodity prices

Above we included changes in each commodity price in the inflation equation in each country. However, we can also use variable selection techniques to identify the most important commodity prices. We next employ a simple search algorithm. An alternative is to use the least absolute shrinkage and selection operator (LASSO), which indicates that pig iron is the only commodity price inflation series selected for two thirds of the countries

---

[21] For instance, the average correlation is 0.28 (rising to 0.56 among the five metals) and the first principal component explains almost 43% of the variance of all the commodity prices.

in our sample.[22] The result using the search algorithm is similar and, since the search algorithm is more intuitive, we focus on it here.

For the search algorithm, we include in the regressions a constant, the lagged inflation rate and all nine commodity prices and then sequentially drop the least significant commodity price until all remaining commodity prices are significant. With each deletion from the model, all the previously added variables are checked against a stopping criterion, and possibly removed.

One problem with using this search algorithm is that the t-statistics or p-values lose their meaning. To see this, consider the following heuristic example. Suppose that we include one in truth irrelevant variable in a regression and use a t-test or, equivalently, the p-value, to decide whether to include it. If we test at the 5% level, the likelihood that we will include a variable that in truth is irrelevant is 5%.

Suppose next that we instead consider nine irrelevant regressors. The likelihood that one will be significant at the 5% level is 29.9%.[23] Thus, searching over multiple regressors dramatically increases the likelihood that an irrelevant variable will spuriously appear significant. One way to deal with this problem is to tighten the criterion used to decide whether to include a variable in the regression. For instance, the likelihood of including one irrelevant variable if nine are considered falls to 18.4% if a p-value of 2.5% is used, and 8.3% if a p-value of 1% is used. We therefore select as stopping criterion a p-value of 1%. However, we find that the choice of stopping criterion does not affect the main finding that changes in pig iron prices are most frequently selected. The results using a stopping

---

[22] Specifically, LASSO minimises the function: $J = \frac{1}{2m}\sum_{i=1}^{m}\left(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_j\right) + \lambda \sum_{j=1}^{p}\left|\beta_j\right|$ to obtain estimates of the coefficients, β_j, where y_i is the dependent variable, x_{ij} are the independent variables, m is the number of data points, and p the number of independent variables. The value for λ is chosen using a 5-fold cross-validation procedure to minimise the error. AIC is used to select across models. Overall, the change in pig iron prices is the only variable selected in 10 of the 15 countries. In three countries, the change in the price of a different commodity is chosen (Belgium (Linseed), France (Jute), US (iron bars)) and in two countries no commodity is selected (Sweden and the UK).

[23] We used the binomial probability calculator at http://statisticshelper.com/binomial-probability-calculator#answer to obtain these results.

criterion of 2.5%, where they differ from those in Table 6, are presented in Appendix Table 1.[24]

The stringent stopping criterion results in no commodity price inflation series being selected for 6 countries using our algorithm.[25] In the interest of brevity we only report the 9 countries for which at least one commodity price inflation series was selected in Table 6. Overall, we find that changes in the prices of metals co-move closely with consumer prices. Pig iron is the most frequently selected commodity price inflation series: despite the stringent stopping criterion it is selected in 5 countries. In addition, changes in lead prices are selected for one country (Sweden). Changes in timber prices are selected for two countries (Germany and Norway) and changes in linseed prices are also selected for two (Belgium and France). Only in Norway is more than one commodity price inflation series selected.

Overall, the results in Tables 5 and 6 suggest an important role for pig iron prices in explaining the inflation process of the economies studied here. [26]

4.2 UK, US and German pig iron prices

We have shown above that changes in pig iron prices appear particularly closely related to inflation in the economies studied, and that controlling for exchange rate changes has no impact on the results. However, other factors, including tariffs and transport costs, may

[24] Using a stopping criterion of 2.5%, at least one commodity price inflation series is selected for 13 countries. Pig iron price inflation is selected for six countries, and other metals (copper and lead price inflation) in a further four countries. In comparison, the next most often selected commodity price inflation series are linseed and timber, which are each selected for three countries.

[25] The economies are Australia, Denmark, Finland, Iceland, the Netherlands and the US. In addition, in the regression for two countries, commodities are selected with counter-intuitive signs: Canada (indigo) and Norway (iron bars). In these instances, the commodity was removed from the search and the algorithm was re-run.

[26] We also use a second algorithm, where we start with a constant and the lagged inflation rate, and then add the commodity price that has the lowest p-value when added, provided the p-value is lower than a specified stopping criterion. With each successive addition to the model, all the previously added variables are checked against a stopping criterion, and possibly removed. The results of the second algorithm – where they differ from the results of the first – are presented in Appendix Table 2. Overall, pig iron price inflation is still the most frequently selected of the commodities. Using a stopping criterion of 1%, pig iron price inflation is selected for four countries in total (selected for the US, but not Canada and the UK). Using the 2.5% stopping criterion, pig iron price inflation is still selected for six countries (not selected for UK, selected for Finland).

lead to a wedge between prices in different countries.[27] To examine this, actual pig iron prices in different countries are required. We therefore collected data on pig iron prices in two other countries that were major producers: the US and Germany. Specifically, the dollar prices of pig iron are taken from Bureau of Statistics (1902)[28], and German prices in local currency are from Jacobs and Richter (1935). The correlation is highest between changes in pig iron prices in the UK and Germany at 0.84, and lowest between changes in prices in the US and Germany at 0.54. The correlation between changes in prices in the UK and US is 0.66.

We next re-estimate equation (2), using changes in US and German pig iron prices denominated in domestic currency, instead of UK prices in pound Sterling. In the interests of brevity, we do not report the results, however, comparing these regressions with those reported in Table 5, we find that in most cases changing the price series used does not much impact on the results. One exception is, unsurprisingly, the US where using US pig iron prices results in a higher r-squared, 0.64, compared to UK prices (r-squared = 0.49). Overall, we conclude that using pig iron prices from the UK has not unduly affected the results above.

5. Pig iron, inflation and global business cycles

5.1 Pig iron as an indicator of US business cycles

We next consider the role of pig iron in nineteenth century business cycles in more detail. The importance of pig iron in US business activity before WWI is well documented. For instance, Burns and Mitchell (1946) use both pig iron production and prices in their business cycle dating during the 19th century. Indeed, at the start of their sample period in the 1850s, pig iron prices are one of just eight series used to date business cycles. Blackett (1923) also studies pig iron and scrap iron prices and the business cycle. Somewhat

---

[27] For instance, the US pig iron industry benefitted from a 'tariff wall' between 1870 and 1940. See Naknoi (2008).

[28] These data are available monthly. The annual changes in the series are calculated as the log change in the yearly average price.

surprisingly however, he uses other commodity price series as a measure of the business cycle.

Moreover, Miron and Romer (1990) note that one of the key measures of monthly economic activity for the 19th century was Frederick Macauley's (1938) series on pig iron production.[29] Another series which was commonly used for a similar purpose, the Persons Index of Production and Trade, is based only on pig iron production and bank clearings in seven cities for the period 1877 to 1902. While subsequent studies included more series in measures of industrial production, these examples point to the importance of pig iron production. In addition, subsequent studies (Miron and Romer (1990), Davis (2004)) use pig iron among their broader set of series used to calculate measures of industrial production.

5.2 Pig iron prices and international business cycles

The above analysis raises the question whether fluctuations in pig iron prices are due to global business cycle movements. Thus, an international business cycle upswing would raise the demand for pig iron, cause its price to rise and presumably stimulate the production of pig iron.

To explore this hypothesis, we compute a measure of the global production of pig iron and the state of the global business cycle. For the global production of pig iron, we use Mitchell (2003), who provides information on quantities produced in European countries over the period under review. To this we add US pig iron production, which is obtained from the St Louis Federal Reserve (Fred) database.[30] In total, information on production in eight countries is collected.[31] For total production, we take the sum of pig iron production across these countries; the growth rate is calculated as log differences.

[29] The authors note that this series was used as a measure of the business cycle in a number of papers, including Calomiris and Hubbard (1989), Zarnowitz (1987) and Gorton (1988).

[30] This is the Macauley (1938) series referred to in section 5.1.

[31] We collect data on large producers of pig iron not included in our sample. For instance, Russian pig iron production is included although we do not study Russian inflation in this paper.

For the global business cycle, we collected data on GDP per capita.[32] Data are available on 14 of the 15 countries in our sample (the exception is Iceland).[33] We calculate year-to-year growth rates for each country using log differences and use the median growth rate as a measure of the global business cycle. This procedure disregards the impact of changes in population growth on fluctuations in GDP growth.

Next, we compute a correlation matrix for changes in pig iron prices, the growth rate of global pig iron production, the growth rate of global economic activity and our measure of global inflation from Figure 2, which we compute as the median inflation rate in our sample of 15 economies. These are presented in Table 7. Given the sample size, correlations larger than 0.25 are significant at the 5% level.[34]

Two points are of interest. First, global growth is positively and significantly correlated with changes in the prices and production of pig iron. This suggests that swings in pig iron prices to an important extent, but by no means fully, reflect global business conditions. Second, global inflation is strongly correlated with changes in pig iron prices but not with global growth.[35] Pig iron prices thus seem to provide a channel for transmission of global business cycle fluctuations to domestic inflation.

6. Conclusions

In this paper we studied the interaction of changes in consumer and commodity prices in 15 countries using annual data for the period 1850-1913. While the literature on historical commodity prices is well developed, it tends to focus on commodity market integration (Klovland (2005), Jacks (2005), Findlay and O'Rourke (2001)) or on identifying long run cycles in commodity prices (Erten and Ocampo (2013), Jacks (2019)). Thus, the question of

---

[32] Data collected from the clio-infra project: https://clio-infra.eu/. Data Compiled by Juta Bolt and Jan Luiten van Zanden over the period January 2011 to January 2013.

[33] Data for most countries are available from 1850, except for Switzerland (1851), Finland (1860) and Austria and Canada (both 1870).

[34] A t-test for the significance of the correlation coefficient, r, has n-2 degrees of freedom and can constructed as: $r(n-2)^{1/2}/(1-r^2)^{1/2}$.

[35] Re-estimating the inflation equation (1) but using global growth instead of the rate of change of pig iron prices confirms this: global growth is significant only in Norway and the Netherland, and in the latter case with a negative sign.

the role of commodity prices in the international transmission of inflation has, to our knowledge, not been studied for the period under review.

While in modern economies, fluctuations in commodity prices, in particular oil prices, have played a key role in triggering fluctuations in inflation, such co-movements might also reasonably be expected during the period studied here since international commodity markets were integrated. Thus, we can expect that increases in their prices would have impacted on import prices across the world, leading to a positive correlation of inflation in individual economies.

In this paper we first calculated a component that represents broad commodity price movements to test whether this co-moved with inflation in our 15 countries. Having done so, we next asked which commodities were particularly important for consumer price movements and why this was. There are four main findings.

First, in all 15 countries consumer prices and our measure of broad commodity prices co-move. Second, searching across the individual commodity prices in our sample, we find that metal prices, and particularly pig iron prices, are most closely tied to inflation in the countries we study. Third, we show that using alternative measures of pig iron prices does not materially alter their explanatory power for inflation in most countries. Fourth, we show that pig iron prices and pig iron production are positively and significantly correlated with the international business cycle during the sample period. Since international inflation is not closely correlated with the international business cycle, it appears that pig iron prices may be a transmission channel through which international business cycle movements affect inflation.

References

Abildgren, Kim (2009) "Consumer Prices in Denmark, 1502-2007," Working paper 60, Danmarks Nationalbank.

Adams, F. Gerard and Yazukazu Ichino (1995), "Commodity prices and inflation: A forward-looking price model", *Journal of Policy Modelling*, 17(4), 397-426.

Alden, Dauril. (1965) "The Growth and Decline of Indigo Production in Colonial Brazil: A Study in Comparative Economic History", *Journal of Economic History*, 25(1), 35-60.

Beckerman, Wilfred and Tim Jenkinson (1986), "What Stopped the Inflation? Unemployment or Commodity Prices?", *The Economic Journal*, 96(381), 39-54.

Bertram, Gordon W. and Michael B. Percy (1979), "Real Wage Trends in Canada, 1900-26: Some Provisional Estimates," *Canadian Journal of Economics*, 12, 299-312.

Blackett, O.W. (1923), "Pig Iron and Scrap Prices during Business Cycles", *The Review of Economics and Statistics*, 5(4), 272-278.

Bomberger, William A. and Gail E. Makinen (1993), "Commodity prices and inflation: A forward-looking price model", *Journal of Money, Credit and Banking*, 25(4), 854-861.

Bureau of Statistics (1902), Movement of Prices, 1840-1901: From Sauerbeck's tables, London Economist, Reports of the US Senate and Department of Labour and Statistics, Treasury Department.

Burns, Arthur F. and Wesley C. Mitchell (1946), Measuring Business Cycles, NBER.

Calomiris, Charles and R. Glenn Hubbard (1989), "Price Flexibility, Credit Availability, and Economic Fluctuations: Evidence from the United States, 1894-1909", *Quarterly Journal of Economics*, 104, 429-452.

Cao, Bolong, Shamila Jayasuriya and William Shambora, (2010), "Holding a commodity futures index fund in a globally diversified portfolio: A placebo effect?", Economics Bulletin, 30(3), 1842-1851.

Cavallo, Michele (2008), "Oil prices and inflation", FRBSF Economic Letter, 2008(13).

Choi, Sangyup, Davide Furceri, Prakash Loungani, Saurabh Mishra and Marcos Poplawski-Ribeiro (2018), "Oil prices and inflation dynamics: Evidence from advanced and developing economies", *Journal of International Money and Finance*, 82, 71-96.

Ciccarelli, Matteo and Benoît Mojon (2010), "Global Inflation," *Review of Economics and Statistics*, 92, 524-535.

Crawford, George, Jim Kyung-Soo Liew and Andrew Marks (2013), "Spot commodities as inflation protection", *The Journal of Wealth Management*, 16 (3) 87-111.

Darby, Michael R. (1982), "The Price of Oil and World Inflation and Recession", *American Economic Review*, 72(4), 738-751.

Davis, Joseph H. (2004), "An annual index of US industrial production, 1790-1915", *Quarterly Journal of Economics*, 119(4), 1177-1215.

De Gregorio, José, Oscar Landerretche, Christopher Neilson, Christian Broda and Roberto Rigobon (2007), "Another Pass-through Bites the Dust? Oil Prices and Inflation", *Economía*, 7(2), 155-208.

Edvinsson, Rodey and Johan Söderberg (2010), "The evolution of Swedish consumer prices 1290–2008," in Historical Monetary and Financial Statistics for Sweden: Exchange rates, prices, and wages, 1277–2008, edited by Edvinsson, Tor Jacobson, and Daniel Waldenström, Sveriges Riksbank.

Eitrheim, Ø., J.T. Klovland and J.F. Qvigstad (eds.), (2004), Historical Monetary Statistics for Norway 1819-2003 (pp.289-328). Norges Bank Occasional Papers No. 35.Erten Bilge and Jose Antonio Ocampo(2013), "Super cycles of commodity prices since the mid-nineteenth century", *World Development*, 44(C):14–30

Esmeralda Ballesteros (1997), "Una estimación del coste de la vida en España. 1861-1936 Revista de Historia Económica," XV, 2: 363-95 Downloaded from http://www.iisg.nl/hpw/barquin1.php.

Federal Reserve Economic Data (FRED), "Consumer Price Index in the United Kingdom," https://fred.stlouisfed.org/series/CPIUKA

Feinstein, Charles H. (1998), "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain during and after the Industrial Revolution", *Journal of Economic History*, 58(3), 625-658.

Feinstein, Charles H. (1995), "Changes in nominal wages, the cost of living and real wages in the United Kingdom over two centuries, 1780-1990" in Scholliers, P. and V. Zamagni (eds), Labour's reward: real wages and economic change in 19th and 20th century Europe, Edward Elgar, England.

Feinstein, Charles H. (1991), "A new look at the cost of living, 1870-1914" in Foreman-Peck, James (ed), New Perspectives on the late Victorian Economy, Cambridge University Press, Great Britain.

Findlay, Ronald and Kevin H. O'Rourke (2001), "Commodity market integration, 1500–2000", NBER Working Paper 8579.

Furlong, Fred and Robert Igenito (1996), "Commodity prices and inflation", FRBSF Economic Review, 1996(2), 27-47.

Geloso, Vincent (2019), "A price index for Canada, 1688 to 1850," *Canadian Journal of Economics*, 52, 526–560.

Geloso, Vincent and Michael Hinton (2020), “Improving deflators or estimating Canadian economic growth, 1870–1900,” *Research in Economic History*, 36, 125–150.

Gerlach, Stefan and Rebecca Stuart (2001), “International Co-movements of Inflation, 1851-1913”, CEPR Discussion Paper, DP15914.

Gorton, Gary (1988), “Banking panics and business cycles”, *Oxford Economic Papers*, 40, 751-781.

Gorton, Gary and K. Geert Rouwenhorst (2006), “Facts and fantasies about commodity futures”, *Financial Analysts Journal*, 62, 47–68.

Gorton, Gary, Fumio Hayashi, and K Geert Rouwenhorst (2007), “The Fundamentals of Commodity Futures Returns,” NBER Working Paper 13249.

Grytten, Ola H. “A Consumer Price Index for Norway, 1516-2003,” in Historical Monetary Statistics for Norway 1819–2003,” in Eitrheim, Øyvind , Jan T. Klovland and Jan F. Qvigstad (eds.), Historical Monetary Statistics for Norway 1819–2003, Occasional Papers 35, Norges Bank.

Heikkinen, Sakari (1997), “Labour and the Market. Workers, Wages and Living Standards in Finland, 1850-1913”. Commentationes Scientiarium Socialium 51, Helsinki.

Historical Statistics of Switzerland HSSO, 2012. Table H.17. hsso.ch/2012/h/17

Jacks, David (2005), “Intra- and international commodity market integration in the Atlantic economy, 1800–1913’, *Explorations in Economic History*, 42, 381-413.

Jacks, David (2019), “From boom to bust: a typology of real commodity prices in the long run”, *Cliometrica*, 13, 201-220.

Jacobs, Alfred and Hans Richter (1935), Die Grosshandelspreise in Deutschland von 1792 bis 1934, Hanseatische Verlagsanstalt Hamburg, Berlin.

Kaufmann, Daniel (2020), “Is deflation costly after all? The perils of erroneous historical classifications,” *Journal of Applied Econometrics*, 35, 614-628.

Kaufmann, Daniel (2019), “Nominal stability over two centuries”, *Swiss Journal of Economics and Statistics*, 155, 1-23.

Klovland, Jan Tore (2005), “Commodity market integration: Evidence from Britain and Germany”, *European Review of Economic History*, 9, 163-197.

Lebergott, Stanley (1964), Manpower in Economic Growth: The American record since 1800, McGraw-Hill, New York.

Macauley, Frederick R. (1938), The movements of interest rates, bond yields and stock prices in the United States since 1856, NBER, New York.

Mardia, K. V., J. T. Kent and J. M. Libby (2003), Multivariate Analysis, Academic Press, San Diego.

McLean, Ian W. (1997), "Consumer prices and expenditure patterns in Australia 1850-1914", *Australian Economic History Review*, 39, 1-28.

Miron, Jeffrey A. and Christina D. Romer (1990), "A new monthly industrial production index, 1884-1940", *Journal of Economic History*, 50(2), 321-337.

Mitchell, B. R. (2003), International Historical Statistics: Europe 1750 – 2000, Palgrave Macmillan, 5TH ed.

Mühlpeck, Vera, Roman Sandgruber and Hannelore Woitek (1979), "Index der Verbraucherpreise 1800–1914 (Index of consumer prices, 1800–1914)", in Österreichisches Statistisches Zentralamt, Geschichte und Ergebnisse der zentralen amtlichen Statistik in Österreich 1829–1979, Beiträge zur österreichischen Statistik, Vienna.

Naknoi, Kanda, (2008), "Tariffs and the Expansion of the American Pig Iron Industry, 1870-1940", Purdue University Economics Working Papers 1214, Purdue University, Department of Economics.

Obstfeld, Maurice and Alan M. Taylor (2005), Global Capital Markets: Integration, Crisis, and Growth, Cambridge University Press, Cambridge.

Sauerbeck, Augustus (1886), "Prices of Commodities and the Precious Metals", *Journal of the Statistical Society of London*, 49(3), 581-648.

Sauerbeck, Augustus (1893), "Prices of Commodities During the Last Seven Years", *Journal of the Statistical Society of London*, 56(2), 215-254.

Sauerbeck, Augustus (1908), "Prices of Commodities in 1907", *Journal of the Statistical Society of London*, 71(1), 132-146.

Sauerbeck, Augustus (1917), "Wholesale Prices of Commodities in 1916", *Journal of the Statistical Society of London*, 80(2), 289-309.

Studer, Roman and Pascal Schuppli (2008), "Deflating Swiss Prices over the Past Five Centuries", *Historical Methods*, Summer 2008, 41(3), 137-153.

Wonnacott, Thomas H., and Ronald J. Wonnacott (1977), Introductory Statistics for Business and Economics, Second ed., John Wiley & Sons, New York.

Zaremba, Adam, Zaghum Umar and Mateusz Mikutowski (2019), "Inflation hedging with commodities: A wavelet analysis of seven centuries worth of data", *Economics Letters*, 181, 90-94.

Zarnowitz, Victor (1987), "The Regularity of Business Cycles", NBER Working Paper No. 2381.

Table 1: Descriptive statistics of inflation, 1851-1913

	Median	Mean	Interquartile range	Standard deviation	Source
Australia	1.29	1.31	5.05	4.91	McLean (1999), W6-series used
Austria	0.00	0.18	6.78	4.68	Mühlpeck, et al., (1979)
Belgium	0.00	0.33	1.10	1.40	Mitchell (2003)
Canada	0.00	0.19	2.55	2.64	Various, see notes
Denmark	0.72	0.67	6.07	6.64	Abildgren (2009)
Finland	0.00	0.47	3.41	5.22	Heikkinen (1997)
France	0.54	0.67	5.79	4.25	Mitchell (2003)
Germany	0.80	0.55	5.09	3.23	Mitchell (2003)
Iceland	1.07	0.73	2.92	3.49	BIS , www.bis.org
Netherlands	1.07	0.73	2.92	3.49	Arthur van Riel, http://iisg.nl/hpw/brannex.php
Norway	0.56	0.55	7.85	5.83	Grytten (2004)
Sweden	0.72	0.20	3.23	2.37	Edvinsson and Söderberg (2010)
Switzerland	-0.08	0.12	4.63	3.19	Studer and Schuppli (2008) Historical Statistics of Switzerland (2012)
UK	0.12	-0.31	6.74	5.69	FRED, fred.stlouisfed.org
US	0.56	0.49	3.38	3.07	www.measuringworth.com

Notes: The Canadian CPI series was constructed as follows. For the period 1800-1870, the data stem from Geloso (2019), for 1870-1900 from Geloso and Hinton (2020), from 1901-1909 from series K33 in Historical Statistics of Canada (https://www150.statcan.gc.ca/n1/pub/11-516-x/sectionk/4057753-eng.htm) and for 1910-1913 from column 1 in Table 1 in Bertram and Percy (1979).

Table 2: Descriptive statistics of percentage changes in commodity prices, 1851-1913

	Median	Mean	Interquartile range	Standard deviation	Sauerbeck's groupings
Wheat	1.18	-0.29	13.43	12.75	Corn
Flour	0.00	-0.31	15.68	11.72	Corn
Barley	-1.31	0.24	11.69	9.23	Corn
Oats	0.00	0.23	12.90	8.67	Corn
Maize	0.00	-0.26	17.98	12.80	Corn
Potatoes	0.00	-0.14	27.13	20.89	Corn
Rice	1.38	-0.06	15.29	10.88	Corn
Beef	0.00	0.72	8.60	6.11	Meat etc
Mutton	1.08	0.63	10.28	7.54	Meat etc
Pork	-1.90	0.45	13.54	9.73	Meat etc
Bacon	0.00	0.72	9.25	8.23	Meat etc
Butter	1.07	0.58	7.23	5.49	Meat etc
Sugar	2.51	-1.40	15.68	12.80	Sugar etc
Coffee	-1.33	0.37	16.45	11.80	Sugar etc
Tea	-1.26	-1.05	9.63	9.51	Sugar etc
Pig iron	0.00	0.64	12.46	13.70	Minerals
Iron bars	0.00	0.45	13.60	13.05	Minerals
Copper	-1.32	-0.21	13.13	15.31	Minerals
Tin	2.27	1.51	17.59	14.18	Minerals
Lead	0.00	0.11	13.76	10.95	Minerals
Coal	-0.62	0.65	10.06	10.77	Minerals
Cotton	-0.80	0.06	23.16	18.07	Textiles
Flax	-1.80	-0.13	16.35	10.83	Textiles
Hemp	0.00	0.15	12.87	11.91	Textiles
Jute	-1.00	0.81	21.73	14.02	Textiles
Wool	-2.13	0.18	16.59	10.42	Textiles
Silk	0.00	-0.87	11.96	12.22	Textiles
Hides	0.00	1.46	12.96	9.74	Sundries
Leather	0.00	1.02	6.17	7.42	Sundries
Tallow	0.00	-0.12	11.30	9.82	Sundries
Oil	0.00	0.23	9.75	7.88	Sundries
Linseed	0.00	-0.23	14.08	11.77	Sundries
Indigo	-1.08	-1.04	12.31	11.50	Sundries
Timber	0.00	-0.03	11.53	7.66	Sundries

Table 3: Correlation of percentage changes in prices of pig iron, iron bars, copper, lead, tin, indigo, jute, linseed and timber with the remaining commodities, 1851-1913

		Copper	Pig iron	Iron bars	Lead	Tin	Indigo	Jute	Linseed	Timber
Corn	Wheat	0.11	0.29	0.16	0.23	0.02	0.03	-0.06	0.15	0.23
	Flour	0.14	0.28	0.21	0.25	-0.01	0.03	-0.04	0.10	0.31
	Barley	0.21	0.26	0.12	0.17	0.08	-0.04	0.04	0.11	0.23
	Oats	0.02	0.11	0.05	0.14	-0.03	0.00	-0.11	0.23	0.28
	Maize	0.14	0.02	-0.02	0.05	0.02	0.14	-0.12	0.22	0.02
	Potatoes	0.10	0.31	0.24	0.23	0.05	0.01	-0.05	0.06	0.11
	Rice	0.28	0.31	0.21	0.30	0.13	0.12	0.32	0.26	0.33
Meat and animal products	Beef	0.25	0.33	0.38	0.20	0.16	-0.01	-0.04	0.17	0.27
	Mutton	0.28	0.32	0.44	0.38	0.23	-0.09	0.15	0.02	0.27
	Pork	-0.01	0.13	0.20	0.12	0.11	0.06	0.07	0.13	0.34
	Bacon	0.04	0.28	0.31	0.14	0.05	-0.07	0.02	0.09	0.47
	Butter	0.07	0.05	0.12	0.06	0.10	0.20	0.18	0.04	0.24
Sugar etc	Sugar	0.11	0.17	0.24	0.13	0.21	0.07	0.15	0.20	0.08
	Coffee	0.06	0.35	0.25	0.23	0.13	0.05	0.23	0.19	0.04
	Tea	0.06	0.25	0.21	0.35	0.21	0.10	0.05	0.14	-0.07
Minerals	Coal	0.26	0.72	0.72	0.48	0.27	-0.14	0.06	0.30	0.38
Textiles	Cotton	0.14	0.25	0.31	0.18	0.19	0.02	0.32	0.27	0.07
	Flax	-0.02	0.07	0.03	0.09	0.05	-0.09	0.08	0.26	0.22
	Hemp	0.25	0.48	0.41	0.31	0.37	-0.26	0.27	0.22	0.30
	Wool	0.41	0.56	0.54	0.48	0.37	-0.01	0.31	0.06	0.24
	Silk	0.23	0.25	0.24	0.40	0.38	0.19	0.27	0.06	0.08
Sundries	Hides	0.20	0.42	0.34	0.38	0.35	-0.14	-0.02	0.14	0.17
	Leather	0.25	0.49	0.40	0.41	0.37	-0.09	0.11	0.17	0.17
	Tallow	0.26	0.21	0.23	0.13	0.12	0.08	0.06	0.18	0.28
	Oil	0.27	0.31	0.27	0.29	0.16	0.13	0.20	0.33	0.23
Average pairwise correlation		0.17	0.29	0.26	0.25	0.16	0.01	0.10	0.16	0.21

Table 4
OLS estimates, 1851-1913

Inflation regressed on a constant, lagged inflation and the median percentage change of commodity prices

	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Iceland	Nether-lands	Norway	Sweden	Switzer-land	UK	US
Constant	0.129	0.503	0.093	-0.223	0.111	0.386	0.344	0.751	0.739	0.037	0.362	0.359	0.293	0.124	0.144
	(1.08)	(0.42)	(0.60)	(0.79)	(0.33)	(0.76)	(0.19)	(0.71)	(0.51)	(0.42)	(0.40)	(0.56)	(0.88)	(0.34)	(0.44)
	[0.12]	[1.20]	[0.16]	[-0.28]	[0.33]	[0.51]	[1.82]	[1.06]	[1.44]	[0.09]	[0.91]	[0.64]	[0.33]	[0.36]	[0.33]
Lagged inflation	0.195	0.114	0.214	0.206	0.492	0.191	0.105	0.339	-0.024	0.389	0.342	0.316	0.115	0.342	0.663
	(0.14)	(0.13)	(0.09)*	(0.15)	(0.11)**	(0.13)	(0.13)	(0.12)**	(0.09)	(0.16)*	(0.10)**	(0.08)**	(0.15)	(0.10)**	(0.20)**
	[1.43]	[0.85]	[2.47]*	[1.36]	[4.31]**	[1.48]	[0.80]	[2.84]**	[-0.28]	[2.37]*	[3.45]**	[3.88]**	[0.77]	[3.39]**	[3.28]**
Commodity Prices	0.266	0.169	0.230	0.400	0.146	0.260	0.075	0.223	0.150	0.157	0.260	0.267	0.535	0.255	0.136
	(0.12)*	(0.05)**	(0.08)**	(0.08)**	(0.06)*	(0.10)**	(0.03)*	(0.08)**	(0.06)*	(0.05)**	(0.07)**	(0.06)**	(0.12)**	(0.06)**	(0.06)*
	[2.13]*	[3.53]**	[3.02]**	[4.93]**	[2.31]*	[2.72]**	[2.63]*	[2.78]**	[2.39]*	[3.19]**	[3.73]**	[4.23]**	[4.32]**	[3.96]**	[2.28]*
Observations:	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62
R-squared:	0.08	0.17	0.15	0.24	0.33	0.14	0.14	0.25	0.08	0.26	0.36	0.26	0.28	0.42	0.47
F-statistic:	2.74	6.18	5.29	9.14	14.55	4.61	4.77	9.93	2.50	10.40	16.80	10.43	11.20	21.58	26.49

Notes: robust standard errors in parenthesis, t-statistic in brackets, */** denotes significance at the 5%/1% level.

Table 5
OLS estimates, 1851-1913

Inflation regressed on a constant, lagged inflation and the percentage change of each commodity price individually

	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Iceland	Nether- lands	Norway	Sweden	Switzer- land	UK	US
Equation 1	0.144	0.107	0.138	0.238	0.058	0.127	0.025	0.110	0.084	0.054	0.141	0.106	0.346	0.120	0.089
Pig iron	(0.13)	(0.02)**	(0.04)**	(0.07)**	(0.04)	(0.05)*	(0.02)	(0.05)*	(0.04)	(0.03)	(0.03)**	(0.04)*	(0.07)**	(0.04)**	(0.03)**
	[1.07]	[5.13]**	[3.19]**	[3.56]**	[1.34]	[2.41]*	[1.21]	[2.07]*	[1.92]	[1.56]	[4.09]**	[2.59]*	[4.81]**	[3.18]**	[3.12]**
R-squared:	*0.08*	*0.22*	*0.17*	*0.27*	*0.27*	*0.12*	*0.06*	*0.24*	*0.08*	*0.21*	*0.36*	*0.19*	*0.36*	*0.34*	*0.49*
Equation 2	0.090	0.102	0.103	0.219	0.066	0.119	0.019	0.088	0.049	0.040	0.111	0.097	0.305	0.117	0.093
Iron bars	(0.08)	(0.02)**	(0.04)**	(0.05)**	(0.04)	(0.05)*	(0.02)	(0.04)	(0.02)	(0.04)	(0.03)**	(0.04)*	(0.07)**	(0.04)**	(0.03)**
	[1.09]	[4.69]**	[2.69]**	[4.08]**	[1.68]	[2.38]*	[0.96]	[1.97]	[1.97]	[1.09]	[3.61]**	[2.21]*	[4.08]**	[2.92]**	[2.74]**
R-squared:	*0.05*	*0.19*	*0.11*	*0.22*	*0.28*	*0.10*	*0.04*	*0.22*	*0.03*	*0.19*	*0.25*	*0.17*	*0.27*	*0.31*	*0.49*
Equation 3	0.036	0.043	0.043	0.086	0.019	0.059	0.012	0.020	0.064	0.009	0.078	0.093	0.110	0.051	0.071
Copper	(0.06)	(0.03)	(0.04)	(0.05)	(0.02)	(0.04)	(0.01)	(0.03)	(0.03)*	(0.02)	(0.03)**	(0.03)**	(0.07)	(0.03)	(0.03)*
	[0.58]	[1.48]	[1.12]	[1.60]	[0.91]	[1.45]	[1.11]	[0.68]	[2.43]*	[0.36]	[2.77]**	[3.22]**	[1.49]	[1.94]	[2.61]*
R-squared:	*0.04*	*0.09*	*0.06*	*0.10*	*0.22*	*0.06*	*0.03*	*0.19*	*0.06*	*0.17*	*0.21*	*0.18*	*0.08*	*0.17*	*0.48*
Equation 4	0.107	0.070	0.103	0.134	0.086	0.083	0.026	0.088	0.055	0.059	0.127	0.167	0.198	0.121	0.064
Lead	(0.07)	(0.03)*	(0.05)*	(0.06)*	(0.04)*	(0.05)	(0.02)	(0.04)*	(0.04)	(0.04)	(0.03)**	(0.04)**	(0.07)**	(0.05)*	(0.03)*
	[1.59]	[2.38]*	[2.28]*	[2.29]*	[2.32]*	[1.55]	[1.23]	[2.15]*	[1.26]	[1.56]	[4.07]**	[3.88]**	[2.67]**	[2.55]*	[2.24]*
R-squared:	*0.05*	*0.10*	*0.09*	*0.10*	*0.30*	*0.06*	*0.05*	*0.21*	*0.02*	*0.20*	*0.24*	*0.24*	*0.10*	*0.27*	*0.45*
Equation 5	-0.001	0.046	0.057	0.109	0.024	0.050	0.013	0.014	0.016	-0.008	0.060	0.062	0.127	0.050	0.065

Tin	(0.06)	(0.02)*	(0.03)	(0.05)*	(0.03)	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)	(0.03)	(0.04)	(0.08)	(0.04)	(0.03)*
	[-0.01]	[2.15]*	[1.70]	[2.01]*	[0.79]	[0.96]	[0.80]	[0.34]	[0.82]	[-0.27]	[1.78]	[1.58]	[1.61]	[1.24]	[2.32]*
R-squared:	*0.04*	*0.09*	*0.06*	*0.11*	*0.22*	*0.06*	*0.03*	*0.19*	*0.00*	*0.17*	*0.16*	*0.13*	*0.08*	*0.16*	*0.47*
Equation 6	-0.079	0.038	0.042	-0.185	0.016	0.072	0.038	0.027	0.016	0.072	0.016	0.068	-0.069	-0.006	-0.064
Indigo	(0.07)	(0.06)	(0.05)	(0.07)*	(0.03)	(0.08)	(0.02)*	(0.08)	(0.03)	(0.04)	(0.04)	(0.05)	(0.10)	(0.03)	(0.06)
	[-1.10]	[0.62]	[0.84]	[-2.55]*	[0.55]	[0.87]	[2.31]*	[0.35]	[0.53]	[1.70]	[0.36]	[1.38]	[-0.68]	[-0.19]	[-1.15]
R-squared:	*0.05*	*0.07*	*0.05*	*0.14*	*0.22*	*0.06*	*0.08*	*0.19*	*0.00*	*0.21*	*0.11*	*0.12*	*0.04*	*0.12*	*0.45*
Equation 7	-0.072	0.055	0.006	0.054	0.020	0.035	0.033	0.018	-0.013	0.044	0.055	0.039	0.071	0.044	0.071
Jute	(0.10)	(0.04)	(0.05)	(0.07)	(0.03)	(0.05)	(0.02)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)	(0.06)	(0.04)	(0.05)
	[-0.70]	[1.44]	[0.12]	[0.76]	[0.65]	[0.64]	[1.93]	[0.34]	[-0.33]	[1.36]	[1.89]	[1.16]	[1.13]	[1.14]	[1.54]
R-squared:	*0.05*	*0.10*	*0.04*	*0.07*	*0.22*	*0.05*	*0.10*	*0.19*	*0.00*	*0.20*	*0.15*	*0.11*	*0.05*	*0.15*	*0.47*
Equation 8	0.125	0.073	0.206	0.168	0.040	0.107	0.042	0.104	0.052	0.075	0.059	0.096	0.157	0.073	0.079
Linseed	(0.13)	(0.03)*	(0.06)**	(0.08)	(0.03)	(0.06)	(0.01)**	(0.05)*	(0.05)	(0.04)*	(0.04)	(0.05)*	(0.08)	(0.03)*	(0.04)*
	[0.99]	[2.39]*	[3.63]**	[1.99]	[1.46]	[1.77]	[3.55]**	[2.06]*	[1.13]	[2.11]*	[1.42]	[2.13]*	[1.86]	[2.56]*	[2.12]*
R-squared:	*0.06*	*0.12*	*0.26*	*0.14*	*0.23*	*0.08*	*0.11*	*0.23*	*0.02*	*0.22*	*0.14*	*0.15*	*0.08*	*0.18*	*0.47*
Equation 9	0.214	0.120	0.203	0.247	0.094	0.235	0.023	0.299	0.090	0.125	0.233	0.198	0.413	0.177	0.118
Timber	(0.14)	(0.06)*	(0.08)*	(0.10)*	(0.05)	(0.10)*	(0.03)	(0.10)**	(0.06)	(0.05)*	(0.05)**	(0.08)*	(0.13)**	(0.05)**	(0.05)*
	[1.56]	[2.05]*	[2.46]*	[2.48]*	[1.82]	[2.33]*	[0.86]	[3.01]**	[1.44]	[2.42]*	[4.29]**	[2.49]*	[3.20]**	[3.53]**	[2.17]*
R-squared:	*0.07*	*0.12*	*0.13*	*0.13*	*0.26*	*0.12*	*0.03*	*0.31*	*0.03*	*0.23*	*0.32*	*0.19*	*0.18*	*0.27*	*0.46*

Notes: robust standard errors in parenthesis, t-statistic in in brackets, */** denotes significance at the 5%/1% level.

Table 6
OLS estimates, 1851-1913
Stepwise search, criterion p = 1%; Inflation regressed on a constant, lagged inflation and percentage changes of all nine commodity prices

	Austria	Belgium	Canada	France	Germany	Norway	Sweden	Switzer-land	UK
Constant	0.455	0.232	-0.294	0.395	0.862	0.363	0.399	0.215	0.118
	(0.41)	(0.57)	(0.76)	(0.20)	(0.66)	(0.38)	(0.58)	(0.84)	(0.36)
	[1.10]	[0.41]	[-0.39]	[1.99]	[1.30]	[0.96]	[0.69]	[0.26]	[0.33]
Lagged inflation	0.133	0.167	0.219	0.65	0.344	0.376	0.337	0.049	0.285
	(0.12)	(0.08)*	(0.13)	(0.12)	(0.11)**	(0.09)**	(0.09)**	(0.14)	(0.10)**
	[1.09]	[2.05]*	[1.63]	[0.55]	[3.09]**	[4.09]**	[3.92]**	[0.35]	[2.75]**
Pig iron	0.107		0.239			0.103		0.346	0.120
	(0.02)**		(0.07)**			(0.03)**		(0.07)**	(0.04)**
	[5.14]**		[3.56]**			[3.04]**		[4.81]**	[3.18]**
Linseed		0.206		0.042					
		(0.06)**		(0.01)**					
		[3.63]**		[3.55]**					
Lead							0.167		
							(0.04)**		
							[3.881]**		
Timber					0.299	0.149			
					(0.10)**	(0.06)**			
					[3.01]**	[2.73]**			
Adjusted R-squared:	0.19	0.24	0.25	0.08	0.29	0.39	0.21	0.34	0.32

Notes: robust standard errors in parenthesis, t-statistic in in brackets, */** denotes significance at the 5%/1% level.

Table 7
International business cycle, pig iron production, pig iron prices and international inflation
Correlation coefficients for percentage changes, 1851-1913

	International business cycle	Global pig iron production	Pig iron prices	International inflation
International business cycle	1.00	0.51*	0.41*	0.06
Global pig iron production	0.51*	1.00	0.46*	0.15
Pig iron prices	0.41*	0.46*	1.00	0.51*
International inflation	0.06	0.15	0.51*	1.00

Note: * indicates significance at the 5% level

Figure 1: Summary measures of percentage changes in nine commodity prices, normalized data, 1851-1913

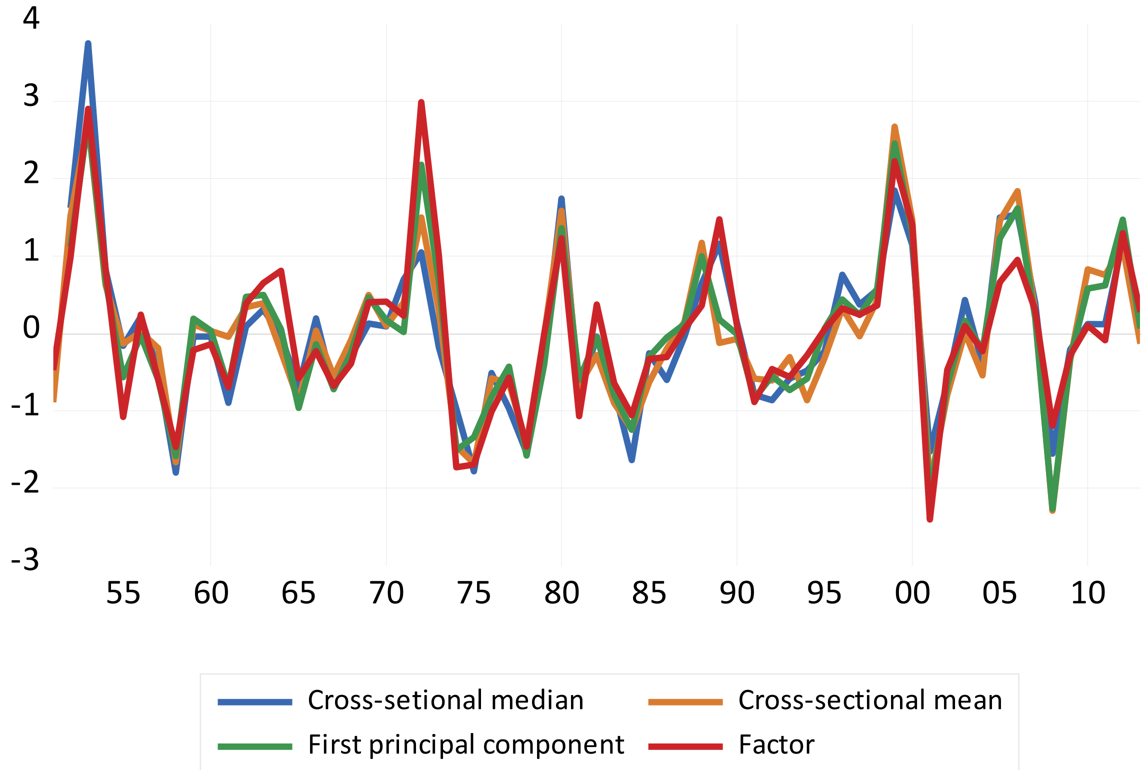
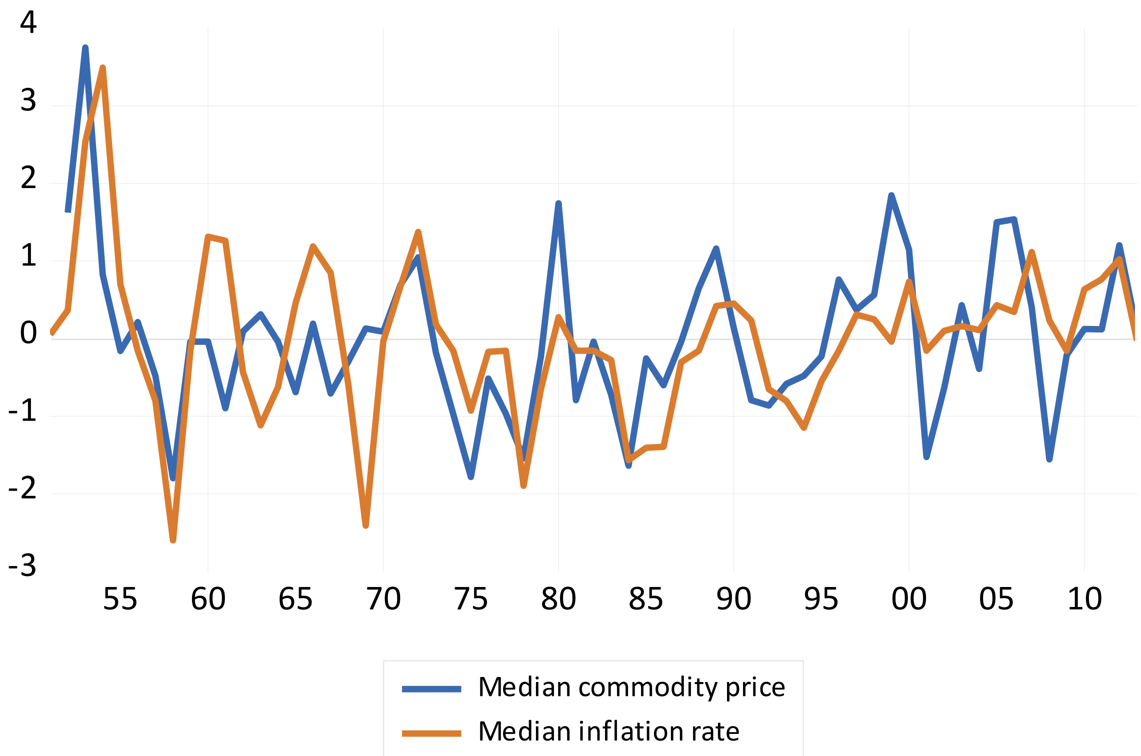


Figure 2: Median percentage change of commodity price (nine commodities) and median inflation rate (15 countries), 1851-1913



Appendix Table 1: OLS estimates, 1851-1913

Stepwise search, criterion p = 2.5%; Inflation regressed on a constant, lagged inflation and percentage changes of all nine commodity prices

Country equations for which different results are obtained compared to Table 6

	Belgium	Denmark	Finland	France	Iceland	US
Constant	0.142	0.133	0.495	0.406	0.800	0.198
	(0.54)	(0.34)	(0.77)	(0.20)*	(0.51)	(0.44)
	[0.26]	[0.39]	[0.65]	[2.05]*	[1.58]	[0.45]
Lagged inflation	0.182	0.522	0.209	0.084	-0.026	0.674
	(0.08)*	(0.11)**	(0.13)	(0.11)	(0.09)	(0.20)**
	[2.29]*	[4.68]**	[1.65]	[0.78]	[0.30]	[3.30]**
Pig iron	0.095					
	(0.04)*					
	[2.54]*					
Linseed	0.174			0.042		
	(0.05)**			(0.01)**		
	[3.27]**			[3.55]**		
Indigo				0.038		
				(0.02)*		
				[2.34]*		
Lead		0.086				
		(0.04)*				
		[2.32]*				
Timber			0.235			
			(0.10)*			
			[2.33]*			
Copper					0.064	0.071
					(0.026)*	(0.03)*
					[2.43]*	[2.61]*
Adjusted R-squared:	0.29	0.27	0.09	0.13	0.03	0.46

Notes: robust standard errors in parenthesis, t-statistic in in brackets, */** denotes significance at the 5%/1% level

Appendix Table 2
OLS estimates, 1851-1913
Forward stepwise search, criterion p = 1% and 2.5%
Inflation regressed on a constant, lagged inflation and 9 commodity price series
Country equations for which different results are obtained compared to Table 6 and Appendix Table 1

	Stopping criterion = 1%			Stopping criterion = 2.5%		
	Canada	UK	US	Finland	Nether-lands	UK
Constant	-0.220	0.226	0.110	0.365	0.103	0.248
	(0.80)	(0.38)	(0.43)	(0.78)	(0.43)	(0.37)
	[-0.27]	[0.60]	[0.26]	[0.47]	[0.24]	[0.67]
Lagged inflation	0.248	0.371	0.672	0.186	0.410	0.331
	(0.15)	(0.10)**	(0.20)**	(0.13)	(0.16)*	(0.09)**
	[1.67]	[3.79]**	[3.31]**	[1.47]	[2.63]*	[3.60]**
Pig iron			0.089	0.127		
			(0.03)**	(0.05)*		
			[3.12]**	[2.41]*		
Iron Bars	0.219					
	(0.05)**					
	[4.08]**					
Linseed						0.057
						(0.02)*
						[2.41]*
Timber		0.177			0.125	0.165
		(0.050)**			(0.05)*	(0.05)**
		[3.53]**			[2.42]*	[3.50]**
Adjusted R-squared	0.20	0.25	0.47	0.09	0.21	0.27

Notes: robust standard errors in parenthesis, t-statistic in in brackets, */** denotes significance at the 5%/1% level.