Commodity Price Booms and Busts: A Primer[*]

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Abstract

This paper considers the evidence on real commodity prices over 160 years for 28 commodities representing 5.03 trillion USD worth of production in 2007. In so doing, it suggests and documents a complete typology of commodity price series, comprising long-run trends, medium-run cycles, and short-run boom and bust episodes. The findings of the paper can be summarized as follows: real commodity prices have been on the rise from at least 1950 if evaluated on the basis of the value of production; there is a consistent pattern of commodity price super-cycles in the historical record as well as the present which entail decades-long positive deviations from these long-run trends; these commodity price super-cycles are punctuated by booms and busts which are historically pervasive and becoming more exacerbated over time. These last elements of boom and bust are also found to be particularly bearing in determining real commodity price volatility as well as potentially bearing in determining trend growth in commodity dependent economies.

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I. Introduction

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II. Long-run Trends and Medium-run Cycles

A long-standing view in the literature holds that in real terms commodity prices oftentimes do little better than tread water, exhibiting either downward or non-discernible trends. This seems to be true regardless of whether the window of observation runs in the mere handful of decades or across entire centuries (Harvey *et al*., 2010). Another well-known fact is the pronounced short-run movement of commodity prices around these long-run trends. It is this extreme inter- and intra-year volatility against a backdrop of exceedingly slow evolving dynamics which lead Cashin and McDermott (2002) to typify the long-run behavior of commodity prices as "small trends and big variability". Or as Deaton (1999, p. 27) put it: "What commodity prices lack in trend, they make up for in variance." A less appreciated fact is the potential existence of cycles in real commodity prices spanning decades associated with key events in economic development over time. What this section sets out to do is re-assess the conventional wisdom on long-run trends as well as introduce new perspectives on commodity price cycles in the medium run.

The data used in this study comprise long-run annual prices for commodities with at least 5 billion USD worth of production in 2007. Consistent and reliable data collection begins for the majority of price series in 1850 while no price series enters the data set later than 1900. All told, they comprise 28 individual series which are drawn from six product categories (animal products, energy products, grains, metals, minerals, and soft commodities) and which are enumerated in Table 1.

As Table 1 also demonstrates, the data series are not only large in number, but also economically significant representing 5.03 trillion USD worth of production in 2007.[1] Finally, the individual price series (being expressed in US dollars) were deflated by the US CPI underlying Officer (2012), supplemented by updates taken from the BLS. The choice of the CPI as deflator—although not entirely uncontroversial—is a fairly standard practice in the literature. In what follows, none of the results are materially altered by the consideration of alternative measures of economy-wide prices such as the US GDP deflator or the US PPI. An appendix to this paper details the sources for the individual series.

Figures 1-6 document the evolution of real commodity prices from 1850 to 2012. All series have been converted into index form with real prices in 1900 set equal to 100. Simply "eye-balling" these series, the previously noted "big variability" of real commodity prices emerges. Using one common measure of volatility, namely the standard deviation of annual changes in logged real prices yields an average value of 0.1959 for all commodities and a range of (0.1348, 0.2955) across commodities. Somewhat curiously, this measure of volatility is itself fairly narrowly distributed with the vast majority of all observations falling in a much tighter range defined by 0.1959 +/- 0.04. For better or worse, no clear patterns emerge with respect to volatility across product categories, except for slightly lower average volatility for metals and slightly higher average volatility for soft commodities.

However, with respect to long-run trends in the real commodity price data, there are clear patterns across product categories. Notwithstanding some common global shocks like the peaks in real prices surrounding World War I, the 1970s, and, to a lesser extent, the late 2000s as well as the troughs in the 1930s and 1990s, there is a clear divergence in between those commodities

[1] Even adjusting for double-counting and neglecting energy products, these productions values are still in excess of 1.92 trillion USD.

mired in a perpetual downward trend and those exhibiting a perpetual upward trend. Table 2 draws out this divergence across categories more clearly. Here, real prices in 2012 are compared to those in 1850, 1900, 1950, and 1975.

It will come as no surprise that energy products have registered increases in real prices since 1900. Slightly more surprising is the presence of steel and related minerals (chromium, iron ore, and manganese) in the same category. On the opposite end of the spectrum, soft commodities have been in collective decline since 1850.[2] Indeed, a broader interpretation of soft commodities often includes grains and hides which suffer from the same fate. The list of perpetual decliners is rounded out by aluminum (and the related mineral of bauxite) as well as zinc. This leaves six commodities with a more mixed performance over the past 162 years: beef and tin which demonstrate a long-run upward trend, but which have eased off somewhat from their all-time highs in the 1970s; copper and potash which have a consistent upward trend from 1950; and lead and nickel which have essentially been trendless from 1975. Thus, energy products and minerals are clearly in the "winner" camp, grains and soft commodities are clearly in the "loser" camp, and metals are left as contested territory.

Interestingly, the combination of Tables 1 and 2 suggest that if anything real commodity prices are on the rise if evaluated on the basis of the value of production. Of course, this result is largely driven by energy products and steel, but even excluding these categories, the "winner" camp accounts for 296.88 billion USD in production versus the 178.41 billion USD in production for the "loser" camp. How then are these results reconciled with those of Cashin and McDermott (2002), for instance? First, Cashin and McDermott among others rely on general commodity price indices, so many of the long-run trends for "winners" are washed out by those

[2] The only exception to this statement is the rise in the real price of rubber from 1975 to 2012. However, this result is more a function of the absolute collapse in rubber prices from the early 1950s and their partial recovery: the index value stood at 31.96 in 1951, at 7.16 in 1975, and at 10.59 in 2012.

of "losers". Second, there is a slightly different composition of commodities with only 11 of their 16 commodities matching the 28 under consideration in this paper. Finally and most importantly, there is a massively different composition of product categories: their index only spans the metals and soft commodities categories. Although metals are somewhat of a mixed bag, soft commodities—even broadly defined—have been the biggest of "losers" over the past 150 years, suggesting that much of the conventional wisdom on long-run trends in real commodity prices may be unduly pessimistic or unduly swayed by events in the very distant past. It also suggests a potentially very large, but somewhat underappreciated distinction in between "commodities to be grown" versus "commodities in the ground".

So much for long-run trends and short-run volatility (of which, more later), now what of cycles in the medium run? In recent years, the investing community has run with the idea of commodity price super-cycles (Heap, 2005; Rogers, 2004). In this view, commodity price super-cycles are broad-based, long-period cycles corresponding to upswings in commodity prices of roughly 10 to 35 years, implying that a full (trough-to-trough) cycle is roughly twice that length. These are demand-driven episodes closely linked to historical episodes of mass industrialization and urbanization which interact with acute capacity constraints in many product categories—in particular, energy, metals, and minerals—in order to generate above-trend real commodity prices for years, if not decades on end.

At the same time, a burgeoning literature in identifying commodity price super-cycles has emerged in the research community (cf. Cuddington and Jerrett, 2008; Erten and Ocampo, 2012; Jerrett and Cuddington, 2008). The common theme of this literature is that commodity price super-cycles can be detected in the data by use of asymmetric band pass filters which decompose the natural log of the real price of commodity *i* in time *t* ($\ln(P_{it})$) into three components: a long-

run trend in excess of 70 years in duration ($\ln(P_{it})\_LR_t$); a super-cycle of 20 to 70 years duration ($\ln(P_{it})\_SC_t$); and all other shorter cyclical components ($\ln(P_{it})\_CC_t$). Thus, this entails breaking down the logged price series into three orthogonal components:

1.) $\ln(P_{it}) \equiv \ln(P_{it})\_LR_t + \ln(P_{it})\_SC_t + \ln(P_{it})\_CC_t$

Procedurally, this simply entails taking the logarithmic transformation of the real price indices reported earlier, estimating a long-run trend (that is, all cyclical components with periods in excess of 70 years), calculating the deviations of log real prices from this trend, and using these deviations to identify commodity price super-cycles (that is, all cyclical components with periods in excess of 20 to 70 years). The reader is referred to the work of Christiano and Fitzgerald (2003) for details of the asymmetric band pass filter used in this paper (and the previously cited papers) to identify both the long-run trends and the medium-run commodity price super-cycles.

Figure 7a displays the log of real beef prices from 1850 to 2012 and its estimated long-run trend. Figure 7b displays the detrended real beef price and the super-cycle component evident in the former. The scaling on the left-hand-side of the figure is in logs, so a value of 1.00 in Figure 7b represents a 174% deviation from the long-run trend. Thus, the cyclical fluctuations in beef prices are sizeable. The complete super-cycles for beef prices which deliver deviations from trend above 0.20 log points (or roughly 22%) can be dated from 1890 to 1929, from 1929 to 1953, and from 1953 to 1999. Figures 8a through 34b replicate the same exercise for the 27 remaining real commodity price series at our disposal. Evidence of large deviations from trend is apparent in almost all series as is the existence of numerous super-cycles over the past 163 years.[3]

[3] Curiously, although subject to wide fluctuations in its real price (both in absolute terms and relative to trend), tobacco is the only commodity for which no super-cycle can be detected. This result does not, however, preclude the existence of multiple booms and busts in real tobacco prices as will be demonstrated below.

Tables 3 through 8 enumerate six features of commodity price super-cycles across the six products categories, namely their start dates, peak dates, trough dates, years to peak, complete cycle length, and peak value (the largest positive deviation from trend in real prices). All told, 56 commodity price super-cycles with positive price deviations from trend of at least 0.20 log points are identified. In an attempt to characterize systematic differences in these super-cycles across time, a battery of regressions were run using three of these features (years to peak, cycle length, and peak value) as dependent variables and a set of indicator variables capturing three different time periods, namely from 1914 to 1945 (interwar), from 1946 to 1971 (Bretton Woods), and from 1972 to 2012 (post-Bretton Woods). Thus, the period from 1850 to 1913 (pre-World War I) acts as the omitted category. Only two statistically significant results emerge from this exercise. The post-Bretton Woods era has given rise to a lower value for the years to peak at 14.05 years $(\hat{\beta}_0 + \hat{\beta}_{PBW} = 19.09 - 5.04)$ and for the length of cycles at 33.31 years $(\hat{\beta}_0 + \hat{\beta}_{PBW} = 40.36 - 7.05)$.

Figures 35 through 40 display the histograms for all six features of commodity price-cycles pooled across the six product categories. Briefly summarizing, we find that the 1890s, 1930s, and 1960s gave rise to the majority of the start dates for commodity price super-cycles while the 1910s, 1950s, and 1970s gave rise to the majority of the peak dates and the 1930s, 1960s, and 1990s gave rise to the majority of the end dates. Collectively, this suggests a big role for not only American industrialization/urbanization in the late 19th century and European/Japanese re-industrialization/re-urbanization in the mid-20th century but also the World Wars in determining the timing of past super-cycles.

Curiously, as Figures 35 through 40 exclude incomplete cycles, they are silent about currently evolving super-cycles: fully 10 of our 28 commodities demonstrate above-trend real prices starting from 1994 to 1999; of these, 8 are in the energy products and metals categories

(with iron ore critically also making an appearance). In combination with Figure 38 which demonstrates that the majority of super-cycles peak within 20 years of their start date, this suggests that we may already be nearing an end to above-trend real commodity prices in the affected categories.[4] Rounding things out, Figures 39 and 40 respectively suggest that the majority of commodity price super-cycles also evidence complete cycle lengths of less than 40 years and are associated with a very well-behaved distribution of peak values (or peak amplitudes) whereby the majority of super-cycles are associated with positive deviations from trend of 20-40%.

Thus, we have been able to establish a consistent pattern of evidence supportive of: 1.) the contention that real commodity prices might best be characterized by upward trends, especially when evaluated on the basis of the value of production and over the years from 1950; 2.) the notion of commodity price super-cycles in the historical record and present day as well as for a broader range of commodities than has been previously considered in the literature. What is missing, however, is any sense of short-run movements in real commodity prices which may be particularly bearing in determining real commodity price volatility as well as potentially bearing in determining trend growth in commodity dependent economies. It is to these themes which the following sections turn.

III. A Century and a Half of Commodity Price Booms and Busts

Up to this point, we have confronted the standing literature on long-run trends and medium-run cycles through a consideration of 163 years of real commodity price data, finding

[4] Indeed, for at least one commodity, natural gas, real prices have already registered their largest deviation from trend (in 2006). It remains to be seen whether this is symptomatic of other commodity price super-cycles or whether it simply reflects idiosyncratic features of the natural gas industry, in particular, recent breakthroughs in extraction technology.

some results which can be aligned with the received wisdom on commodity price super-cycles, but which offers a slightly contrarian—and dare we say, optimistic—view of the long-run course of real commodity prices. Next, we turn to exploring the short-run dynamics of real commodity prices, in particular, the widely appreciated phenomena of commodity booms and busts.

Naturally, one important question looms large in this context: how exactly should real commodity price booms and busts be characterized? Admittedly, there are a number of ways forward, but one of the most natural is to build on what we have already seen before. Here, we follow the lead of Mendoza and Terrones (2012) and will take as our basic input the deviations from the long-run trend in logged real prices for commodity *i* in time *t*, calling this component d_{it}. Let z_{it} represent the standardized version of d_{it}. Commodity *i* is defined to have experienced a commodity price boom when we identify one or more contiguous dates for which the boom condition $z_{it} > 1.65$ holds (as the value of 1.65 defines the threshold for the 5% upper tail of a standardized normal distribution). A commodity price boom peaks at t^*_{boom} when the maximum value of z_{it} is reached for the set of contiguous dates that satisfy the commodity boom condition. A commodity price boom starts at t^s_{boom} where $t^s_{boom} < t^*_{boom}$ and z_{it} is the smallest, positive observation in a 7-year centered window. A commodity price boom ends at t^e_{boom} where $t^e_{boom} > t^*_{boom}$ and z_{it} is the smallest, positive observation in a 7-year centered window.

Highly symmetric conditions define the opposite set of circumstances as well. Commodity *i* is defined to have experienced a commodity price bust when we identify one or more contiguous dates for which the bust condition $z_{it} < -1.65$ hold (as the value of -1.65 defines the threshold for the 5% lower tail of a standardized normal distribution). A commodity price bust troughs at t^*_{bust} when the minimum value of z_{it} is reached for the set of contiguous dates that satisfy the commodity bust condition. A commodity price bust starts at t^s_{bust} where $t^s_{bust} < t^*_{bust}$ and

z_{it} is the largest, negative observation in a 7-year centered window. A commodity price bust ends at t^{e}_{bust} where $t^{e}_{bust} > t^{*}_{bust}$ and z_{it} is the largest, negative observation in a 7-year centered window.

For illustration purposes, the reader is referred to Figure 41 which presents the evidence on price booms and busts for beef. Again, the log of real beef prices from 1850 to 2012 is chartered along with the episodes of boom and bust determined by the algorithm given above. This indicates the presence of three booms (in green) and two busts (in red) for real beef prices over the past 163 years. Notably, the booms occurred from 1914 to 1921, from 1963 to 1975, and from 1977 to 1981 while the busts occurred from 1862 to 1870 and from 1949 to 1955, suggesting that real commodity price booms do not automatically generate real commodity price busts, nor vice versa. This pattern—or lack thereof—is repeated in Figures 42 through 68 which replicate the same exercise for the 27 remaining real commodity price series at our disposal. Evidence of both common and idiosyncratic real commodity price booms and busts is readily apparent.

Just as in the case of commodity price super-cycles, we provide a full enumeration of the various commodity price booms and busts underlying these figures in Tables 9 through 14. There, six features of commodity price super-cycles across the six products categories are documented, namely their start dates, peak/trough dates, end dates, years to peak/trough, cycle length, and change to peak/trough (the cumulative increase/decrease in real prices from the beginning of the boom/bust to the peak/trough). All told, 79 commodity price booms and 73 commodity price busts are identified.

As before, we attempt to characterize systematic difference in these commodity price booms/busts across time. First, considering commodity price booms alone, a battery of regressions were run using three of their features (years to peak, cycle length, and change to

peak) as dependent variables and a set of indicator variables capturing three different time periods, namely from 1914 to 1945 (interwar), from 1946 to 1971 (Bretton Woods), and from 1972 to 2012 (post-Bretton Woods). Thus, the period from 1850 to 1913 (pre-World War I) acts as the omitted category. In terms of statistically significant results, the post-Bretton Woods era gave rise to a higher value for the years to peak at 4.08 years ($\hat{\beta}_0 + \hat{\beta}_{PBW} = 2.57 + 1.51$). As to the cumulative increase in real prices from the beginning of the boom to the peak, this variable has witnessed a fairly dramatic increase over time ($\hat{\beta}_0 = \hat{\beta}_{PWWI} = 84.43,\ \hat{\beta}_{IW} = 55.45,\ \hat{\beta}_{BW} = 43.77,$ $\hat{\beta}_{PBW} = 114.78$). Thus, the last 40 years have witnessed longer and larger real commodity price booms than the past.

Figures 69 through 74 display the histograms for these six features of commodity price booms pooled across the six product categories. Briefly summarizing, we find that the 1850s, 1910s, and 1970s gave rise to the majority of the start dates for commodity price booms while the 1850/60s, 1910s, and 1970/80s gave rise to the majority of the peak dates and the 1860s, 1910/20s, and 1970/80s gave rise to the majority of the end dates. Collectively, this suggests much shorter years to peak and cycle lengths than in the case of commodity price super-cycles as demonstrated in Figures 72 and 73 with the majority of commodity price booms peaking 1-4 years from their start and being 3-6 years in length. What is also very clear is that commodity price booms are associated with much more pronounced start-to-peak increases in real prices than would be suggested by the evidence on commodity price super-cycles alone: the majority of booms are associated with spikes in real prices of 50-150% with values in excess of 300% and even 1000% not being unheard of.[5]

[5] We also note that currently five commodities are currently experiencing a boom now but are likely past their peak (iron ore, lead, manganese, steel, and tin) while one commodity is currently experiencing a boom now and likely not past its peak (wool).

Turning to the evidence on commodity price busts, another battery of regressions were run using three of their features (years to trough, cycle length, and change to trough) as dependent variables and the same set of indicator variables capturing the three different time periods with the period from 1850 to 1913 (pre-World War I) acting as the omitted category. Once again, the post-Bretton Woods era distinguishes itself with significantly longer years to trough at 4.58 years $(\hat{\beta}_0 + \hat{\beta}_{PBW} = 3.29 + 1.29)$ and cycle length at 8.43 years $(\hat{\beta}_0 + \hat{\beta}_{PBW} = 6.86 + 1.57)$. The post-Bretton Woods era along with the interwar period also distinguished themselves with lower associated values for the change to trough at -52.94% and -57.84, respectively $(\hat{\beta}_0 = -43.00;\ \hat{\beta}_{IW} = -14.84;\ \hat{\beta}_{PBW} = -9.94)$. Thus, the last 40 years have witnessed longer and larger real commodity price busts—in addition to booms—than the past.

Figures 75 through 80 display the histograms for these six features of commodity price busts pooled across the six product categories. Briefly summarizing, we find that the 1920s and 1990s gave rise to the majority of the start dates for commodity price busts while the 1930s and 2000s gave rise to the majority of the trough dates and end dates. Figures 78 and 79 suggest similar dynamics as with commodity price booms with the majority of commodity price busts troughing 1-4 years from their start and being 3-8 years in length. What is also very clear that commodity price busts are likewise associated with very pronounced start-to-trough decreases in real prices: the majority of busts are associated with a cratering in real prices of 45-65%.[6]

In sum, this consideration of commodity price booms and busts gives rise to a much more turbulent view of commodities than provided from the lofty perspective of the long- and medium-run, subject as these commodity booms and busts are to manic price increases and

[6] There are two commodities currently experiencing a bust but likely past their trough (aluminum and hides).

depressive price declines. And this is seemingly a situation which has only exacerbated over time and, thus, promises to do so in the future.

IV. Implications for Commodity Price Volatility and Economic Growth

In light of these results, it may be worth our while to consider what the implications of commodity price booms and busts, in particular their relation to commodity price volatility and from there to economic growth and development. Admittedly, the nexus between volatility and growth is a well-tread path (see Jacks, O'Rourke, and Williamson, 2011 on this point), and this paper does not make any claims to originality in this respect. Rather, by taking the correlation between higher commodity price volatility and lower economic growth as given, we will set a more limited goal in trying to associate commodity price booms and busts with periods of acute commodity price volatility and present some suggestive—but far from convincing—evidence relating commodity price booms and busts to economic growth.

To begin, we can consider once again the deviations from the long-run trend in logged real prices estimated in section II. Taking the standard deviation of these values over the entire span of prices available for each series, we arrive at the figures reported in column (A) of Table 15. There, we can see that the average volatility of these deviations stands at 0.4496 (with a low of 0.2660 for iron ore and a high of 0.9286 for rubber). Next, we calculate the standard deviation of these values over the entire span of prices still available for each series, once we exclude periods of time associated with commodity booms and busts as defined in section III. Thus, we arrive at the figures reported in column (B) of Table 15 with the average volatility of these deviations at 0.3290 (and a low of 0.1706 for iron ore and a high of 0.8310 for rubber). Finally, taking the ratio of (B) to (A), we find that simply by neglecting periods associated with

commodity price booms and busts generates levels of volatility which, on average, stand at 72% of their actual levels (with an associated range of 59% for potash and 95% for bauxite—that is, every commodity demonstrates lower levels of volatility in the absence of commodity price booms and busts).

Of course, this may be an unsatisfying exercise for some in that commodity price booms and busts were defined as those deviations in log prices from their long-run trend which exceeded a certain threshold. Therefore, the association between boom and bust and volatility as defined above may seem too automatic. Table 16 repeats the same exercise but with a different metric for commodity price volatility. Here, we return to a standard measure in the literature, namely the standard deviation of annual changes in logged real prices. Column (A) again reports the value of this metric over the entire span of data by commodity, reporting an average value of 0.1959 (and a low of 0.1348 for bauxite and a high of 0.2955 for sugar). Column (B) again reports the value of this metric over the entire span of data by commodity, once we exclude periods of time associated with commodity booms and busts as defined in section III. Thus, we arrive at an average value of 0.1571 (and a low of 0.0729 for steel and a high of 0.2298 for rubber). Finally, taking the ratio of (B) to (A), we find that simply by neglecting periods associated with commodity price booms and busts generates levels of volatility which, on average, stand at 80% of their actual levels (with an associated range of 48% for steel and 97% for copper—again, every commodity demonstrates lower levels of volatility in the absence of commodity price booms and busts).

In combination then, it is hard to escape the conclusion that commodity price booms and busts as defined in this paper are associated with heightened levels of commodity price volatility, variously defined. But can we push these results even further and draw on the presumed existing

link between commodity price volatility and economic growth? Here, things become a little murkier in that the share of any one commodity in the value of exports—much less to say aggregate production—is typically small apart from some very rare instances. Thus, with booms and busts necessarily being defined at the commodity level, more work is needed in: a.) determining the patterns of commodity production across countries and time; and b.) determining what constitutes an economy-wide commodity price shock, whether boom or bust.

Provided the reader is willing to grant us a very large grain of salt, we are willing to admit the following pieces of antipodean evidence for consideration. Cumulatively, beef, natural gas, wheat, copper, iron ore, and wool represent 85.3 billion AUD, or roughly 29% of Australian goods and services exports. Conveniently, we also have the real price data and information on commodity booms and busts detailed above as they relate to these six items. Defining an economy-wide commodity price shock as the simultaneous occurrence of two or more commodity price booms or busts for the individual commodities, we find that in the post-World War II period Australia has experienced two economy-wide commodity price booms (one very long one from 1971 to 1989 and one newly emergent one from 2005) and one economy-wide commodity price bust (from 1995 to 2004).

Combining this new information with data from Barro and Ursua (2008) on the evolution of GDP per capita from 1950 to 2009, we arrive at Figure 81 where again booms are depicted in green and busts are depicted in red. Here, a consistent—albeit somewhat counterintuitive—story plays out, namely that commodity price booms have been bad for Australia's health while commodity price busts have been good for Australia's health. This admittedly contentious claim can be seen more clearly by considering the evidence on trend growth before and after the initiation of commodity price booms and busts. Thus, in the five years prior to the commodity

boom staring in 1971, trend growth in GDP per capita was 1.96% while trend growth in the five years pursuant to 1971 was 0.49%. Likewise, in the five years prior to the commodity bust staring in 1995, trend growth in GDP per capita was 2.21% while trend growth in the five years pursuant to 1995 was 2.72%. Finally, in the five years prior to the commodity boom staring in 2005, trend growth in GDP per capita was 1.83% while trend growth in the five years pursuant to 2005 was 1.37%.

Undoubtedly, much more could and should be done on the front connecting commodity price booms and busts and their potentially asymmetric linkages to economic growth. At the very least, however, the previous exercise at least points one way forward in using the dating of commodity price booms and busts presented in this paper as the raw material for a more rigorous and hopefully more convincing treatment of the nexus among commodity price booms and busts, commodity price volatility, and economic growth and development.

V. Conclusion

TO BE WRITTEN.

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Appendix

This appendix details the sources of the annual price data used throughout this paper. As such, there are a few key sources of data: the annual Sauerbeck/*Statist* (SS) series dating from 1850 to 1950; the annual Grilli and Yang (GY) series dating from 1900 to 1986; the annual unit values of mineral production provided by the United States Geographical Survey (USGS) dating from 1900 to 2012; the annual Pfaffenzeller, Newbold, and Rayner (PNR) update to Grilli and Yang's series dating from 1987 to 2010; and the monthly International Monetary Fund (IMF), United Nations Conference on Trade and Development (UNCTAD), and World Bank (WB) series dating variously from 1960 and 1980 to 2012. The relevant references are:

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In what follows, a more detailed enumeration of the sources for each individual series is provided.

Aluminum: 1900-2010, GY and PNR; 2011-2012, UNCTAD.
Bauxite: 1900-2012, USGS.
Beef: 1850-1899, SS; 1900-1959, GY; 1960-2012, WB.
Chromium: 1900-2012, USGS.
Cocoa: 1850-1899, Global Financial Data; 1900-1959, GY; 1960-2012, WB.
Coffee: 1850-1899, SS; 1900-1959, GY; 1960-2012, WB.
Copper (wire bars): 1850-1899, SS; 1900-2010, GY and PNR; 2011-2012, UNCTAD.
Corn: 1850-1851, Cole, A.H. (1938), *Wholesale Commodity Prices in the United States, 1700-1861: Statistical Supplement*. Cambridge: Harvard University Press; 1852-1859, Bezanson, A. (1954), *Wholesale Prices in Philadelphia 1852-1896*. Philadelphia: University of Pennsylvania Press; 1860-1999, Global Financial Data; 2000-2012, United States Department of Agriculture National Agricultural Statistics Service.
Cotton: 1850-1899, SS; 1900-1959, GY; 1960-2012, WB.
Hides: 1850-1899, SS; 1900-1959, GY; 1960-2012, UNCTAD.
Iron ore: 1900-2012, USGS.
Lead: 1850-1899, SS; 1900-2010, GY and PNR; 2011-2012, UNCTAD.
Manganese: 1900-2012, USGS.

Natural gas (wellhead): 1900-1921, Carter, S. *et al*. (2006), *Historical Statistics of the United States*; 1922-2012, United States Energy Information Administration.
Nickel: 1850-1899, Carter, S. *et al*. (2006), *Historical Statistics of the United States*; 1900-2012, USGS.
Palm oil: 1850-1899, SS; 1900-1959, GY; 1960-2012, WB.
Petroleum (WTI): 1860-2000, Global Financial Data; 2001-2012, IMF.
Potash: 1900-2012, USGS.
Rice: 1850-1899, SS; 1900-1956, GY; 1957-1979, Global Financial Data; 1980-2012, IMF.
Rubber: 1890-1899, Global Financial Data; 1900-1959, GY; 1960-2012, WB.
Steel (hot-rolled bar): 1897-1998, Carter, S. *et al*. (2006), *Historical Statistics of the United States*; 1999-2012, WB.
Sugar: 1850-1899, SS; 1900-1959, GY; 1960-2012, WB.
Tea: 1850-1899, SS; 1900-1959, GY; 1960-2012, WB.
Tin: 1850-1899, SS; 1900-2010, GY and PNR; 2011-2012, UNCTAD.
Tobacco: 1850-1865, Clark, G. (2005), "The Condition of the Working Class in England, 1209-2004." *Journal of Political Economy* 113(6): 1307-1340; 1866-1899, Carter, S. *et al*. (2006), *Historical Statistics of the United States*; 1900-1959, GY; 1960-2012, WB.
Wheat: 1850-1999, Global Financial Data; 2000-2012, United States Department of Agriculture National Agricultural Statistics Service.
Wool: 1850-1899, SS; 1900-1979, GY; 1980-2012, IMF.
Zinc: 1850-2000, Global Financial Data; 2001-2012, IMF.

Table 1: Value of Production across Commodities			
Commodity	**Production in 2007**	**Units of measurement**	**Value of production (b 2007 USD)**
Animal products			**42.12**
Beef	11.90	Million tonnes	30.97
Hides	7.01	Million tonnes	11.15
Energy products			**2899.76**
Natural gas	2939.30	Billion cubic m.	648.75
Petroleum	29759.55	Million barrels	2251.01
Grains			**430.70**
Corn	789.52	Million tonnes	102.26
Rice	656.97	Million tonnes	218.37
Wheat	612.60	Million tonnes	110.07
Metals			**1303.22**
Aluminum	32.00	Million tonnes	87.92
Copper	15.00	Million tonnes	100.23
Lead	8.10	Million tonnes	20.71
Nickel	1.45	Million tonnes	53.85
Steel	1351.30	Million tonnes	998.34
Tin	0.35	Million tonnes	5.33
Zinc	11.30	Million tonnes	36.84
Minerals			**167.00**
Bauxite	213.00	Million tonnes	6.65
Chromium	7.03	Million tonnes	14.13
Iron ore	2043.00	Million tonnes	121.35
Manganese	12.10	Million tonnes	14.40
Potash	34.90	Million tonnes	10.47
Soft commodities			**189.16**
Cocoa	3.90	Million tonnes	7.63
Coffee	7.44	Million tonnes	17.34
Cotton	25.20	Million tonnes	35.16
Palm oil	39.76	Million tonnes	28.59
Rubber	9.89	Million tonnes	22.65
Sugar	169.00	Million tonnes	37.11
Tea	3.98	Million tonnes	8.43
Tobacco	6.19	Million tonnes	20.51
Wool	1.35	Million tonnes	11.73
Sources: British Geological Survey, World Mineral Production, 2003-2007; BP Energy Yearbook; FAO; USGS.			

Figure 1: Real Animal Product Prices, 1850-2012 (1900=100)

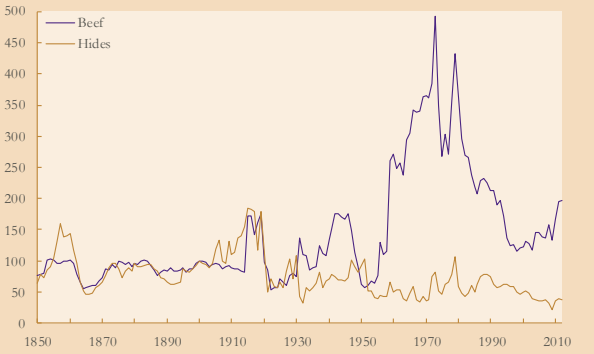


Figure 2: Real Energy Prices, 1860-2012 (1900=100)

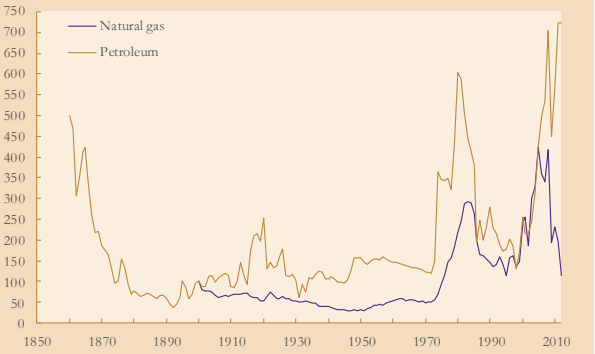


Figure 3: Real Grain Prices, 1850-2012 (1900=100)

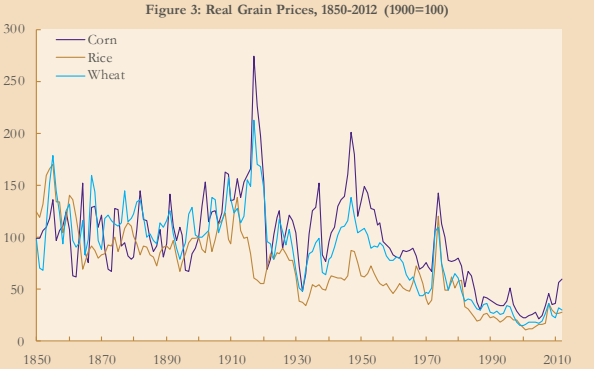


Figure 4a: Real Metal Prices, 1850-2012 (1900=100)

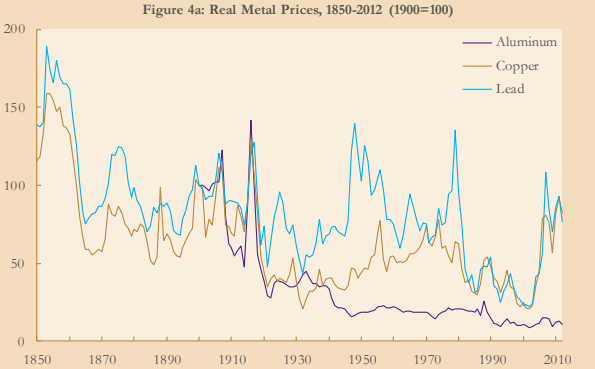


Figure 4b: Real Metal Prices, 1850-2012 (1900=100)

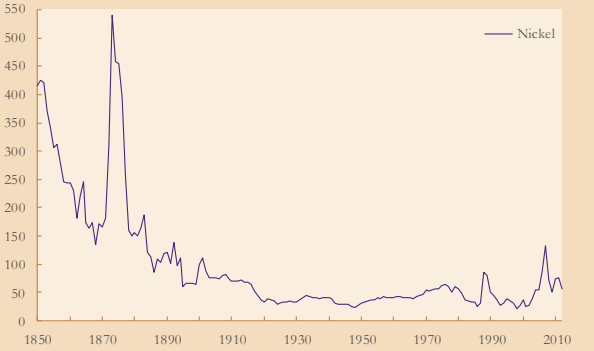


Figure 4c: Real Metal Prices, 1850-2012 (1900=100)

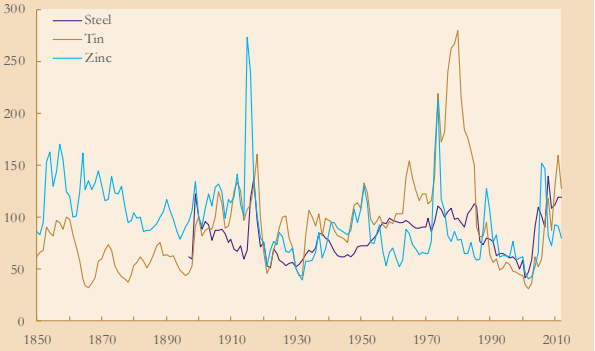


Figure 5a: Real Mineral Prices, 1900-2012 (1900=100)

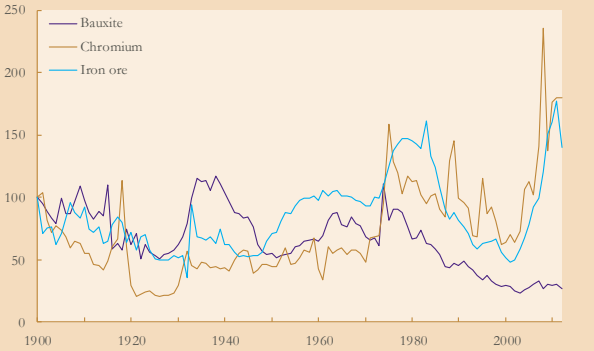
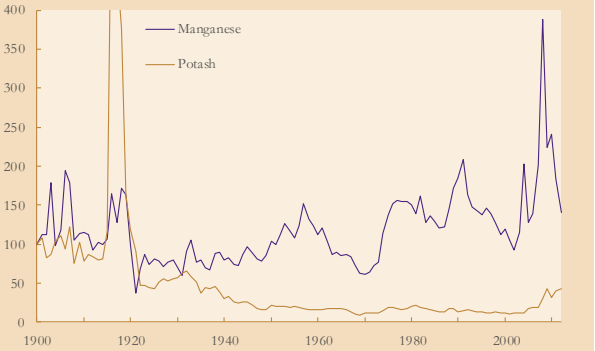


Figure 5b: Real Mineral Prices, 1900-2012 (1900=100)



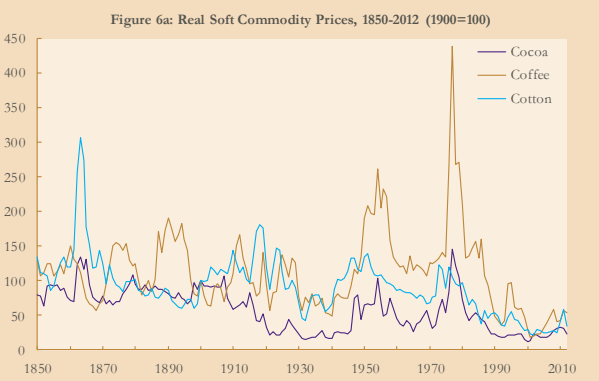


Figure 6a: Real Soft Commodity Prices, 1850-2012 (1900=100)
450
400
350
300
250
200
150
100
50
0
1850
1870
1890
1910
1930
1950
1970
1990
2010
Cocoa
Coffee
Cotton

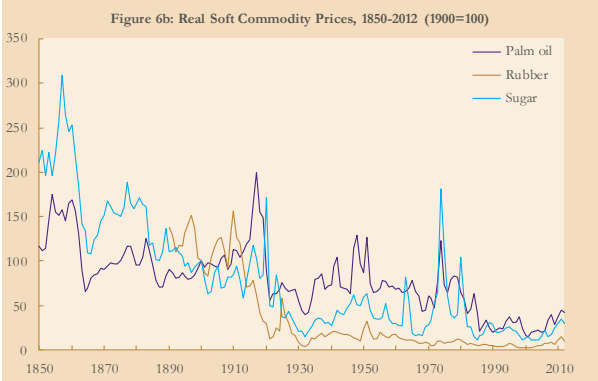


Figure 6b: Real Soft Commodity Prices, 1850-2012 (1900=100)
350
300
250
200
150
100
50
0
1850
1870
1890
1910
1930
1950
1970
1990
2010
Palm oil
Rubber
Sugar

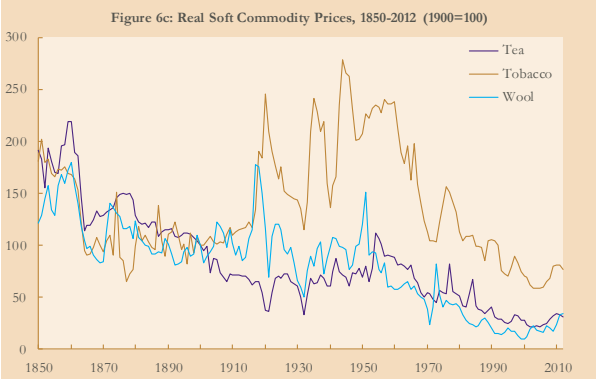


Figure 6c: Real Soft Commodity Prices, 1850-2012 (1900=100)
300
250
200
150
100
50
0
1850
1870
1890
1910
1930
1950
1970
1990
2010
Tea
Tobacco
Wool

Table 2: Cumulative Changes in Prices over the Long-Run				
Commodity	Cumulative change in in price from 1850 (%)	Cumulative change in price from 1900 (%)	Cumulative change in price from 1950 (%)	Cumulative change in price from 1975 (%)
Animal products				
Beef	156.79	97.24	215.99	-26.52
Hides	-41.48	-62.24	-59.35	-18.00
Energy products				
Natural gas	N/A	14.95	250.24	24.58
Petroleum	N/A	623.30	361.55	109.28
Grains				
Corn	-39.73	-40.45	-55.75	-47.16
Rice	-77.76	-72.21	-55.68	-62.53
Wheat	-69.23	-69.83	-71.64	-59.67
Metals				
Aluminum	N/A	-89.38	-41.97	-42.28
Copper	-28.92	-17.68	85.61	38.73
Lead	-44.74	-23.37	-25.52	2.87
Nickel	-86.19	-42.53	88.49	-8.30
Steel	N/A	18.71	62.93	10.60
Tin	107.03	27.84	18.35	-25.61
Zinc	-7.95	-20.57	-26.16	-32.26
Minerals				
Bauxite	N/A	-73.51	-52.22	-67.63
Chromium	N/A	79.76	302.42	13.43
Iron ore	N/A	40.48	98.50	12.56
Manganese	N/A	40.60	36.47	1.98
Potash	N/A	-57.60	97.58	135.82
Soft commodities				
Cocoa	-70.09	-76.10	-63.00	-55.80
Coffee	-58.17	-46.02	-71.63	-60.01
Cotton	-74.04	-65.01	-74.02	-60.75
Palm oil	-63.84	-57.58	-51.00	-41.79
Rubber	N/A	-89.41	-55.86	47.91
Sugar	-86.01	-70.50	-50.40	-74.19
Tea	-83.57	-68.60	-54.45	-41.93
Tobacco	-57.54	-23.04	-62.87	-44.75
Wool	-72.09	-66.18	-71.88	-16.60

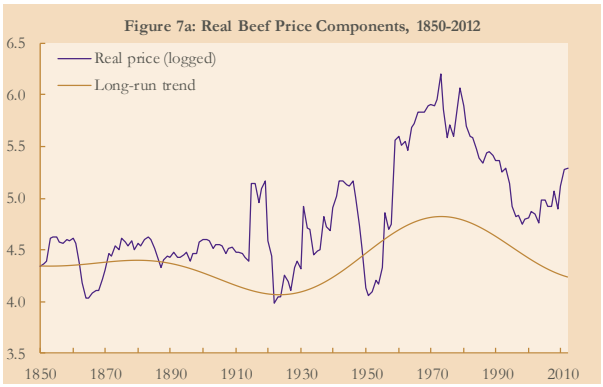


Figure 7a: Real Beef Price Components, 1850-2012
Real price (logged)
Long-run trend
6.5
6.0
5.5
5.0
4.5
4.0
3.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

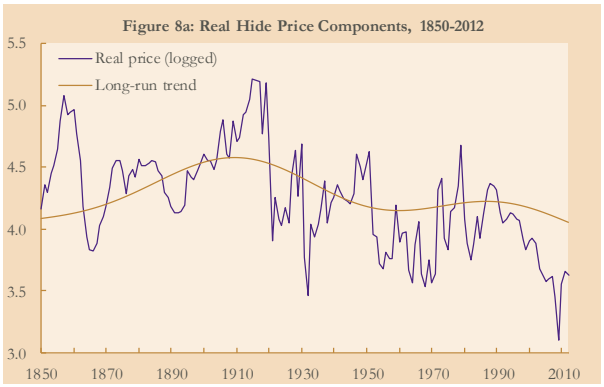


Figure 8a: Real Hide Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

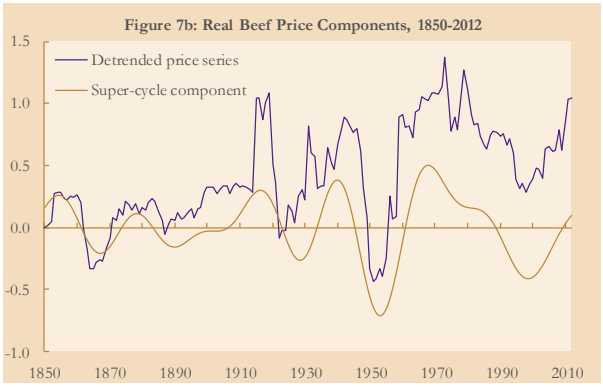


Figure 7b: Real Beef Price Components, 1850-2012
Detrended price series
Super-cycle component
1.5
1.0
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

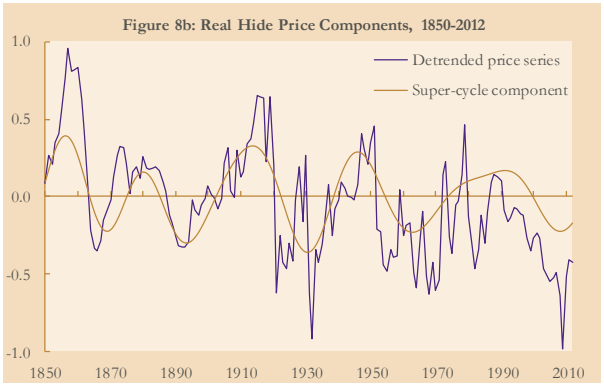


Figure 8b: Real Hide Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

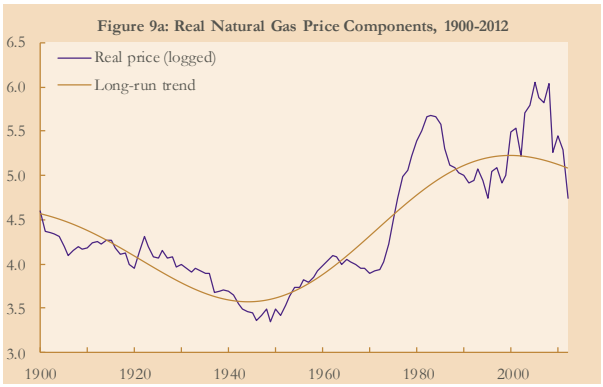


Figure 9a: Real Natural Gas Price Components, 1900-2012
Real price (logged)
Long-run trend
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1900
1920
1940
1960
1980
2000

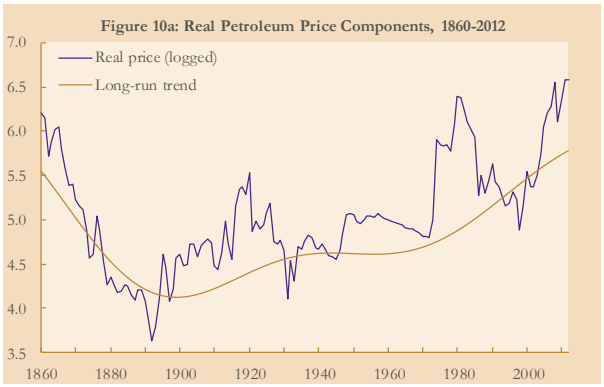


Figure 10a: Real Petroleum Price Components, 1860-2012
Real price (logged)
Long-run trend
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
1860
1880
1900
1920
1940
1960
1980
2000

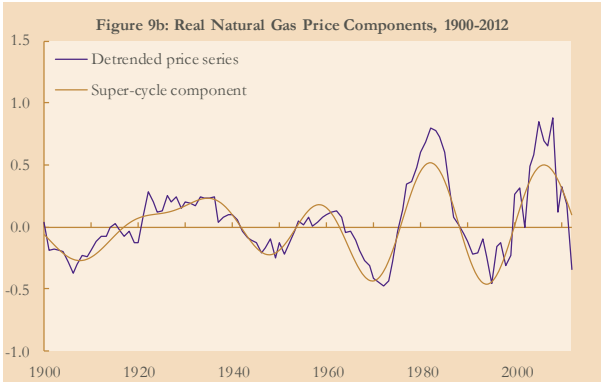


Figure 9b: Real Natural Gas Price Components, 1900-2012
Detrended price series
Super-cycle component
1.5
1.0
0.5
0.0
-0.5
-1.0
1900
1920
1940
1960
1980
2000

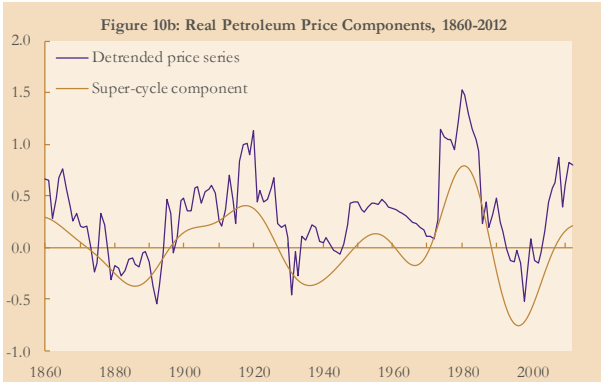


Figure 10b: Real Petroleum Price Components, 1860-2012
Detrended price series
Super-cycle component
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1860
1880
1900
1920
1940
1960
1980
2000

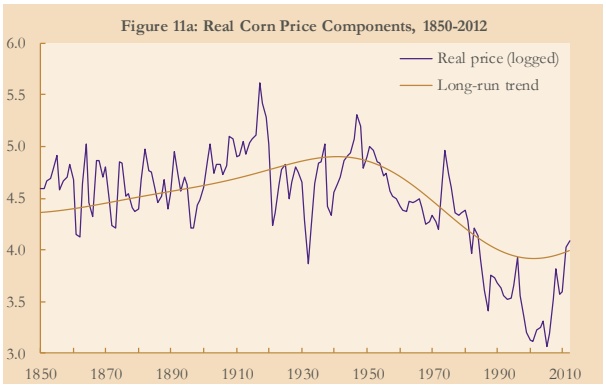


Figure 11a: Real Corn Price Components, 1850-2012
Real price (logged)
Long-run trend
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

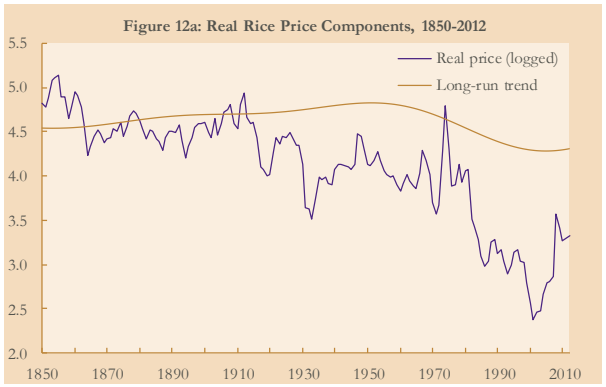


Figure 12a: Real Rice Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

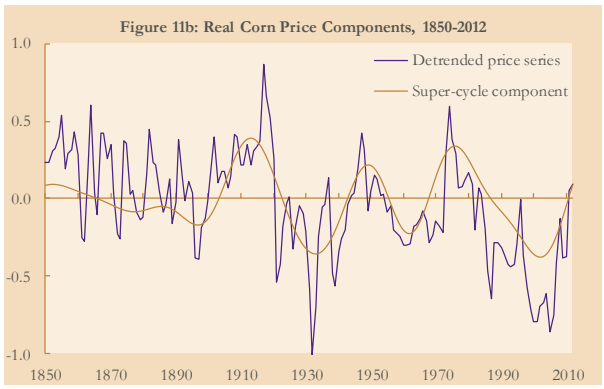


Figure 11b: Real Corn Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

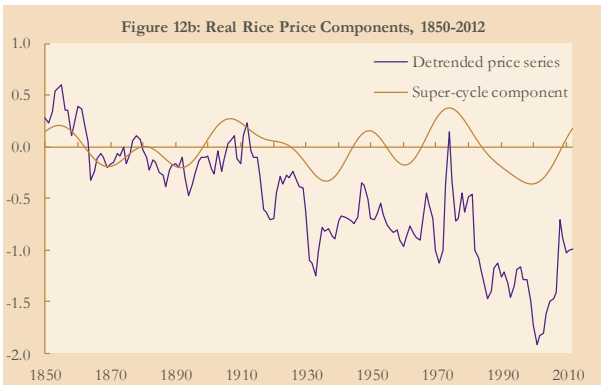


Figure 12b: Real Rice Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

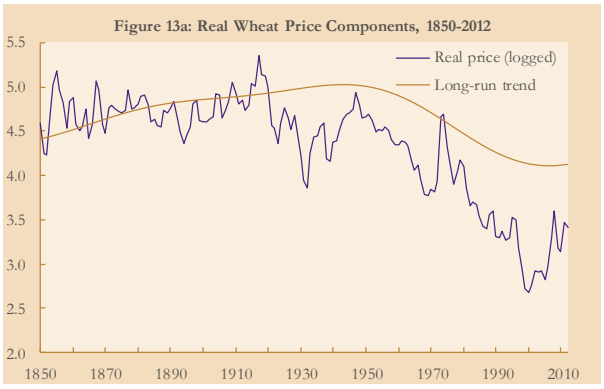


Figure 13a: Real Wheat Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

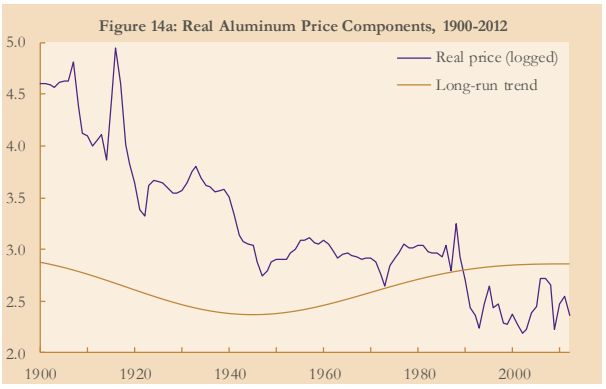


Figure 14a: Real Aluminum Price Components, 1900-2012
Real price (logged)
Long-run trend
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1900
1920
1940
1960
1980
2000

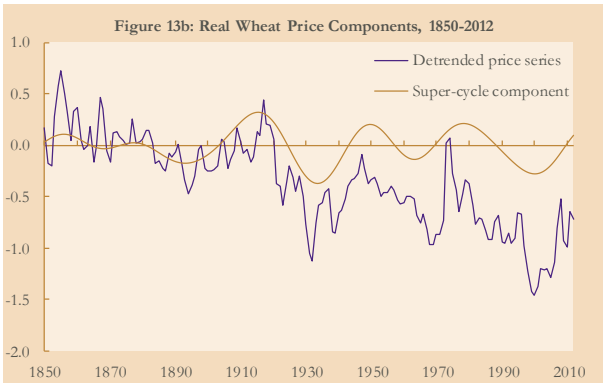


Figure 13b: Real Wheat Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

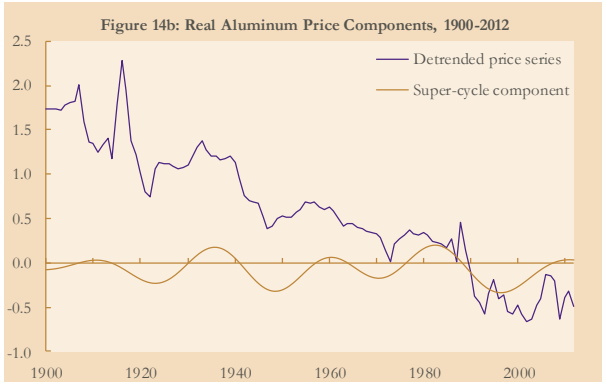


Figure 14b: Real Aluminum Price Components, 1900-2012
Detrended price series
Super-cycle component
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1900
1920
1940
1960
1980
2000

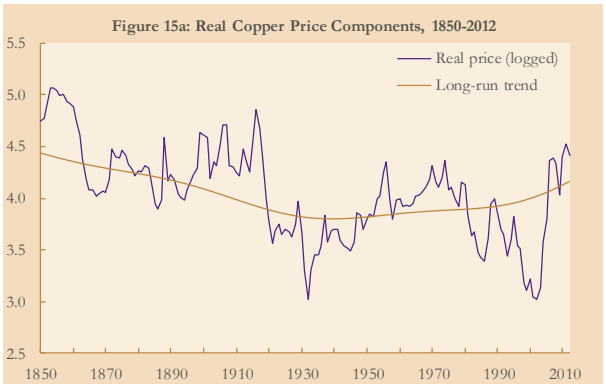


Figure 15a: Real Copper Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
2.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

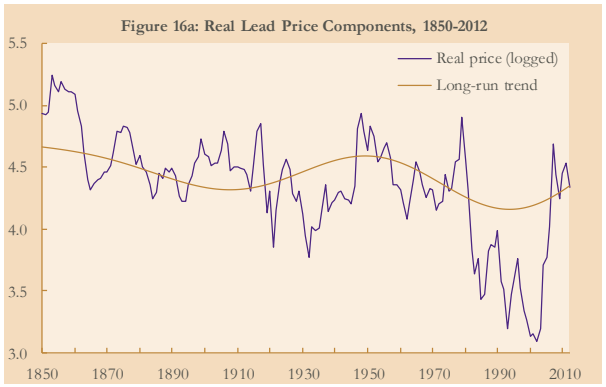


Figure 16a: Real Lead Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

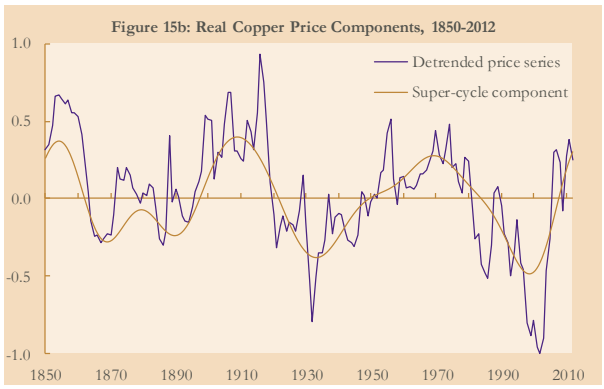


Figure 15b: Real Copper Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

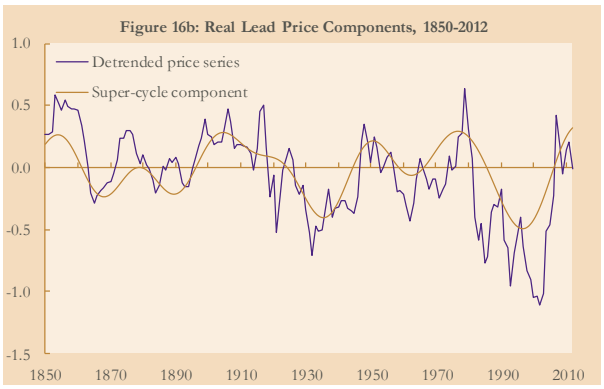


Figure 16b: Real Lead Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

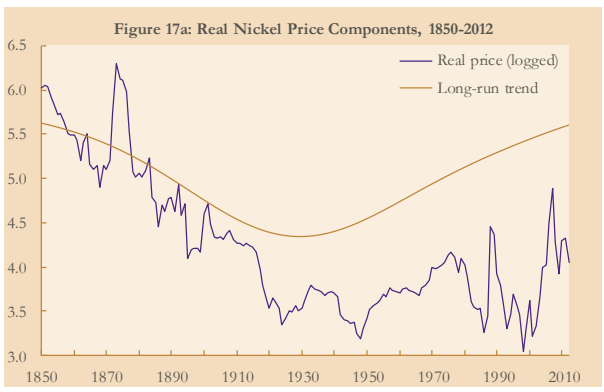


Figure 17a: Real Nickel Price Components, 1850-2012
Real price (logged)
Long-run trend
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

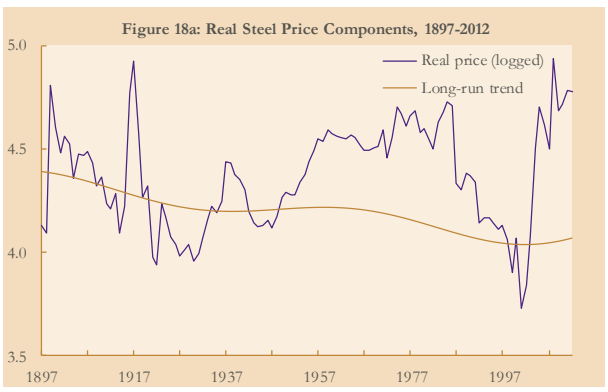


Figure 18a: Real Steel Price Components, 1897-2012
Real price (logged)
Long-run trend
5.0
4.5
4.0
3.5
1897
1917
1937
1957
1977
1997

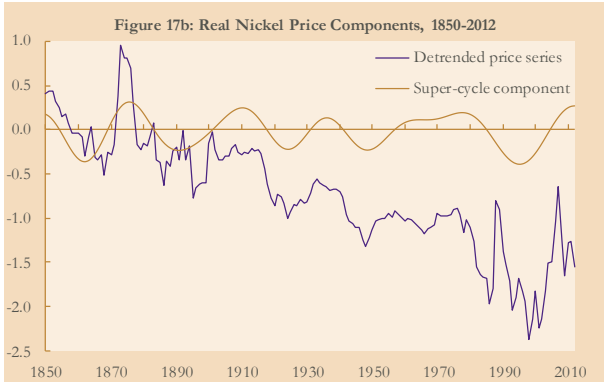


Figure 17b: Real Nickel Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

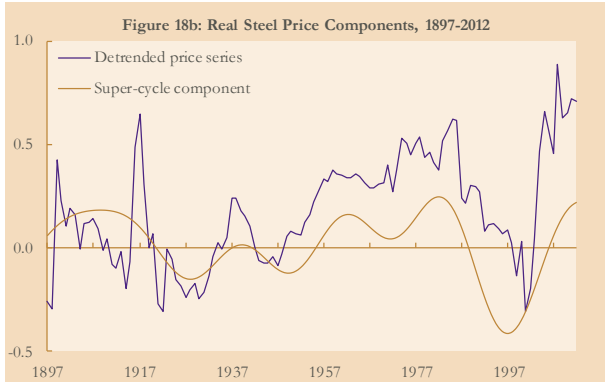


Figure 18b: Real Steel Price Components, 1897-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
1897
1917
1937
1957
1977
1997

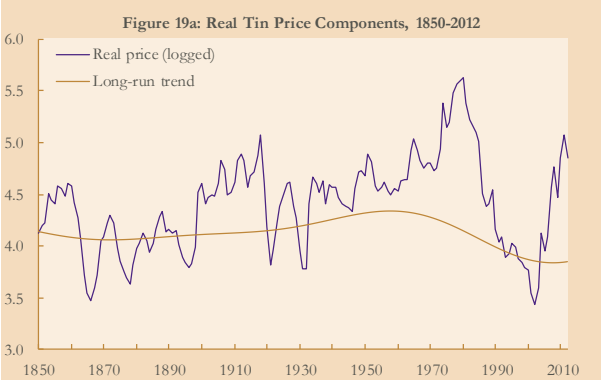


Figure 19a: Real Tin Price Components, 1850-2012
Real price (logged)
Long-run trend
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

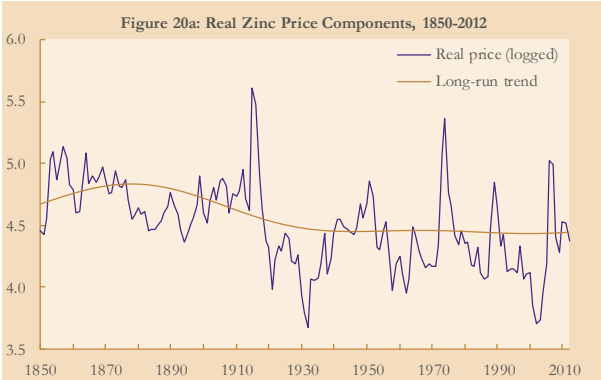


Figure 20a: Real Zinc Price Components, 1850-2012
Real price (logged)
Long-run trend
6.0
5.5
5.0
4.5
4.0
3.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

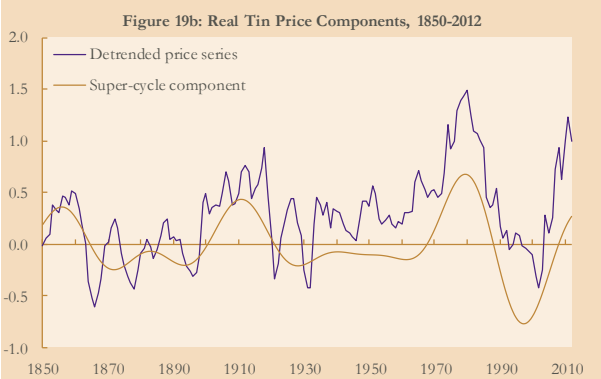


Figure 19b: Real Tin Price Components, 1850-2012
Detrended price series
Super-cycle component
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

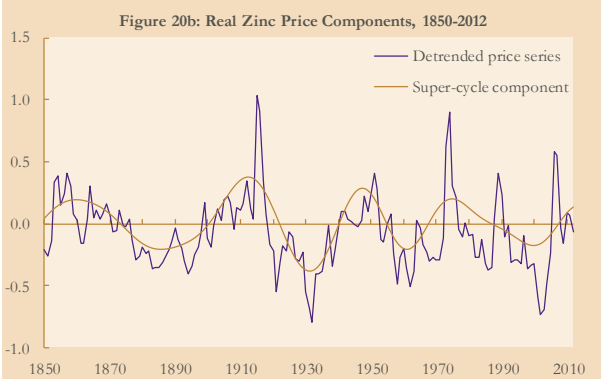


Figure 20b: Real Zinc Price Components, 1850-2012
Detrended price series
Super-cycle component
1.5
1.0
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

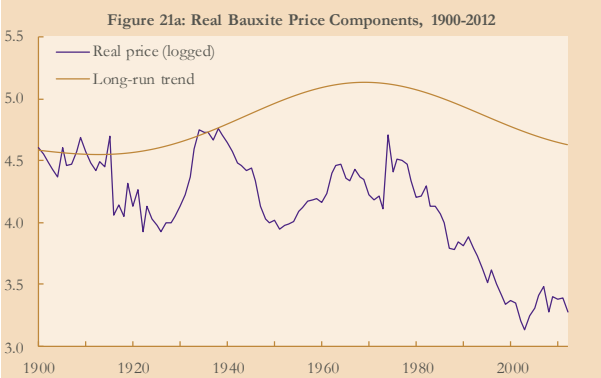


Figure 21a: Real Bauxite Price Components, 1900-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
1900
1920
1940
1960
1980
2000

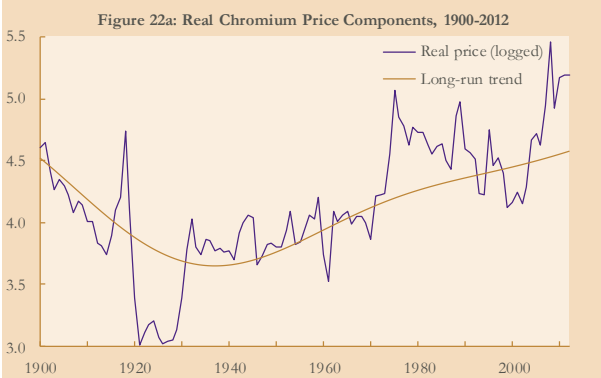


Figure 22a: Real Chromium Price Components, 1900-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
1900
1920
1940
1960
1980
2000

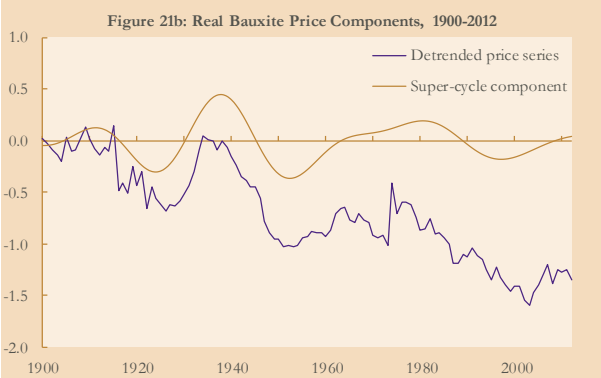


Figure 21b: Real Bauxite Price Components, 1900-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1900
1920
1940
1960
1980
2000

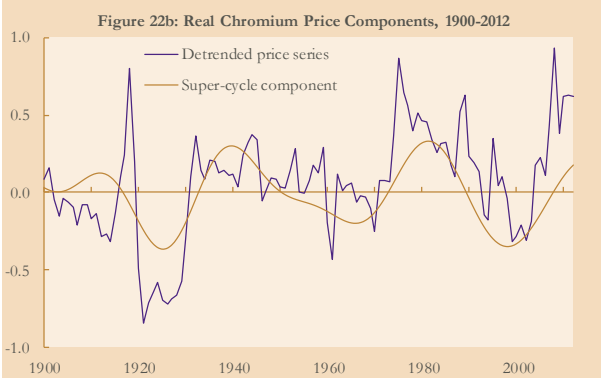


Figure 22b: Real Chromium Price Components, 1900-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
1900
1920
1940
1960
1980
2000

Figure 23a: Real Iron Ore Price Components, 1900-2012

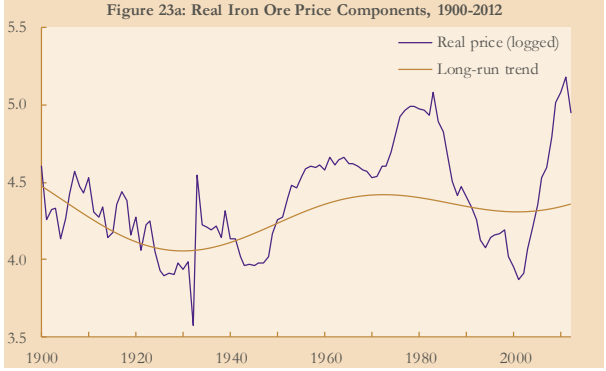


Figure 24a: Real Manganese Price Components, 1900-2012

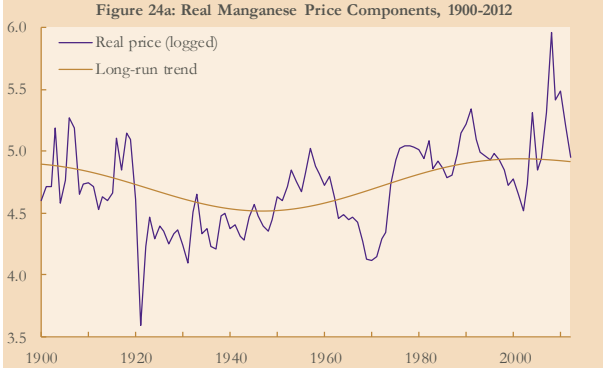


Figure 23b: Real Iron Ore Price Components, 1900-2012

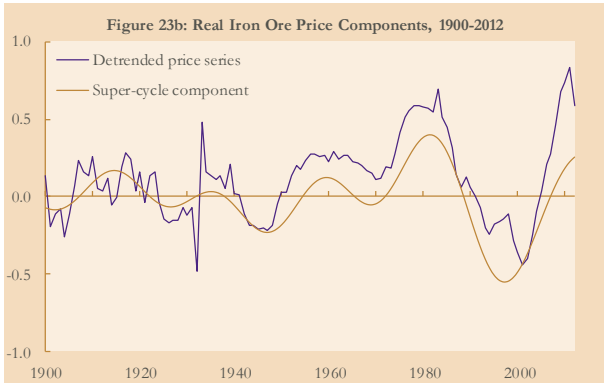


Figure 24b: Real Manganese Price Components, 1900-2012

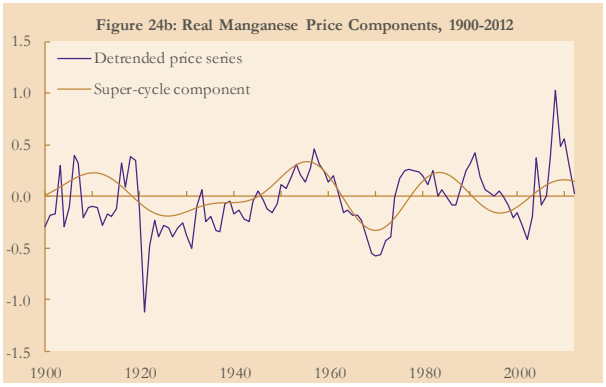


Figure 25a: Real Potash Price Components, 1900-2012

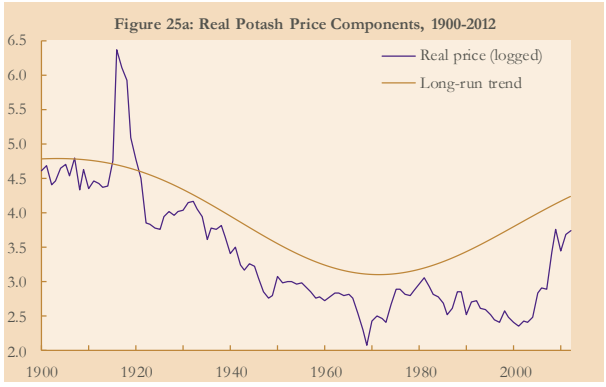


Figure 26a: Real Cocoa Price Components, 1850-2012

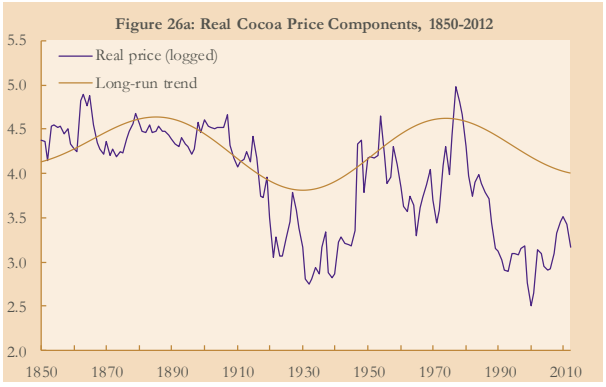


Figure 25b: Real Potash Price Components, 1900-2012

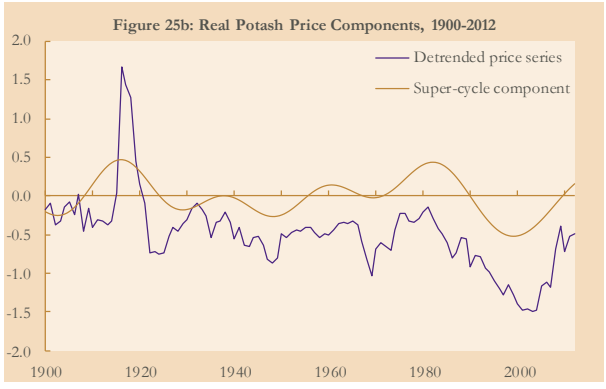
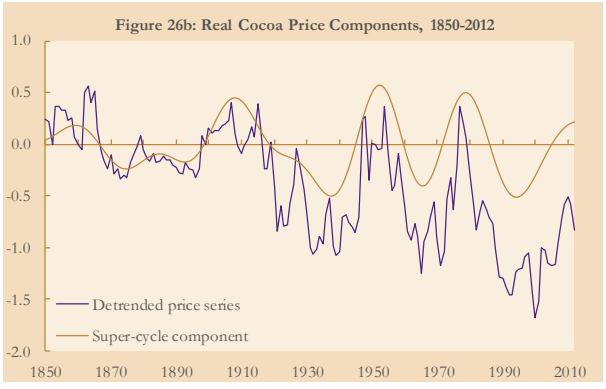


Figure 26b: Real Cocoa Price Components, 1850-2012



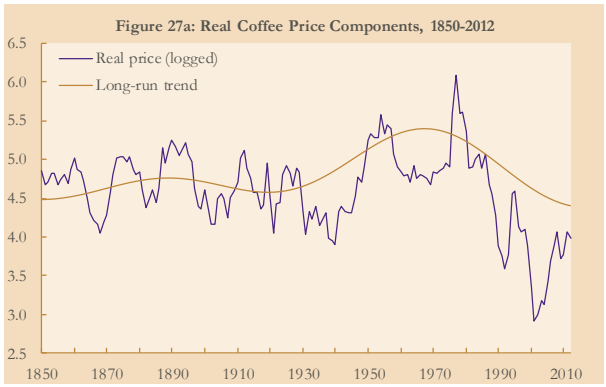


Figure 27a: Real Coffee Price Components, 1850-2012
Real price (logged)
Long-run trend
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

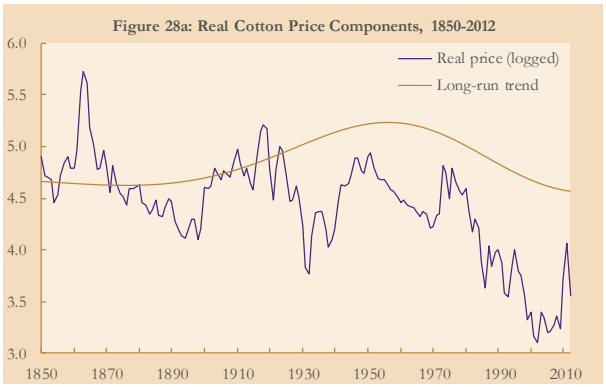


Figure 28a: Real Cotton Price Components, 1850-2012
Real price (logged)
Long-run trend
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

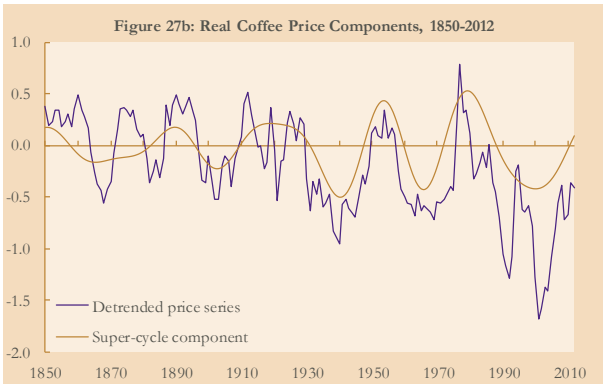


Figure 27b: Real Coffee Price Components, 1850-2012
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Detrended price series
Super-cycle component
1850
1870
1890
1910
1930
1950
1970
1990
2010

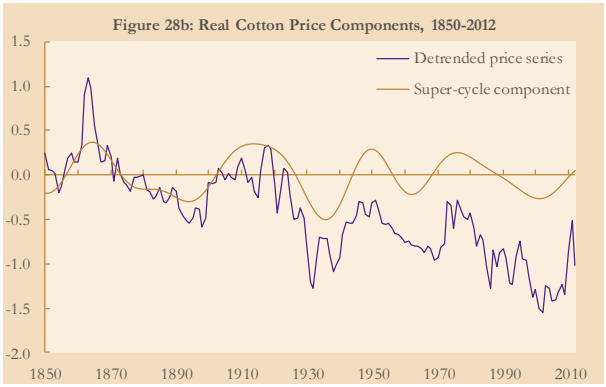


Figure 28b: Real Cotton Price Components, 1850-2012
Detrended price series
Super-cycle component
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

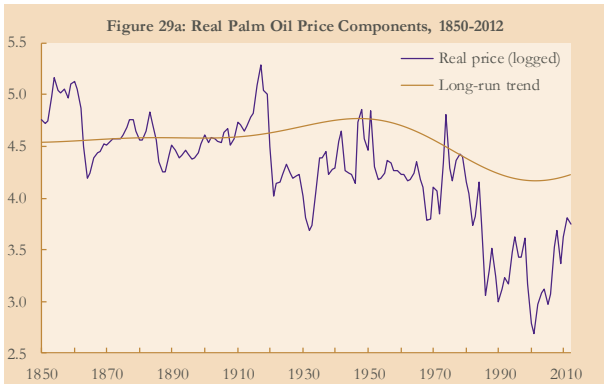


Figure 29a: Real Palm Oil Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
2.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

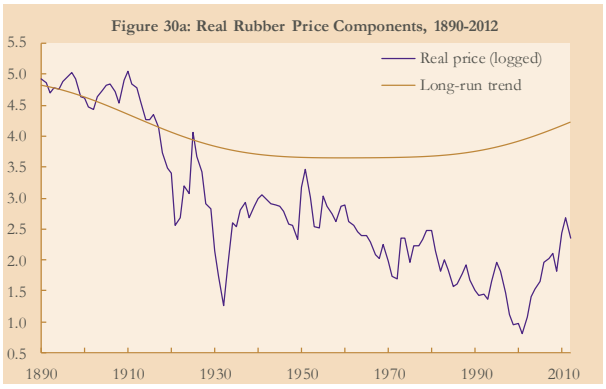


Figure 30a: Real Rubber Price Components, 1890-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1890
1910
1930
1950
1970
1990
2010

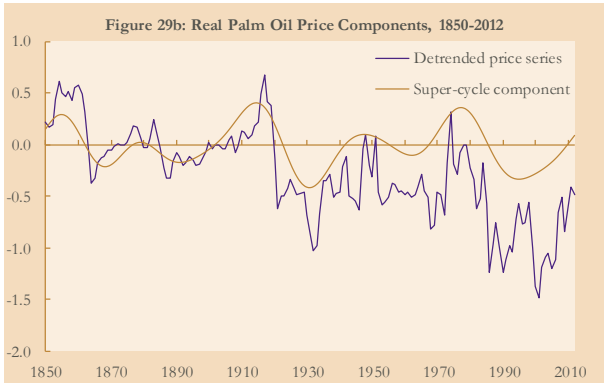


Figure 29b: Real Palm Oil Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

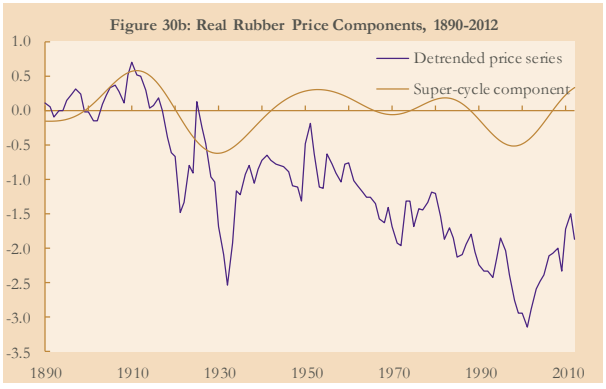


Figure 30b: Real Rubber Price Components, 1890-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
1890
1910
1930
1950
1970
1990
2010

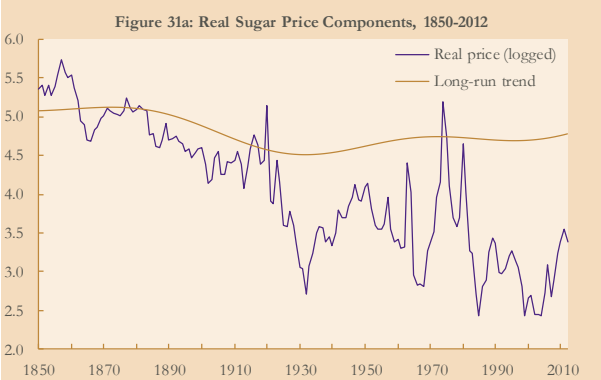


Figure 31a: Real Sugar Price Components, 1850-2012
Real price (logged)
Long-run trend
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

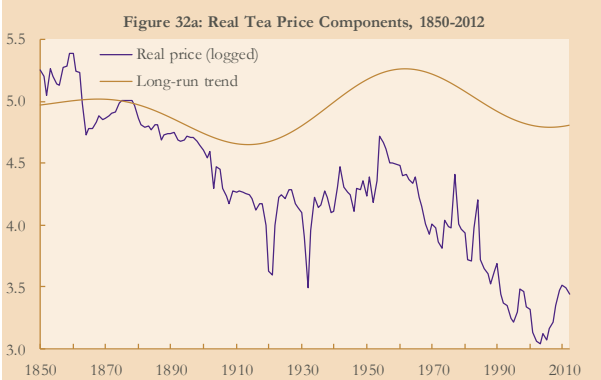


Figure 32a: Real Tea Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

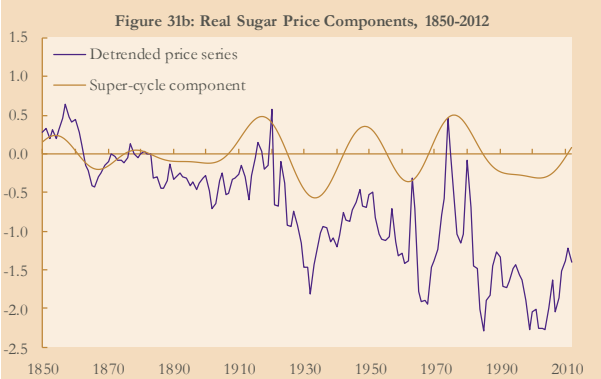


Figure 31b: Real Sugar Price Components, 1850-2012
Detrended price series
Super-cycle component
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

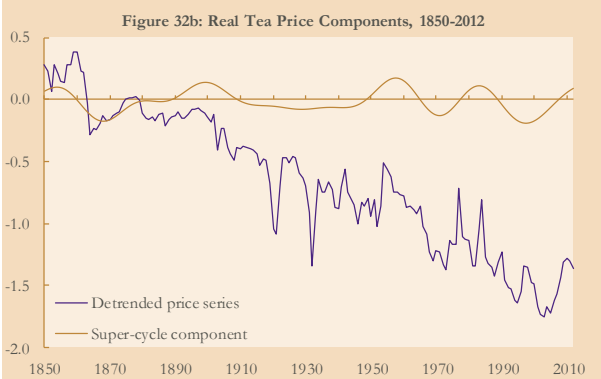


Figure 32b: Real Tea Price Components, 1850-2012
Detrended price series
Super-cycle component
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

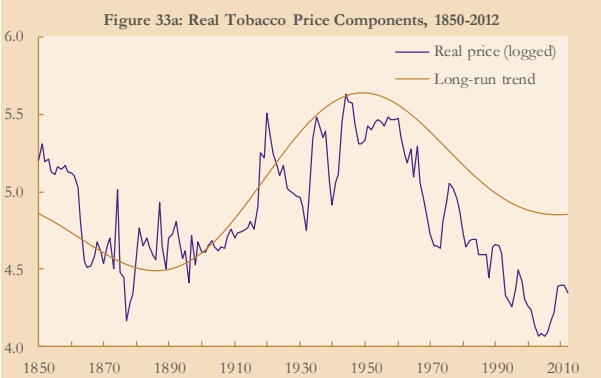


Figure 33a: Real Tobacco Price Components, 1850-2012
Real price (logged)
Long-run trend
6.0
5.5
5.0
4.5
4.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

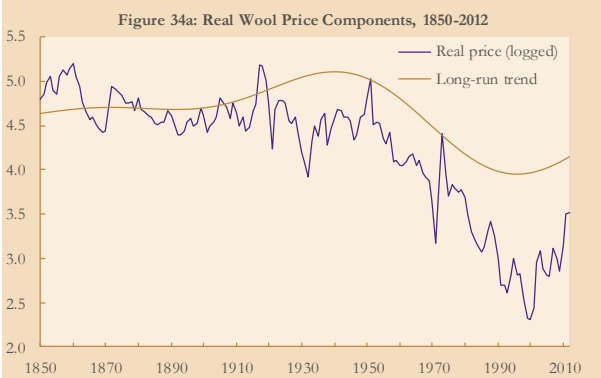


Figure 34a: Real Wool Price Components, 1850-2012
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

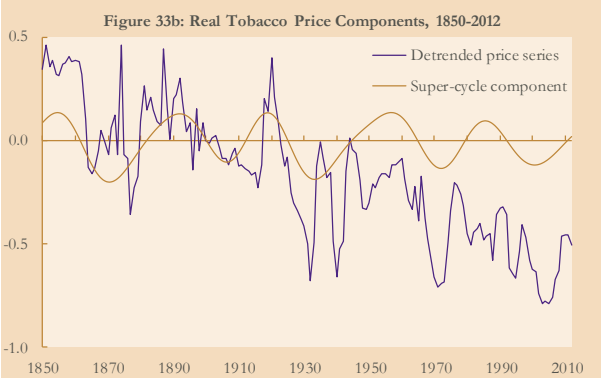


Figure 33b: Real Tobacco Price Components, 1850-2012
Detrended price series
Super-cycle component
0.5
0.0
-0.5
-1.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

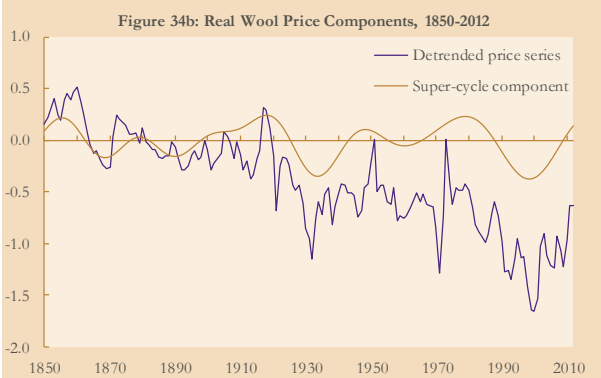


Figure 34b: Real Wool Price Components, 1850-2012
Detrended price series
Super-cycle component
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

Table 3: Dates of Commodity Price Supercycles for Animal Products

Commodity	Start date	Peak	Trough	Years to peak	Cycle length	Peak value (%)
Beef	1850?	1854	1867	4?	17?	25.90
Hides	1850?	1856	1869	6?	19?	39.15
Beef	1890	1916	1929	26	39	29.87
Hides	1893	1914	1931	21	39	32.64
Beef	1929	1940	1953	11	24	38.28
Hides	1931	1946	1963	15	32	28.74
Beef	1953	1968	1999	15	46	50.14

Table 4: Dates of Commodity Price Supercycles for Energy Products

Commodity	Start date	Peak	Trough	Years to peak	Cycle length	Peak value (%)
Petroleum	1860?	1860	1886	0?	26?	29.25
Petroleum	1886	1918	1936	32	50	40.57
Natural gas	1908	1935	1948	27	40	23.10
Petroleum	1967	1981	1996	14	29	79.08
Natural gas	1970	1982	1994	12	24	51.81
Natural gas	1994	2006	-	12	-	50.04
Petroleum	1996	-	-	-	-	21.11

Table 5: Dates of Commodity Price Supercycles for Grains

Commodity	Start date	Peak	Trough	Years to peak	Cycle length	Peak value (%)
Rice	1850?	1854	1869	4?	19?	20.76
Rice	1892	1907	1936	15	44	27.31
Wheat	1893	1915	1934	22	41	32.12
Corn	1897	1913	1933	16	36	38.94
Corn	1933	1949	1962	16	29	21.66
Wheat	1934	1950	1963	16	29	20.29
Rice	1960	1974	1999	14	39	37.74
Corn	1962	1976	2002	14	40	33.80
Wheat	1963	1978	2000	15	37	21.21

Table 6: Dates of Commodity Price Supercycles for Metals						
Commodity	Start date	Peak	Trough	Years to peak	Cycle length	Peak value (%)
Copper	1850?	1854	1869	4?	19?	37.07
Lead	1850?	1854	1868	4?	18?	26.40
Tin	1850?	1856	1872	6?	22?	36.06
Nickel	1862	1876	1891	14	29	31.08
Zinc	1886	1912	1931	26	45	37.58
Lead	1889	1905	1935	16	46	28.26
Copper	1890	1909	1933	19	43	39.71
Nickel	1891	1910	1924	19	33	24.57
Tin	1893	1911	1928	18	35	43.45
Zinc	1931	1947	1961	16	30	28.54
Copper	1933	1969	1999	36	66	27.61
Lead	1935	1951	1962	16	27	21.44
Tin	1961	1979	1997	18	36	67.59
Zinc	1961	1975	2000	14	39	20.03
Lead	1962	1977	1997	15	35	29.24
Steel	1972	1982	1997	10	25	24.56
Nickel	1995	-	-	-	-	26.83
Lead	1997	-	-	-	-	32.05
Steel	1997	-	-	-	-	21.85
Tin	1997	-	-	-	-	26.97
Copper	1999	-	-	-	-	30.17

Table 7: Dates of Commodity Price Supercycles for Minerals						
Commodity	Start date	Peak	Trough	Years to peak	Cycle length	Peak value (%)
Manganese	1900?	1910	1926	10?	26?	22.92
Potash	1903	1916	1929	13	26	46.87
Bauxite	1924	1938	1952	14	28	44.69
Chromium	1925	1940	1966	15	41	29.90
Manganese	1926	1955	1970	29	44	33.66
Chromium	1966	1981	1998	15	32	33.00
Iron ore	1969	1981	1997	12	28	39.73
Potash	1969	1982	1999	13	30	43.57
Manganese	1970	1983	1996	13	26	23.13
Iron ore	1997	-	-	-	-	25.44

Table 8: Dates of Commodity Price Supercycles for Soft Commodities						
Commodity	Start date	Peak	Trough	Years to peak	Cycle length	Peak value (%)
Cotton	1850?	1864	1894	14?	44?	36.79
Palm oil	1850?	1855	1868	5?	18?	29.23
Sugar	1850?	1854	1867	4?	17?	23.76
Wool	1850?	1855	1869	5?	19?	21.71
Wool	1890	1918	1934	28	44	24.25
Palm oil	1891	1914	1931	23	40	40.47
Rubber	1891	1911	1930	20	39	57.96
Cocoa	1893	1908	1937	15	44	44.99
Cotton	1894	1914	1936	20	42	35.04
Sugar	1901	1917	1933	16	32	48.13
Coffee	1903	1919	1940	16	37	21.42
Rubber	1930	1953	1970	23	40	30.45
Sugar	1933	1949	1962	16	29	35.28
Cotton	1936	1950	1962	14	26	28.99
Cocoa	1937	1952	1966	15	29	57.14
Coffee	1940	1954	1966	14	26	43.28
Wool	1960	1979	1999	19	39	23.15
Cotton	1962	1976	2001	14	39	25.16
Palm oil	1962	1977	1995	15	33	35.99
Sugar	1962	1976	2002	14	40	50.02
Cocoa	1966	1979	1994	13	28	50.00
Coffee	1966	1979	2000	13	34	52.94
Cocoa	1994	-	-	-	-	21.69
Rubber	1998	-	-	-	-	33.39

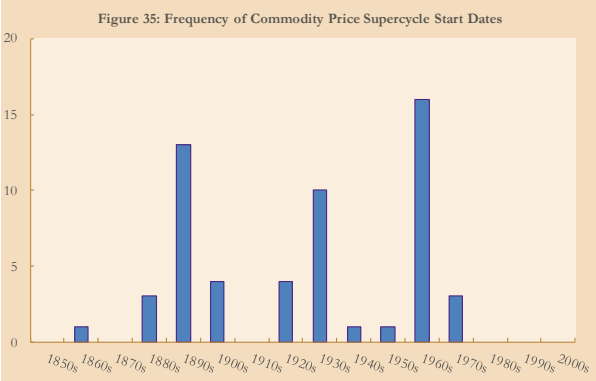


Figure 35: Frequency of Commodity Price Supercycle Start Dates
20
15
10
5
0
1850s 1860s 1870s 1880s 1890s 1900s 1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s

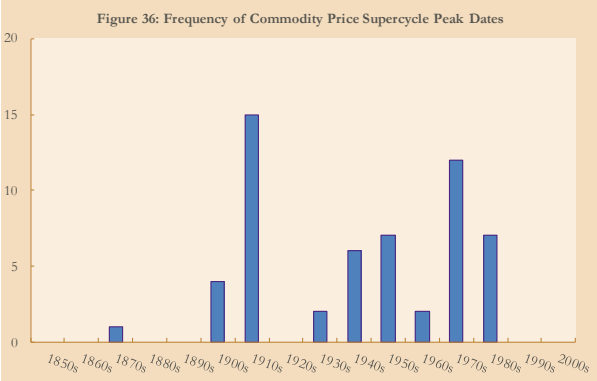


Figure 36: Frequency of Commodity Price Supercycle Peak Dates
20
15
10
5
0
1850s 1860s 1870s 1880s 1890s 1900s 1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s

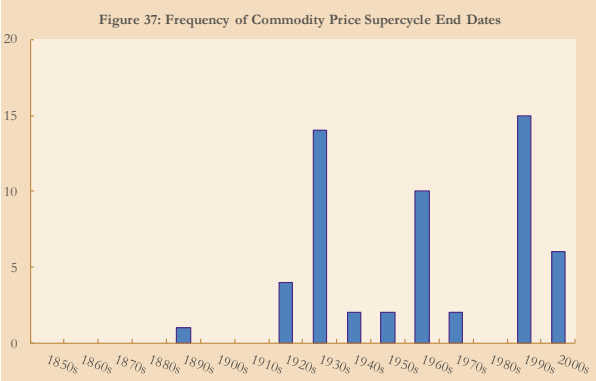


Figure 37: Frequency of Commodity Price Supercycle End Dates
20
15
10
5
0
1850s 1860s 1870s 1880s 1890s 1900s 1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s

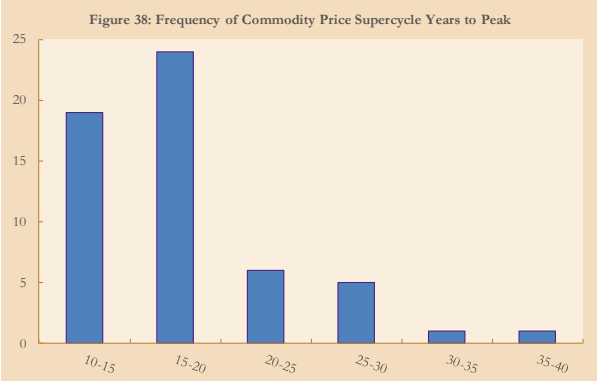


Figure 38: Frequency of Commodity Price Supercycle Years to Peak
25
20
15
10
5
0
10-15 15-20 20-25 25-30 30-35 35-40

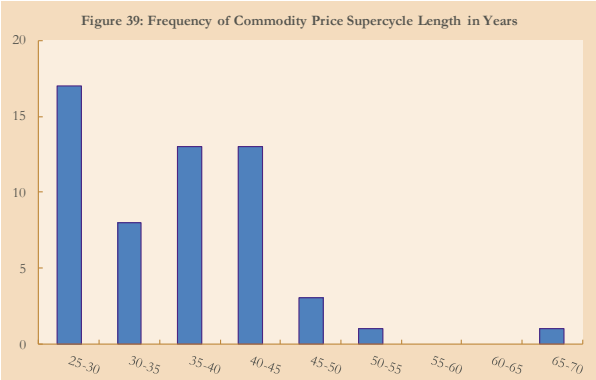


Figure 39: Frequency of Commodity Price Supercycle Length in Years
20
15
10
5
0
25-30 30-35 35-40 40-45 45-50 50-55 55-60 60-65 65-70

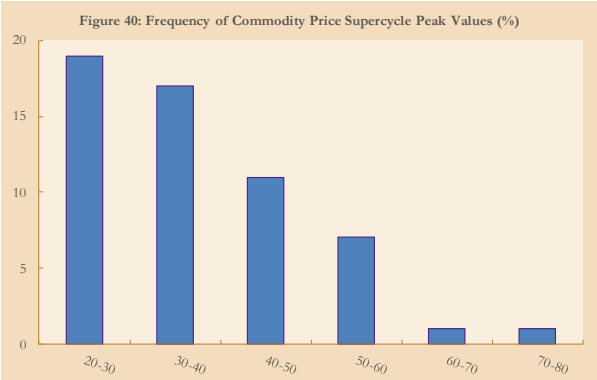


Figure 40: Frequency of Commodity Price Supercycle Peak Values (%)
20
15
10
5
0
20-30 30-40 40-50 50-60 60-70 70-80

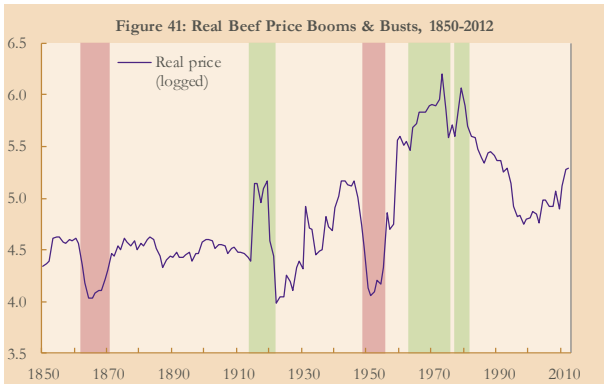


Figure 41: Real Beef Price Booms & Busts, 1850-2012
Real price (logged)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
1850
1870
1890
1910
1930
1950
1970
1990
2010

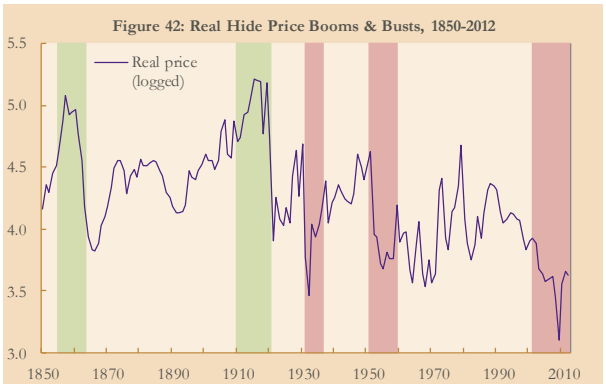


Figure 42: Real Hide Price Booms & Busts, 1850-2012
Real price (logged)
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

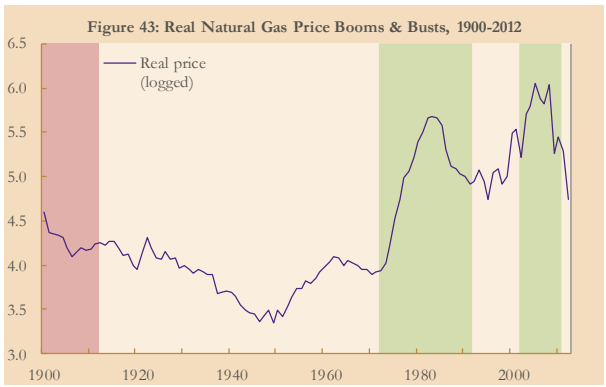


Figure 43: Real Natural Gas Price Booms & Busts, 1900-2012
Real price (logged)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1900
1920
1940
1960
1980
2000

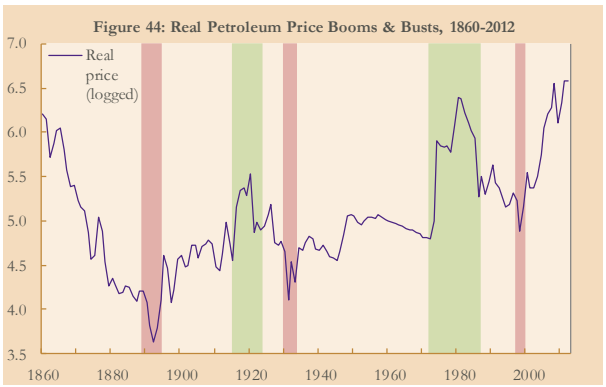


Figure 44: Real Petroleum Price Booms & Busts, 1860-2012
Real price (logged)
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
1860
1880
1900
1920
1940
1960
1980
2000

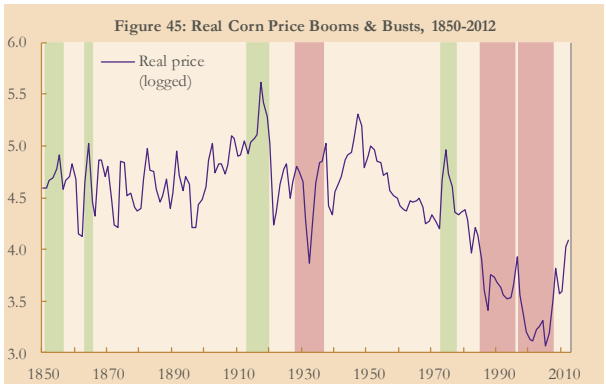


Figure 45: Real Corn Price Booms & Busts, 1850-2012
Real price (logged)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

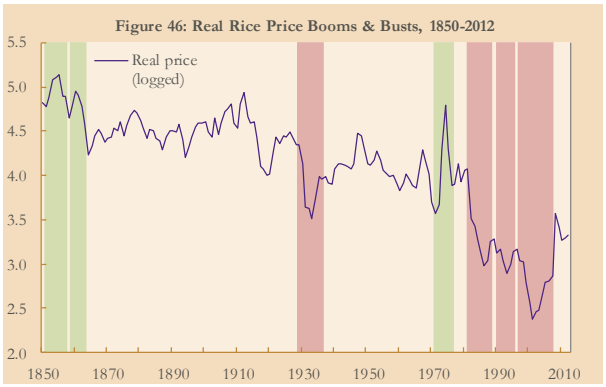


Figure 46: Real Rice Price Booms & Busts, 1850-2012
Real price (logged)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

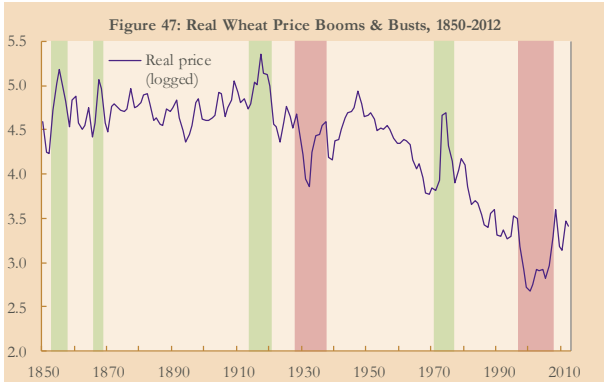


Figure 47: Real Wheat Price Booms & Busts, 1850-2012
Real price (logged)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1850
1870
1890
1910
1930
1950
1970
1990
2010

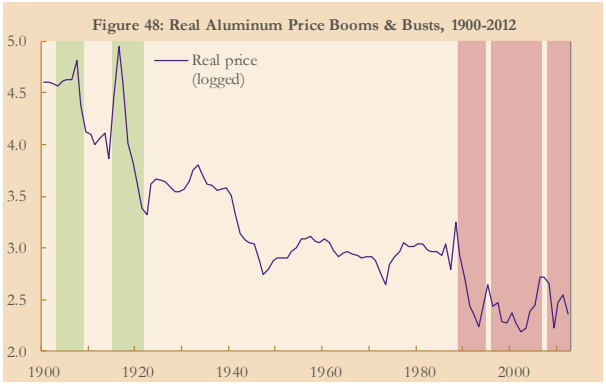


Figure 48: Real Aluminum Price Booms & Busts, 1900-2012
Real price (logged)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1900
1920
1940
1960
1980
2000

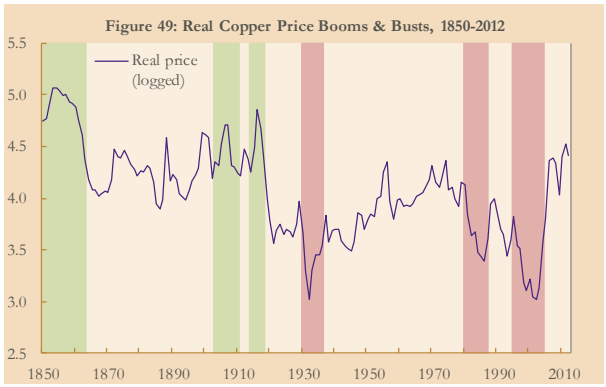


Figure 49: Real Copper Price Booms & Busts, 1850-2012

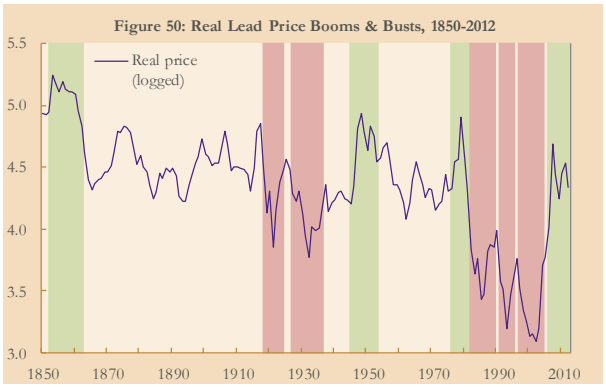


Figure 50: Real Lead Price Booms & Busts, 1850-2012

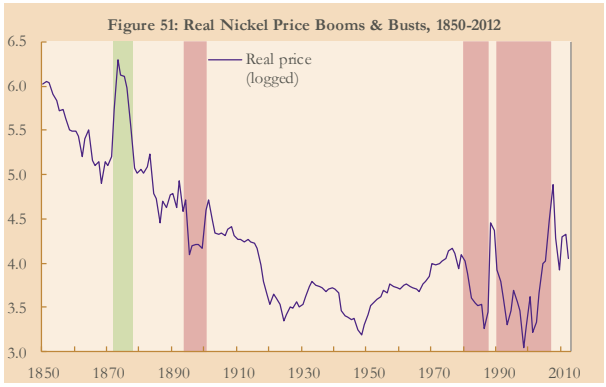


Figure 51: Real Nickel Price Booms & Busts, 1850-2012

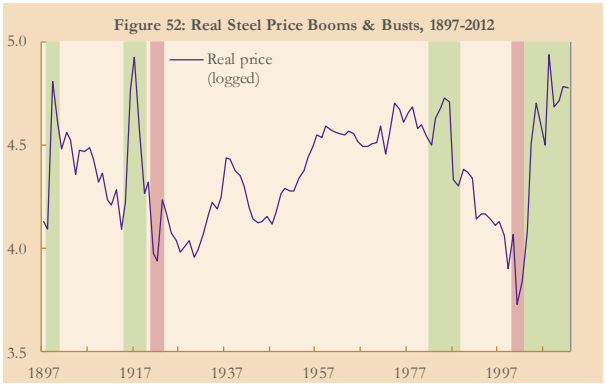


Figure 52: Real Steel Price Booms & Busts, 1897-2012

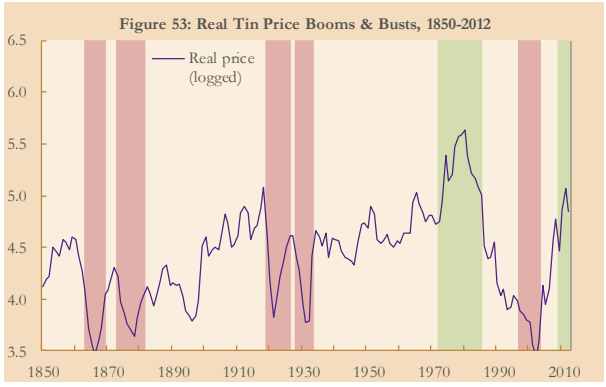


Figure 53: Real Tin Price Booms & Busts, 1850-2012

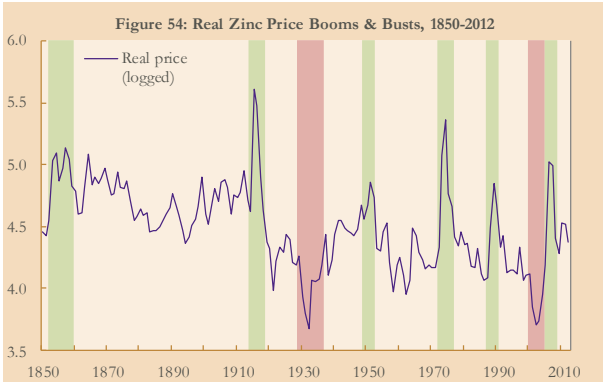


Figure 54: Real Zinc Price Booms & Busts, 1850-2012

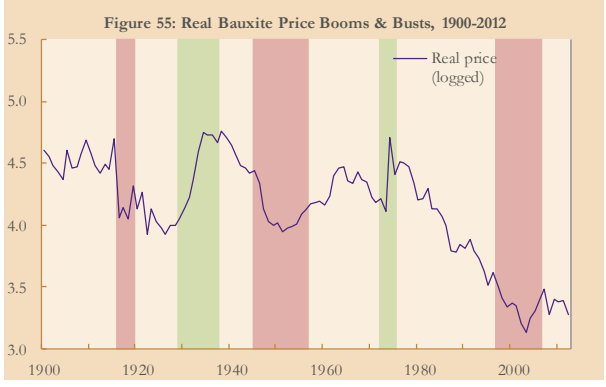


Figure 55: Real Bauxite Price Booms & Busts, 1900-2012

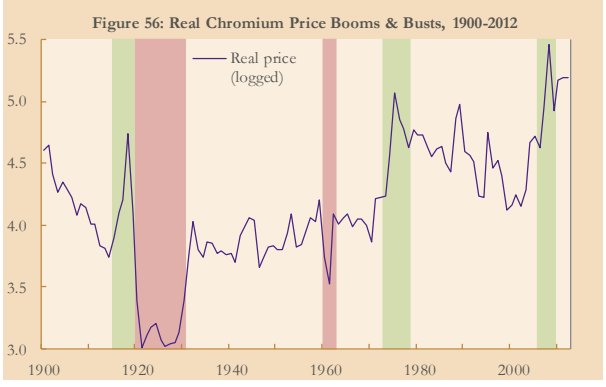


Figure 56: Real Chromium Price Booms & Busts, 1900-2012

Figure 57: Real Iron Ore Price Booms & Busts, 1900-2012

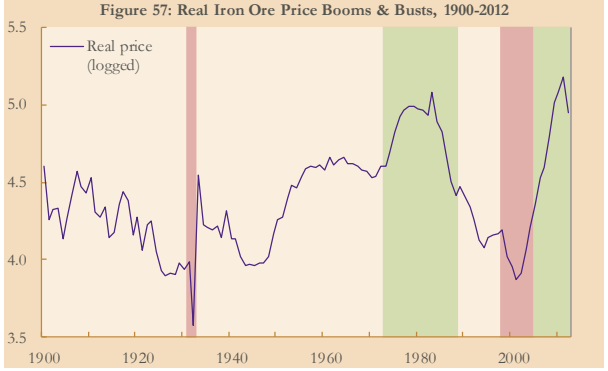


Figure 58: Real Manganese Price Booms & Busts, 1900-2012

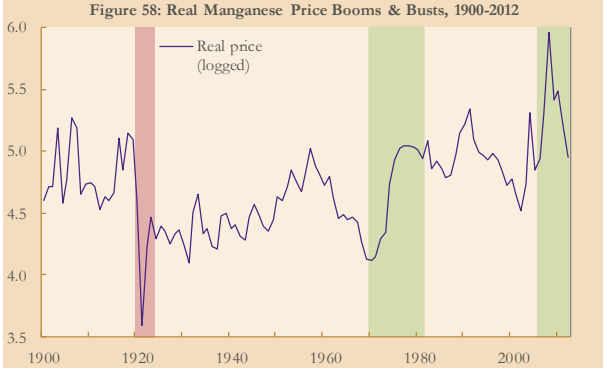


Figure 59: Real Potash Price Booms & Busts, 1900-2012

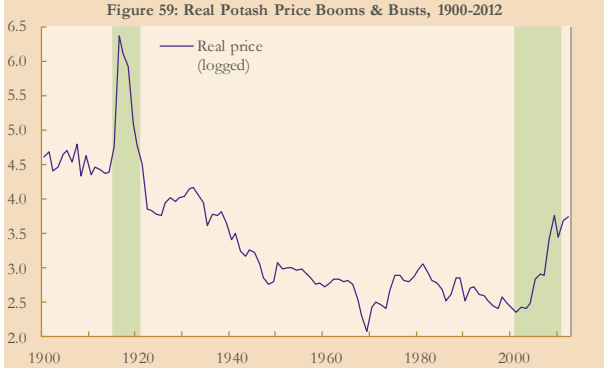


Figure 60: Real Cocoa Price Booms & Busts, 1850-2012

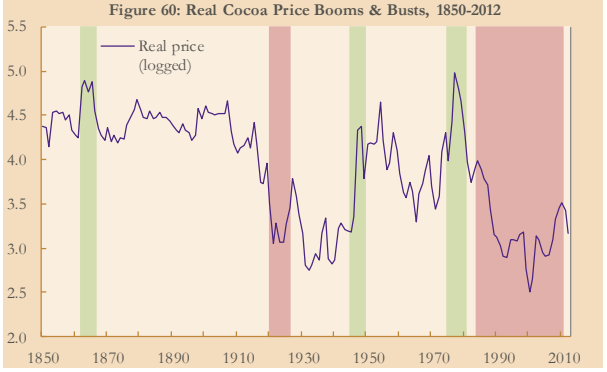


Figure 61: Real Coffee Price Booms & Busts, 1850-2012

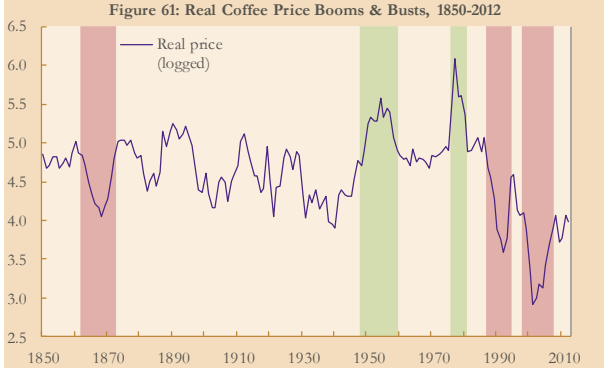


Figure 62: Real Cotton Price Booms & Busts, 1850-2012

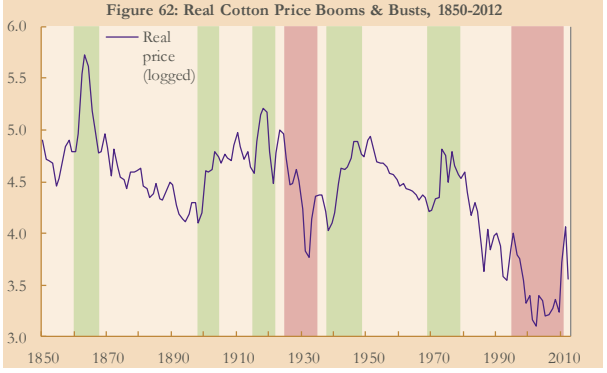


Figure 63: Real Palm Oil Price Booms & Busts, 1850-2012

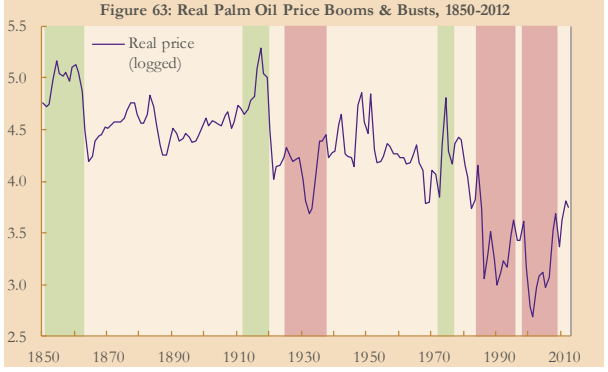


Figure 64: Real Rubber Price Booms & Busts, 1890-2012

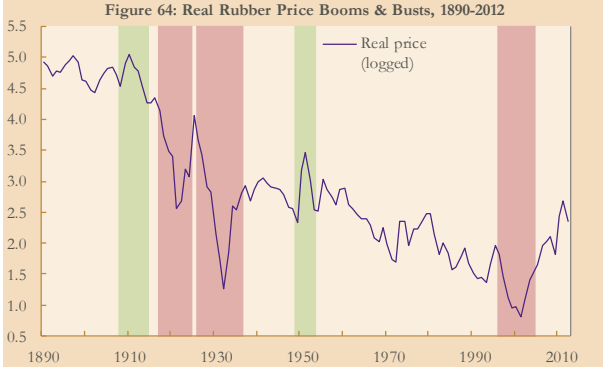


Figure 64: Real Rubber Price Booms & Busts, 1890-2012

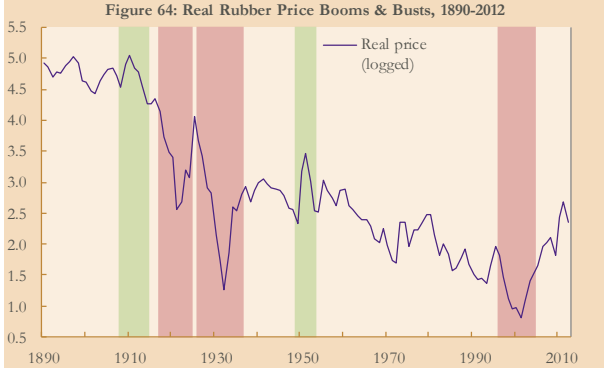


Figure 66: Real Tea Price Booms & Busts, 1850-2012

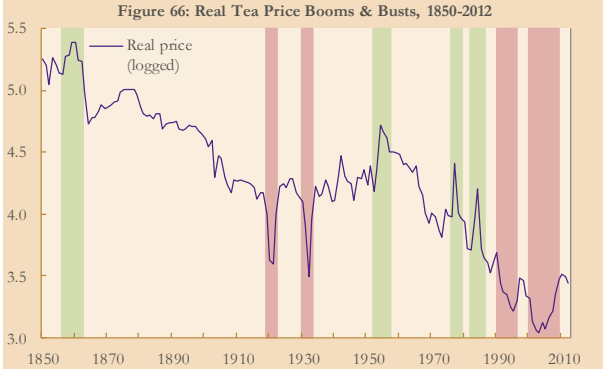


Figure 67: Real Tobacco Price Booms & Busts, 1850-2012

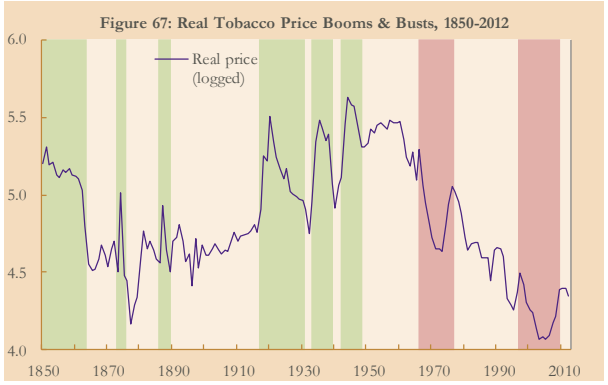


Figure 68: Real Wool Price Booms & Busts, 1850-2012

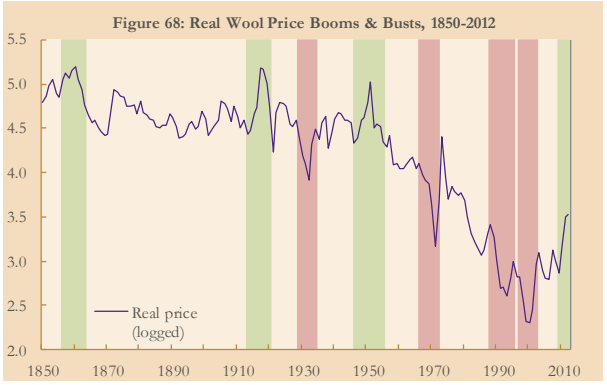


Table 9: Dates of Commodity Price Booms & Busts for Animal Products

Panel A: Booms

Commodity	Start date	Peak	End date	Years to peak	Cycle length	Change to peak (%)
Hides	1855	1857	1863	2	8	148
Hides	1910	1915	1920	5	10	67
Beef	1914	1919	1921	5	7	116
Beef	1963	1973	1975	10	12	329
Beef	1977	1979	1981	2	4	60

Panel B: Busts

Commodity	Start date	Trough	End date	Years to trough	Cycle length	Change to trough (%)
Beef	1862	1864	1870	2	8	-28
Hides	1931	1932	1937	1	6	-70
Beef	1949	1951	1955	2	6	-37
Hides	1951	1955	1959	4	8	-61
Hides	2001	2009	2012?	8	11?	-56

Table 10: Dates of Commodity Price Booms & Busts for Energy Products

Panel A: Booms

Commodity	Start date	Peak	End date	Years to peak	Cycle length	Change to peak (%)
Petroleum	1915	1920	1923	5	8	69
Natural gas	1972	1983	1991	11	19	494
Petroleum	1972	1980	1986	8	14	397
Natural gas	2002	2008	2010	6	8	126

Panel B: Busts

Commodity	Start date	Trough	End date	Years to trough	Cycle length	Change to trough (%)
Petroleum	1889	1892	1894	3	5	-44
Natural gas	1900?	1906	1911	6?	11?	-40
Natural gas	1908	1911	1913	3	5	-29
Petroleum	1930	1931	1934	1	3	-48
Petroleum	1997	1998	1999	1	2	-35

Table 11: Dates of Commodity Price Booms & Busts for Grains

Panel A: Booms

Commodity	Start date	Peak	End date	Years to peak	Cycle length	Change to peak (%)
Corn	1851	1855	1856	4	5	37
Rice	1851	1855	1857	4	6	44
Wheat	1853	1855	1857	2	4	160
Rice	1859	1860	1863	1	4	34
Corn	1863	1864	1865	1	2	145
Wheat	1866	1867	1868	1	2	92
Corn	1913	1917	1919	4	6	98
Wheat	1914	1917	1920	3	6	87
Rice	1971	1974	1976	3	5	241
Wheat	1971	1974	1976	3	5	140
Corn	1973	1974	1977	1	4	113

Panel B: Busts

Commodity	Start date	Trough	End date	Years to trough	Cycle length	Change to trough (%)
Corn	1928	1932	1936	4	8	-61
Wheat	1928	1932	1937	4	9	-56
Rice	1929	1933	1936	4	7	-56
Rice	1981	1986	1988	5	7	-66
Corn	1985	1987	1995	2	10	-55
Rice	1990	1993	1995	3	5	-32
Corn	1997	2001	2007	4	10	-56
Rice	1997	2001	2007	4	10	-55
Wheat	1997	2000	2007	3	10	-56

Table 12: Dates of Commodity Price Booms & Busts for Metals

Panel A: Booms

Commodity	Start date	Peak	End date	Years to peak	Cycle length	Change to peak (%)
Copper	1850?	1853	1863	3?	13?	37
Nickel	1850?	1851	1857	1?	7?	2
Lead	1852	1853	1862	1	10	38
Zinc	1852	1857	1859	5	7	104
Nickel	1872	1873	1877	1	5	227
Steel	1898	1899	1900	1	2	105
Aluminum	1903	1907	1908	4	5	28
Copper	1903	1906	1910	3	7	67
Copper	1914	1916	1918	2	4	82
Zinc	1914	1915	1918	1	4	169
Aluminum	1915	1916	1921	1	6	197
Steel	1915	1917	1919	2	4	102
Lead	1945	1948	1953	3	8	107
Zinc	1949	1951	1952	2	3	36
Tin	1972	1980	1985	8	13	149
Zinc	1972	1974	1976	2	4	228
Lead	1976	1979	1981	3	5	81
Steel	1982	1985	1988	3	6	25
Zinc	1987	1989	1990	2	3	119
Steel	2003	2008	2012?	5	9?	236
Zinc	2005	2006	2008	1	3	192
Lead	2006	2007	2012?	1	6?	94
Tin	2009	2011	2012?	2	3?	83

Table 12: Dates of Commodity Price Booms & Busts for Metals

Panel B: Busts

Commodity	Start date	Trough	End date	Years to trough	Cycle length	Change to trough (%)
Tin	1863	1866	1869	3	6	-55
Tin	1873	1878	1881	5	8	-45
Nickel	1894	1895	1900	1	6	-46
Lead	1918	1921	1924	3	6	-46
Tin	1919	1921	1926	2	7	-72
Steel	1920	1922	1923	2	3	-32
Lead	1927	1932	1936	5	9	-55
Tin	1928	1931	1933	3	5	-57
Zinc	1929	1932	1936	3	7	-44
Copper	1930	1932	1936	2	6	-62
Nickel	1980	1986	1987	6	7	-56
Copper	1980	1986	1987	6	7	-36
Lead	1982	1985	1989	3	7	-60
Aluminum	1989	1993	1994	4	5	-63
Nickel	1990	1998	2006	8	16	-76
Lead	1991	1993	1995	2	4	-55
Copper	1995	2002	2004	7	9	-55
Aluminum	1996	2002	2006	6	10	-37
Lead	1997	2002	2004	5	7	-49
Tin	1997	2002	2003	5	6	-43
Steel	2000	2001	2003	1	3	-29
Zinc	2000	2002	2004	2	4	-34
Aluminum	2008	2009	2012?	1	4?	-39

Table 13: Dates of Commodity Price Booms & Busts for Minerals

Panel A: Booms

Commodity	Start date	Peak	End date	Years to peak	Cycle length	Change to peak (%)
Chromium	1915	1918	1919	3	4	171
Potash	1915	1916	1920	1	5	640
Bauxite	1929	1934	1937	5	8	100
Manganese	1970	1977	1981	7	11	152
Bauxite	1972	1974	1975	2	3	64
Chromium	1973	1975	1978	2	5	231
Iron ore	1973	1983	1988	10	15	61
Potash	2001	2009	2010	8	9	300
Iron ore	2005	2011	2012?	6	7?	163
Manganese	2006	2008	2012?	2	6?	203
Chromium	2006	2008	2009	2	3	132

Panel B: Busts

Commodity	Start date	Trough	End date	Years to trough	Cycle length	Change to trough (%)
Bauxite	1916	1918	1919	2	3	-48
Chromium	1920	1921	1930	1	10	-66
Manganese	1920	1921	1923	1	3	-79
Iron ore	1931	1932	1932	1	1	-33
Bauxite	1945	1951	1956	6	11	-39
Chromium	1960	1961	1962	1	2	-49
Bauxite	1997	2003	2006	6	9	-38
Iron ore	1998	2001	2004	3	6	-28

Table 14: Dates of Commodity Price Booms & Busts for Soft Commodities

Panel A: Booms

Commodity	Start date	Peak	End date	Years to peak	Cycle length	Change to peak (%)
Tobacco	1850?	1851	1863	1?	13?	11
Palm oil	1851	1854	1862	3	11	56
Sugar	1854	1857	1862	3	8	58
Tea	1856	1860	1862	4	6	30
Wool	1856	1860	1863	5	8	40
Cotton	1860	1863	1867	3	7	155
Cocoa	1862	1863	1866	2	4	93
Tobacco	1873	1874	1875	1	2	67
Tobacco	1886	1887	1889	1	3	44
Cotton	1898	1903	1904	5	6	100
Rubber	1908	1910	1914	2	6	70
Palm oil	1912	1917	1919	5	7	90
Wool	1913	1917	1920	4	7	110
Cotton	1915	1918	1921	3	6	88
Tobacco	1917	1920	1930	3	13	111
Sugar	1919	1920	1921	1	2	112
Tobacco	1933	1935	1939	2	4	109
Cotton	1938	1946	1948	8	10	139
Tobacco	1942	1944	1948	2	6	77
Cocoa	1945	1948	1949	3	4	233
Wool	1946	1951	1955	5	9	98
Coffee	1948	1956	1959	8	11	111
Rubber	1949	1951	1953	2	4	209
Tea	1952	1954	1957	2	5	71
Sugar	1961	1963	1964	2	3	201
Sugar	1968	1974	1976	6	8	1002
Cotton	1969	1973	1978	4	9	83
Palm oil	1972	1974	1976	2	4	161
Cocoa	1975	1977	1980	2	5	170
Coffee	1976	1977	1980	1	4	218
Tea	1976	1977	1979	1	3	55
Sugar	1978	1980	1981	2	3	190
Tea	1982	1984	1986	2	4	65
Wool	2009	-	-	-	-	94

Table 14: Dates of Commodity Price Booms & Busts for Soft Commodities

Panel B: Busts

Commodity	Start date	Trough	End date	Years to trough	Cycle length	Change to trough (%)
Coffee	1862	1868	1872	6	10	-54
Rubber	1917	1921	1924	4	7	-80
Tea	1919	1921	1922	2	3	-44
Cocoa	1920	1921	1926	1	6	-59
Cotton	1925	1932	1934	7	9	-71
Palm oil	1925	1932	1937	7	12	-48
Rubber	1926	1932	1936	7	12	-94
Sugar	1928	1932	1935	4	7	-59
Wool	1929	1932	1934	3	5	-58
Tea	1930	1932	1933	2	3	-48
Tobacco	1966	1973	1976	7	10	-48
Wool	1966	1971	1972	5	16	-61
Sugar	1983	1985	1988	2	5	-89
Cocoa	1984	2000	2010	16	26	-77
Palm oil	1984	1990	1995	6	11	-68
Coffee	1987	1992	1994	5	7	-74
Wool	1988	1993	1995	5	7	-55
Tea	1990	1995	1996	5	6	-38
Cotton	1995	2002	2010	7	15	-59
Sugar	1995	1999	2006	4	11	-57
Rubber	1996	2001	2004	5	8	-69
Tobacco	1997	2003	2009	6	12	-35
Wool	1997	2000	2002	3	5	-50
Palm oil	1998	2001	2008	3	10	-61
Coffee	1998	2002	2007	4	9	-71
Tea	2000	2003	2009	3	9	-36

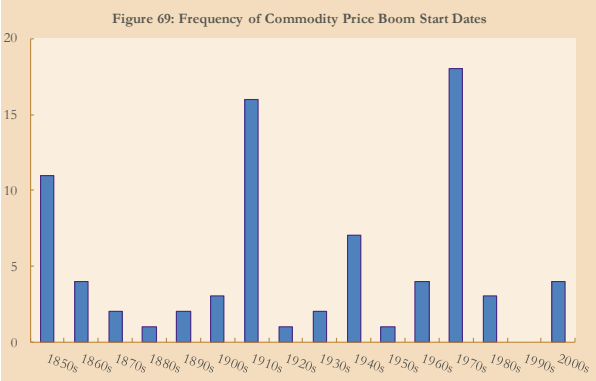


Figure 69: Frequency of Commodity Price Boom Start Dates
20
15
10
5
0
1850s 1860s 1870s 1880s 1890s 1900s 1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s

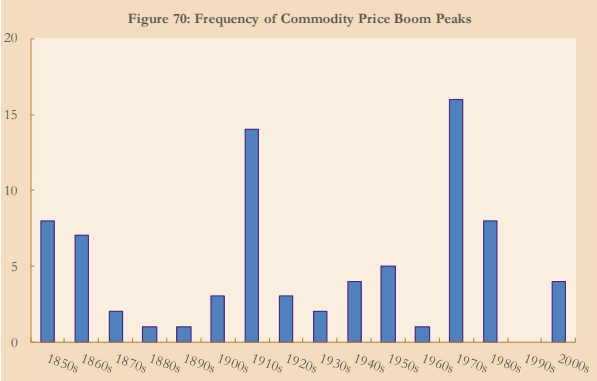


Figure 70: Frequency of Commodity Price Boom Peaks
20
15
10
5
0
1850s 1860s 1870s 1880s 1890s 1900s 1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s

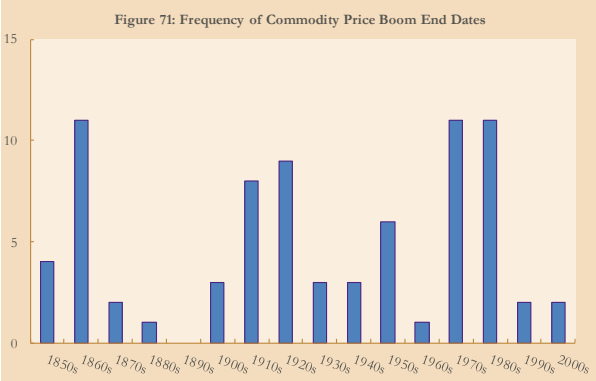


Figure 71: Frequency of Commodity Price Boom End Dates
15
10
5
0
1850s 1860s 1870s 1880s 1890s 1900s 1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s

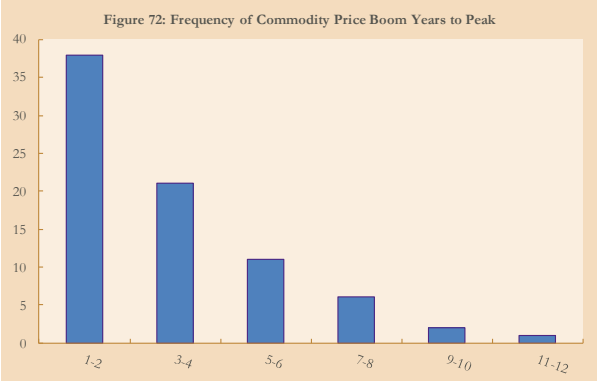


Figure 72: Frequency of Commodity Price Boom Years to Peak
40
35
30
25
20
15
10
5
0
1-2 3-4 5-6 7-8 9-10 11-12

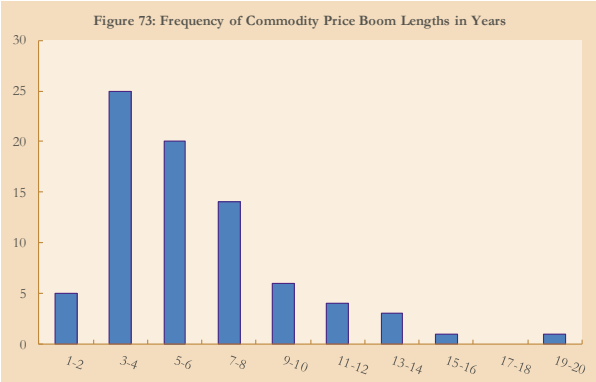


Figure 73: Frequency of Commodity Price Boom Lengths in Years
30
25
20
15
10
5
0
1-2 3-4 5-6 7-8 9-10 11-12 13-14 15-16 17-18 19-20

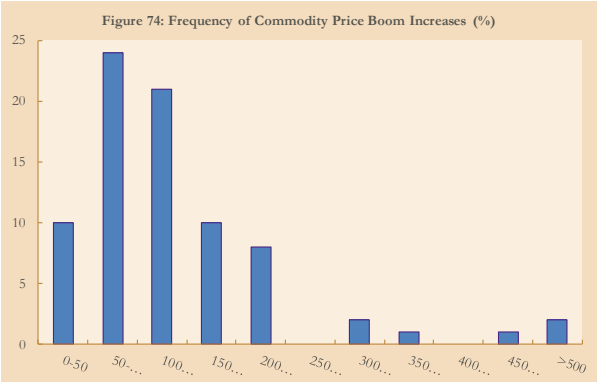


Figure 74: Frequency of Commodity Price Boom Increases (%)
25
20
15
10
5
0
0-50 50-... 100... 150... 200... 250... 300... 350... 400... 450... >500

Figure 75: Frequency of Commodity Price Bust Start Dates

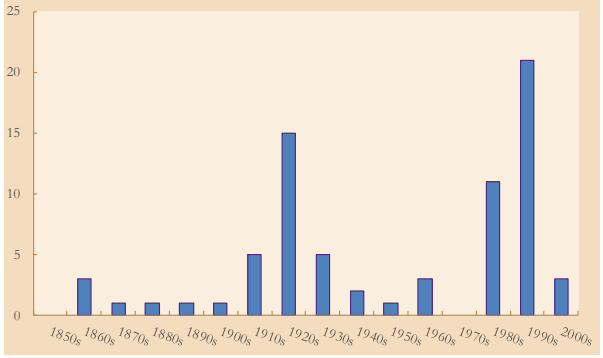


Figure 76: Frequency of Commodity Price Bust Troughs

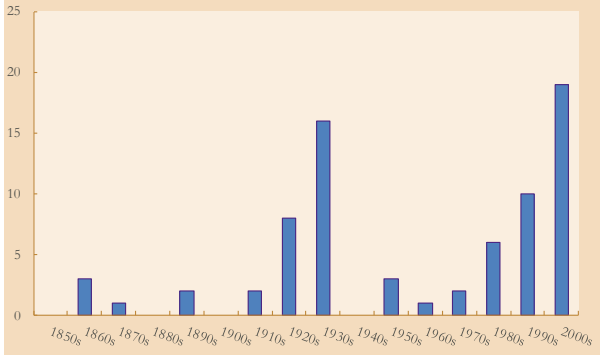


Figure 77: Frequency of Commodity Price Bust End Dates

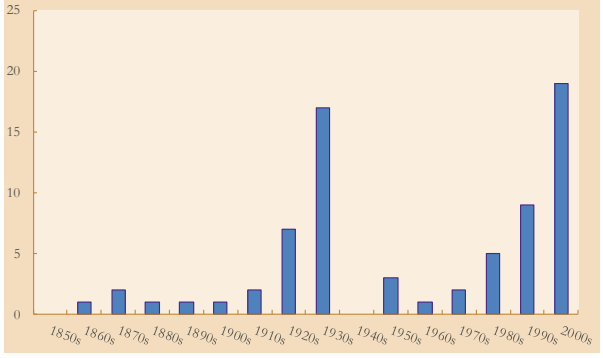


Figure 78: Frequency of Commodity Price Bust Years to Trough

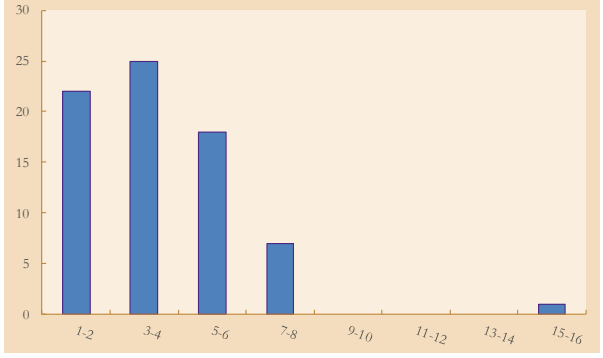


Figure 79: Frequency of Commodity Price Bust Lengths in Years

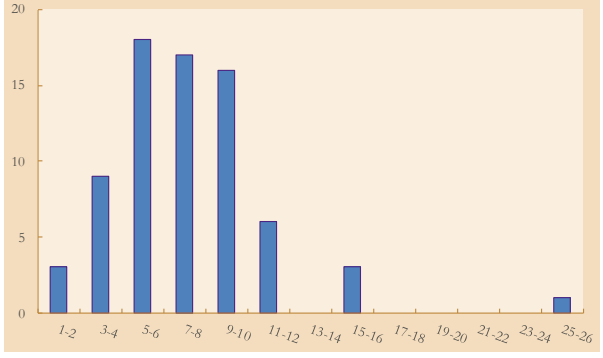


Figure 80: Frequency of Commodity Price Bust Declines (%)

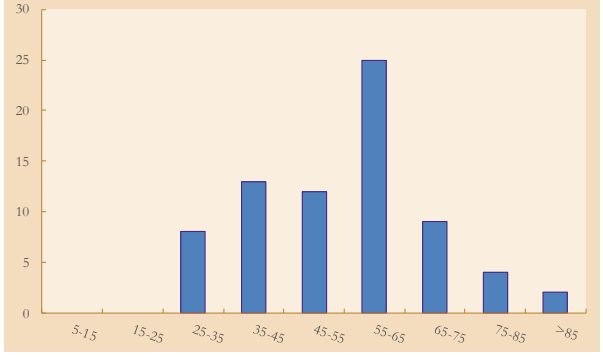


Table 15: Contribution of Booms & Busts to Volatility of Deviations from Long-run Trends

Commodity	SD of deviation from long-run trend (A)	SD of deviation without booms/busts (B)	Proportion of two SDs (B)/(A)
Animal products			
Beef	0.4022	0.2846	0.71
Hides	0.3544	0.2531	0.71
Energy products			
Natural gas	0.3004	0.1875	0.62
Petroleum	0.4013	0.2687	0.67
Grains			
Corn	0.3386	0.2423	0.72
Rice	0.5389	0.3428	0.64
Wheat	0.4410	0.3410	0.77
Metals			
Aluminum	0.7087	0.4579	0.65
Copper	0.3592	0.2283	0.64
Lead	0.3587	0.2211	0.62
Nickel	0.6460	0.4535	0.70
Steel	0.2663	0.2070	0.78
Tin	0.4141	0.2514	0.61
Zinc	0.2912	0.1821	0.63
Minerals			
Bauxite	0.4572	0.4363	0.95
Chromium	0.3451	0.2308	0.67
Iron ore	0.2660	0.1706	0.64
Manganese	0.2956	0.2369	0.80
Potash	0.4852	0.2877	0.59
Soft commodities			
Cocoa	0.5157	0.4185	0.81
Coffee	0.4658	0.3866	0.83
Cotton	0.5071	0.3977	0.78
Palm oil	0.4408	0.2638	0.60
Rubber	0.9286	0.8310	0.89
Sugar	0.7220	0.5622	0.78
Tea	0.5573	0.4641	0.83
Tobacco	0.3137	0.2376	0.76
Wool	0.4662	0.3679	0.79

Table 16: Contribution of Booms & Busts to Volatility of Deviations from Long-run Trends			
Commodity	SD of price changes (A)	SD of price changes without booms/busts (B)	Proportion of two SDs (B)/(A)
Animal products			
Beef	0.1677	0.1488	0.89
Hides	0.2244	0.2023	0.90
Energy products			
Natural gas	0.1592	0.1265	0.79
Petroleum	0.2166	0.1761	0.81
Grains			
Corn	0.2242	0.2145	0.96
Rice	0.1715	0.1448	0.84
Wheat	0.1852	0.1584	0.86
Metals			
Aluminum	0.1648	0.1050	0.64
Copper	0.1790	0.1730	0.97
Lead	0.1727	0.1098	0.64
Nickel	0.2050	0.1739	0.85
Steel	0.1525	0.0729	0.48
Tin	0.1837	0.1591	0.87
Zinc	0.2161	0.1518	0.70
Minerals			
Bauxite	0.1348	0.1245	0.92
Chromium	0.2210	0.1642	0.74
Iron ore	0.1488	0.1058	0.71
Manganese	0.2383	0.1990	0.83
Potash	0.2473	0.1620	0.66
Soft commodities			
Cocoa	0.2251	0.1915	0.85
Coffee	0.2269	0.2008	0.89
Cotton	0.1793	0.1467	0.82
Palm oil	0.1994	0.1727	0.87
Rubber	0.2880	0.2298	0.80
Sugar	0.2955	0.2216	0.75
Tea	0.1368	0.0975	0.71
Tobacco	0.1370	0.1058	0.77
Wool	0.1831	0.1594	0.87

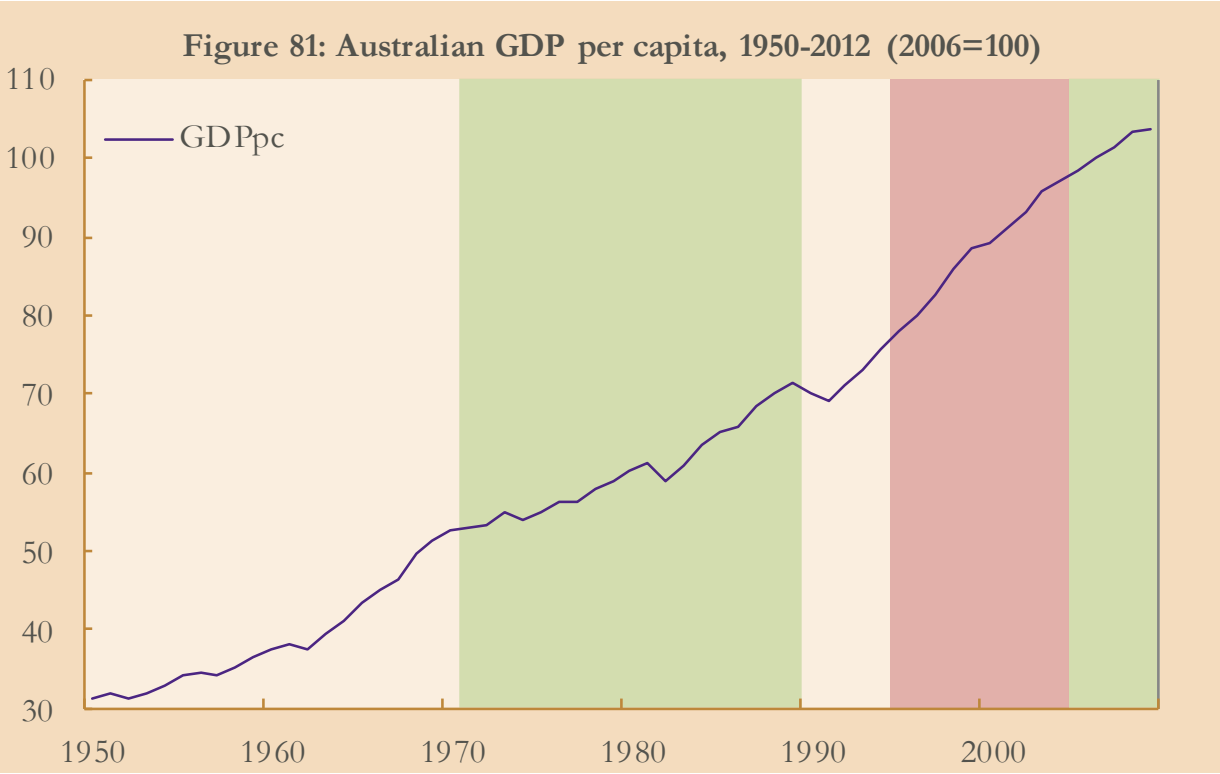


Figure 81: Australian GDP per capita, 1950-2012 (2006=100)
110
100
90
80
70
60
50
40
30
GDPpc
1950
1960
1970
1980
1990
2000