From Boom to Bust: A Typology of Real Commodity Prices in the Long Run*

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Abstract

This paper considers the evidence on real commodity prices from 1850 to 2015 for 40 commodities, representing 8.72 trillion US dollars of production in 2011. In so doing, it suggests and documents a comprehensive typology of real commodity prices, comprising long-run trends, medium-run cycles, and short-run boom/bust episodes. The main findings can be summarized as follows: (1) real commodity prices have been on the rise—albeit modestly—from 1950; (2) there is a pattern—in both past and present—of commodity price cycles, entailing long-lived deviations from underlying trends with the set of currently evolving cycles having passed their peak; (3) these commodity price cycles are themselves punctuated by boom/bust episodes which are historically pervasive, exacerbated during periods of freely floating nominal exchange rates, and highly relevant for the growth experience of commodity exporting nations.

Keywords: Booms and busts, real commodity prices, trend-cycle decomposition

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1. Introduction

At least once in every generation, the global economy witnesses a protracted and widespread commodity boom. And in each boom, the common perception is that the world is quickly running out of key materials. The necessary consequence of this demand-induced scarcity is that economic growth must inexorably grind to a halt. On the other hand, economists are often quick to counter that such thinking is somehow belied by the long-run history of real commodity prices. Building on an extensive academic and policy literature charting developments in the price of commodities relative to manufactured goods, this side of the debate holds that the price signals generated in the wake of a global commodity boom have always been sufficiently strong to induce a countervailing supply response as formerly dormant exploration and extraction activities take off and induced technological change takes hold (cf. Ehrlich, 1968; Ehrlich and Ehrlich, 1990; Moyo, 2012; Sabin, 2013; Simon, 1981, 1996).

What is missing from this debate is a comprehensive body of evidence on real commodity prices and a consistently-applied methodology for characterizing their long-run evolution. To that end, this paper considers the evidence on real commodity prices from 1850 to 2015 for 40 commodities. Individually, these series span a wide range of economically important commodities, being drawn from the animal product, energy product, grain, metals, minerals, precious metals, and soft commodity sectors. What is more, they collectively represent 8.72 trillion USD worth of production in 2011. Even accounting for potential double-counting and excluding potentially idiosyncratic sectors like energy, the sample constitutes a meaningful share of global economic activity.

Furthermore, this paper suggests and documents a complete typology of real commodity over the past 165 years. In this framework, real commodity price series are comprised of long-run trends, medium-run cycles, and short-run boom/bust episodes. As such, there a few key findings of the paper. First, perceptions of the trajectory of real commodity prices over time are vitally influenced by how long a period is being considered and by how particular commodities are weighted when constructing commodity price indices. Applying weights drawn from the value of production in 1975, real commodity prices are estimated to have increased by 34.20% from 1950. This suggests that much of the conventional wisdom on long-run trends in real commodity prices may be unduly swayed by events either in the very distant or very recent past. It also suggests a potentially large, but somewhat underappreciated distinction in between "commodities to be grown" which have experienced secular declines in real prices versus "commodities in the ground"—in particular, energy products—which have experienced secular increases in real prices over the long run.

Second, there is a consistent pattern of commodity price cycles which entail long-lived deviations from these underlying trends in both the past and present. In this paper as in others it follows (cf. Cuddington and Jerrett, 2008; Erten and Ocampo, 2013; Jerrett and Cuddington, 2008), commodity price cycles are thought of as comprising medium-run swings in real commodity prices. 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. Here, it is important to note that the notion of cycles is not meant to evoke a sense of regularity—much less predictability in commodity price dynamics—but instead provides us with a convenient means of statistically characterizing deviations from long-run trends. Significantly, this paper finds that fully 20 of the 40 commodities under consideration are in the midst of such cycles, demonstrating above-trend real prices starting from 1994 to 1999. The common origin of these commodity price cycles in the late 1990s underlines an important implicit theme of this paper, namely that long-run patterns can be easy to miss if we confuse cycles for trends. That is, some of the recent appreciation of real commodity prices simply represents a recovery from their multi-year—and in some instances, multi-decade—nadir around the year 2000. At the same time, the accumulated historical evidence suggests that the current upswing in commodity prices has peaked and, thus, we are witnessing the end of above-trend real commodity prices.

Third, this paper offers a straightforward methodology for determining real commodity price booms and busts which punctuate the aforementioned commodity price cycles. These boom/bust episodes are found to be historically pervasive and demonstrate one clear pattern: periods of freely floating nominal exchange rates have been associated with longer and larger real commodity price boom/bust episodes. This exercise also underlines one of the key outputs of this paper in the form of long-run series on commodity-specific price booms and busts which will be of interest to researchers looking for plausibly exogenous shocks to either domestic economies or global markets.[1]

To illustrate this last idea, the paper considers the case of Australia and constructs country-specific indicators of boom and bust episodes based on export-share weighted sums of commodity-specific booms and busts for the period from 1900 to 2010. The paper then relates these indices to deviations in Australian real GDP from its rolling ten-year trend. The results suggest that the transition from relatively placid conditions in global commodity markets for Australian exports to a full-blown commodity price boom is associated with a positive but statistically insignificant 0.67% deviation from trend growth while the opposite transition to a

[1] All of the data used as input or produced as output along with the accompanying STATA code are available at the author's website.

full-blown commodity price bust is associated with a negative and statistically significant 5.79% deviation from trend growth. Undoubtedly, much more work could be done connecting commodity price booms and busts and their potentially asymmetric linkages to economic growth. However, this exercise at the very 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 treatment of the nexus among commodity price booms and busts, commodity price volatility, and economic growth (Jacks *et al*., 2011; Ploeg and Poelhekke, 2009).

The rest of the paper proceeds as follows. Section 2 sets out the underlying data while Section 3 outlines the methodology of trend-cycle decomposition. Sections 4 and 5 provide the evidence on long-run trends and medium-run cycles in real commodity prices, respectively. Section 6 introduces one of this paper's unique contributions in the form of characterizing real commodity price booms and busts. Section 7 considers the implications of these boom and bust episodes for economic growth over the business cycle for commodity-exporting nations while Section 8 concludes.

2. New Data on Old Prices

A long-standing view in the literature holds that in real terms commodity prices do little better than tread water, exhibiting either non-discernible or decidedly downward trends. This seems to be true regardless of whether the window of observation runs in the mere handful of decades or across entire centuries (Arezki *et al*., 2014; Harvey *et al*., 2010; Yamada and Yoon, 2014). Another well-known fact is the pronounced inter- and intra-year volatility against a backdrop of slowly evolving dynamics which lead Cashin and McDermott (2002a) to typify the long-run behavior of commodity prices as "small trends and big variability". A less appreciated fact is the existence of extended periods of time when real commodity prices are either significantly above or below trend (Slade, 1982). These periods are typically associated with key events in global economic history and are characterized here as cycles. What the subsequent sections set out to do is reassess the conventional wisdom on long-run trends as well as introduce new perspectives on commodity price cycles in the medium run and boom/bust episodes in the short run.

The data used in this study comprise all consistently-defined, long-run annual prices for commodities with at least 5 billion US dollars of production in 2011. 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, this paper considers the evidence on 40 individual commodity price series which are drawn from seven product categories—animal products, energy products, grains, metals, minerals, precious metals, and soft commodities—and which are enumerated in Table 1. As Table 1 also demonstrates, the series are not only large in number, but also economically significant representing 8.72 trillion US dollars of production in 2011.[2] Finally, the individual price series are expressed in US dollars and 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.[3] In what follows, none of the results are materially altered by the consideration of alternative measures of economy-wide

[2] Neglecting energy products, these production values are still in excess of 4.54 trillion USD. Furthermore, there is likely very little room for sample selection issues in driving the results presented below. In particular, there may be concerns about the potential influence of once-important, but now-irrelevant commodities or once-irrelevant, but now-important commodities which would be ruled out on the basis of the criteria laid out here. For example, uranium had no wide commercial application until the atomic age and, thus, remains outside of the sample. At the same time, production of uranium in 2011 was valued at 6.65 billion USD—that is, a mere 0.076% of the current sample's cumulative value of production in the same year.

[3] Naturally, to the extent that the quality of commodities has remain unchanged over time (which is highly likely), any upward bias in the US CPI induced by insufficient correction for changes in the quality of other goods over time will lead to a downward bias in the calculation of increases in real commodity price documented below.

prices such as the US GDP deflator, US manufacturing prices, or the US PPI. Appendix I details the sources for the individual series.

Figures 1a through 7d document the evolution of real commodity prices from 1850 to 2015. All series have been converted into index form with real prices in 1900 set equal to 100. A visual inspection of these series reveals the previously noted "big variability" of real commodity prices. 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 the 2000s as well as the troughs in the 1930s and 1990s, there is a clear divergence in between those commodities exhibiting a perpetual downward trend—notably, grains and soft commodities—and those exhibiting a perpetual upward trend—notably, energy and precious metals.

Figure 8 attempts to abstract from these commodity-specific developments and instead applies three different sets of weights in the construction of real commodity price indices: shares drawn from the value of production in 1975, shares drawn from the value of production in 2011, and equal shares.[4] Relying on the series drawn from the value of production in 2011 is likely unsatisfactory, in that it puts the most weight on precisely those commodities which ex-post have risen the most. Likewise, relying on the series drawn from equal weights is somewhat unsatisfactory, in that it assigns as much as importance to rye with 5.57 billion USD in production in 2011 as petroleum with 3.16 trillion USD in production in 2011. In what follows, we focus our attention on the series drawn from the value of production in 1975 which represents

[4] Using weights from the value of production prior to 1975 is problematic for the fact that the prices of certain key commodities were dictated by government and industry as opposed to being determined by market forces. The case of gold and the role of the US Treasury in maintaining its nominal value from 1934 to 1972 is one well-known example. A less well-known, but even more important example comes from the actions of the Texas Railroad Commission in large part dictating global petroleum prices up to the first oil shock in 1973 (Yergin, 1991).

a rough compromise between these two extremes. The picture emerging from this exercise is a pattern of rising real commodity prices from the 1960s.

However, there is an implicit danger in simply "eyeballing" these series or comparing the level of real commodity prices in the present with values drawn from the past. Namely, we run the risk of conflating currently evolving cycles with long-run trends. The following section lays out the methodology used to decompose real commodity prices into long-run trend and medium-run cyclical components.

3. Trend-cycle decomposition

Borrowing from the large body of work in empirical macroeconomics on trend-cycle decomposition, a burgeoning literature in identifying medium-run commodity price cycles has emerged (cf. Cuddington and Jerrett, 2008; Erten and Ocampo, 2013; Jerrett and Cuddington, 2008). The common theme of this literature is that commodity price cycles can be detected by use of the Christiano-Fitzgerald band pass filter which decomposes 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, LRT_t; a medium-run cycle of 20 to 70 years duration, MRC_t; and all other shorter cyclical components, SRC_t. This entails estimating three orthogonal components for the log of the real commodity price series, or namely $\ln(P_{it}) \equiv LRT_{it} + MRC_{it} + SRC_{it}$.

Broadly, the work of Christiano and Fitzgerald (2003) has as its basic insight that time-series data—like the real commodity price series under consideration here—can be characterized as the sum of periodic functions. Their work then establishes the ideal (infinite sample) band-pass filter as an application of spectral analysis, allowing for slowly evolving trends and imposing no restrictions on the distribution of the underlying data. Furthermore, they suggest a finite-sample asymmetric band pass filter which allows for the extraction of filtered series over the entire sample, thus, ensuring that no data from either the beginning or end of the sample is discarded.

The means of establishing these results is by, first, considering the ideal filter for isolating time-series components with specified frequency bands. For simplicity, we can characterize a representative stochastic process, x_t, as being composed of a trend, cycle, and an irregular component, or $x_t = \tau_t + c_t + \varepsilon_t$ such that the power of the second sub-process is bounded by the interval $\{(a,b) \cup (-b,-a)\} \in (-\pi, \pi)$, the powers of the first and third sub-processes are bounded by this interval's complement, and a and b define the period of oscillation such that $0 < a \leq b \leq \pi$. The ideal (infinite sample) band pass filter would then be $c_t = B(L)x_t = \sum_{j=-\infty}^{\infty} B_j L^j x_t$ where $L^k x_t \equiv x_{t-k}$. In this way, the characterization of the sub-process, c_t, is a function of every observation in the infinite set of x_t.

An appropriate, finite sample counterpart comes from the following expression, $\hat{c}_t = \hat{B}_t(L)x_t = \sum_{j=-n_1}^{n_2} \hat{B}_{t,j} x_{t+j}$. Conveniently for our purposes, this expression does not require either symmetry (such that $\hat{B}_{t,j} = \hat{B}_{t,j-1}$) or time-invariance (such that $\hat{B}_{t,j} = \hat{B}_j$). That is, such a filter can be used in real time as observations drawn from the beginning of a period can be filtered only using future values and observations drawn from the end of a period can be filtered only using past values. What is more, the characterization of the sub-process, c_t, is a function of all available observations on x_t.

The Christiano-Fitzgerald Filter is then designed to be the set of weights which minimizes the mean squared error between c_t and c_t-hat in the case that x_t follows a random walk.

Thus, they make the assumption that the underlying commodity price series are integrated of order one with drift, an assumption implicitly followed in this paper as well. Furthermore, the authors demonstrate that their filter converges in the long run to the optimal filter since the approximation error of the weights diminishes as the sample size increases and that there is little gained by knowing the true data generating process in simulations, suggesting its applicability in a fairly wide set of circumstances.

Procedurally, estimation of the three components simply entails taking the logarithmic transformation of the real price indices reported earlier and estimating a long-run trend (LRT_{it})—that is, all cyclical components with periods in excess of 70 years. Next comes calculating the deviations of log real prices from this long-run trend and using these deviations to identify medium-run commodity price cycles (MRC_{it})—that is, all cyclical components with periods of 20 to 70 years in duration. Finally, the deviations of log real prices from both the long-run trend and medium-run cycle define the short-run cyclical components (SRC_{it}) —that is, all cyclical components with periods of 1 to 20 years in duration. In what follows, we will consider these three components in turn. The results presented below are not materially altered when different durations are used for defining trends and cycles, e.g., a trend comprising cyclical components in excess of 50 years and a cycle comprising cyclical components with periods of 15 to 50 years in duration. In these cases, the magnitudes marginally differ from those reported below, but general tendencies for estimated trends and cycles do not.[5]

[5] In what follows, there is also little material difference in estimated trends or cycles when alternate asymmetric band pass filters are used. For example, using the Butterworth band pass filter, the results remain broadly unaffected in that: (1) the Christiano-Fitzgerald filter estimates an index value of 160.99 in 2015 versus the Butterworth filter which estimates an index value of 154.59 in the same year; and (2) the Christiano-Fitzgerald filter estimates complete cycles for the years from 1903 to 1932 and from 1965 to 1996 versus the Butterworth filter which estimates complete cycles for the years from 1900 to 1932 and from 1966 to 1997.

4. Long-Run Trends in Real Commodity Prices

Figure 9a displays the log of real petroleum prices from 1860 to 2015 and its estimated long-run trend. Petroleum was chosen as the commodity with the largest value of production in 1975, representing 24% of the sample by value in that year and 36% of the sample by value in 2011. Figure 10a depicts the long-run trend for the real commodity price index drawn from 1975 value-of-production shares. Finally, Table 2 calculates on a commodity-by-commodity basis the cumulative change in the long-run trend in 2015 versus benchmark dates in 1850, 1900, 1950, and 1975.

From Table 2, it will perhaps come as no surprise that natural gas and petroleum have uniformly registered increases in real prices since 1900. Slightly more surprising is the presence of precious metals as well as chromium, lamb, and manganese in the same category. This leaves six commodities with a positive, but slightly more mixed performance over the past 115 years: copper, nickel, and potash which have a consistent upward trend from 1950 and beef, coal, and steel which demonstrate a long-run upward trend, but which have eased off somewhat from their all-time highs in the 1970s.

On the opposite end of the spectrum, soft commodities have been in collective and constant decline since 1900. 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, bauxite, iron ore, lead, pork, and sulfur. Thus, energy products and precious metals are clearly in the “gainer” camp; grains and soft commodities are clearly in the “loser” camp; and metals and minerals are left as contested territory. In aggregate, Figure 10a suggests that if anything real commodity prices have been on the rise if evaluated on the basis of the value of production. Again applying weights drawn from 1975 suggests that real commodity prices have been modestly on the rise over the long run with annualized rates of increase of 0.18% from 1900, of 0.45% from 1950, and of 0.13% from 1975.

How then are these results reconciled with the conclusions of Cashin and McDermott (2002a), for instance, who find that real commodity prices have been declining by roughly one percent per year since the mid-nineteenth century? First, Cashin and McDermott rely on a commodity price index which applies weights equal to the value of world imports, rather than the value of world production as here. Second, there is a fairly substantial difference in the composition of commodities with only 11 of their 18 commodities matching the 40 under consideration in this paper. Finally and most importantly, there is a massive difference in the composition of product categories: their index only spans the metals and soft commodities categories. Although metals are somewhat of a mixed bag, soft commodities—both broadly and narrowly defined—have been the biggest of “losers” over the past 165 years.

These two sets of findings then suggest a potentially very large, but somewhat underappreciated distinction in between “commodities to be grown” versus “commodities in the ground”. Figure 11 makes this distinction clear by separating the two types of commodities along the lines suggested above. We can also drill down further as in Figure 11 and consider “commodities in the ground, ex-energy”. In this last case, the long-run trend would be decidedly more muted as the peaks of the mid-1970s were vastly eroded up to the turn of the century and have only recently been re-attained. However, it seems that much of the conventional wisdom on long-run trends in real commodity prices may have been unduly swayed by the experience of product categories characterized by downward trends.

5. Medium-Run Cycles in Real Commodity Prices

In recent years, the investing community has run with the idea of commodity price cycles (Heap, 2005; Rogers, 2004). In this view, commodity price cycles are medium-run events corresponding to deviations from underlying trends in commodity prices of roughly 20 to 70 years in 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. However, once such a demand shock emerges, there is generally a countervailing supply response as formerly dormant exploration and extraction activities take off and induced technological change takes hold. Thus, as capacity constraints are eased, real commodity prices revert back to— and below— trend.

Figure 9b displays the detrended real petroleum price and the cyclical component evident in the medium-run for the former. The scaling on the left-hand-side of the figures is in logs, so a value of 1.0 in Figure 9b represents a 174% deviation from the long-run trend. Thus, the cyclical fluctuations in petroleum prices are sizeable. The complete cycles for real petroleum prices which deliver deviations from trend of at least 20% can be dated from 1886 to 1937 and from 1967 to 1996. Petroleum is also estimated to be in the midst of a currently evolving cycle which began in 1996.[6] Evidence of large deviations from trend is apparent in all of the series as is the existence of numerous commodity price cycles over the past 165 years. Finally, Figure 10b depicts the trend-cycle decomposition of the real commodity price index drawn from 1975 value-of-production shares, indicating two complete cycles—from 1903 to 1932 and from 1965 to 1996—and one incomplete cycle which emerged in 1996.

[6] The working version of this paper, Jacks (2013), provides a complete enumeration of real commodity price cycles and boom/bust episodes by commodity and by year as well as the accompanying set of figures.

Replicating this exercise for the remaining 39 commodities, 91 complete commodity price cycles with positive price deviations from trend of at least 20% are identified for the 40 commodities.[7] Here, these cycles are characterized by six features: their start dates, peak dates, trough dates, years to peak, complete cycle length, and peak value—that is, the largest positive deviation from trend in real prices. Figures 12 through 14 display the histograms for the start, peak, and trough dates of the 91 complete commodity price cycles. Briefly summarizing, we find that the 1890s, 1930s, and 1960s gave rise to the majority of the start dates for commodity price cycles while the 1910s, 1940s, 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 large 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 cycles. Rounding things out, Figures 15 through 17 suggest that the majority of cycles peak within 10 to 20 years of their start date, the majority of cycles also evidence complete cycle lengths of less than 35 years, and the majority of cycles are associated with positive deviations of 20 to 50% from trend.

A battery of (unreported) regressions were also run using three of these features—years to peak, cycle length, and peak value—as dependent variables and a set of indicator variables capturing two different time periods, namely from 1914 to 1945 (interwar) and from 1946 to 2015 (post-World War II). Thus, the period from 1850 to 1913 (pre-World War I) acts as the omitted category. A few statistically significant results emerge from this exercise: the interwar and post-World War II era gave rise to a lower value for the years to peak at 15.89 years $(\hat{\beta}_0 + \hat{\beta}_{IW} = 19.91 - 3.22)$ and 16.30 years $(\hat{\beta}_0 + \hat{\beta}_{PWWII} = 19.91 - 3.61)$, respectively, and a lower

[7] An additional set of incomplete commodity price cycles are also estimated: 19 with an indeterminate start date and 20 with an indeterminate end date (that is, post-2015).

value for the length of cycles at 31.31 $(\hat{\beta}_0 + \hat{\beta}_{IW} = 37.84 - 6.53)$ and 34.52 years $(\hat{\beta}_0 + \hat{\beta}_{PWWII} = 37.84 - 3.32)$.

Finally, as Figures 12 through 17 exclude incomplete cycles, they are silent about current conditions: fully 20 of our 40 commodities—in addition to all of the commodity price indices and sub-indices from Figures 8 and 11—demonstrate above-trend real prices starting from 1994 to 1999.[8] Critically, 13 of these are in the energy products, metals, minerals, and precious metals categories (that is, "commodities in the ground"). The common origin of these commodity price cycles in the late 1990s underlines an important implicit theme of this paper, namely that long-run patterns can be easy to miss if we confuse cycles for trends. That is, much of the recent appreciation of real commodity prices simply represents a recovery from their multi-year—and in some instances, multi-decade—nadir around the year 2000. A further insight comes from combining these results with Figure 15 which suggests that we are likely witnessing the end of above-trend real commodity prices in the affected categories.[9]

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 modest upward trends when evaluated on the basis of the value of production; and (2) the notion of commodity price cycles being present in both the past and present 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 the nature of short-run movements in real commodity prices which may be

[8] These commodities are comprised of chromium, cocoa, copper, corn, cottonseed, gold, iron ore, lead, nickel, petroleum, phosphate, platinum, potash, rice, rubber, rye, silver, steel, tin, and wool.
[9] Indeed, for at least one commodity, natural gas, real prices have already registered their largest positive deviation from trend (in 2006). It remains to be seen whether this is symptomatic of other commodity price cycles or whether it simply reflects idiosyncratic features of the natural gas industry, in particular, recent breakthroughs in extraction technology.

particularly bearing in determining the pace of economic growth in commodity exporting economies. It is to these themes which the following sections turn.

6. Short-run Boom/Bust Episodes in Real Commodity Prices

Up to this point, we have confronted the standing literature on long-run trends and medium-run cycles in real commodity prices through a consideration of 165 years of data, finding some results which can be aligned with the received wisdom on commodity price cycles, but which offers a slightly contrarian 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.

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 (cf. Cashin *et al*., 2002 and Harding and Pagan, 2002), but one of the most natural is to simply build on what has been seen before. Here, we follow the lead of Mendoza and Terrones (2012) and take as our basic input the deviations from the combined long-run trend and medium-run cycle in logged real prices for commodity *i* in time *t*, or $SRC_{it} = \ln(P_{it}) - LRT_{it} - MRC_{it}$. Let z_{it} represent the standardized version of SRC_{it}—that is, for any given observation, we simply subtract the sample mean of all the deviations and divide by the sample standard deviation.

Commodity *i* is defined to have experienced a commodity price boom when we identify one or more contiguous dates for which the boom condition $z_{it} > 1.282$ holds as this value defines the threshold for the 10% 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 $z_{it} > 1.00$. A commodity price boom ends at t^e_{boom} where $t^e_{boom} > t^*_{boom}$ and $z_{it} > 1.00$.

Symmetric conditions define commodity price busts. Commodity *i* is defined to have experienced a commodity price bust when we identify one or more contiguous dates for which the bust condition $z_{it} < -1.282$ holds as this value defines the threshold for the 10% 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 $z_{it} < -1.00$. A commodity price bust ends at t^e_{bust} where $t^e_{bust} > t^*_{bust}$ and $z_{it} < -1.00$.

For illustration purposes, the reader is referred to Figures 18a through 18c which present the evidence on price booms and busts for petroleum. Figure 18a depicts the log of real petroleum prices from 1860 to 2015 along with the summation of the long-run trend and medium-run cycle. Figure 18b depicts the (standardized) deviation of logged real prices from these two series. Finally, Figure 18c combines the underlying real price series for petroleum along with the episodes of boom and bust determined by the algorithm given above. It indicates the presence of nine booms (in green) and twelve busts (in red) for real petroleum prices over the past 165 years. Reassuringly, these results suggest that in this context real commodity price booms do not mechanically generate real commodity price busts, nor vice versa. This pattern—or lack thereof—is repeated in Figure 19 which replicates the same exercise for the real commodity price index drawn from 1975 value-of-production shares. Evidence of both common and idiosyncratic real commodity price booms and busts is readily apparent.

Just as in the case of commodity price cycles, we identify and enumerate six features of commodity price booms across the 40 commodities, namely their start date, peak date, end date, years to peak, boom length, and the cumulative (positive) deviation from the long-run trend and medium-run cycle in real prices from the beginning of the boom to the peak. Figures 20 through 25 display the histograms for these six features of the 326 complete commodity price booms pooled across the seven product categories. Briefly summarizing, we find that the 1910s, 1930s, 1970s, 1990s, and 2000s gave rise to the majority of the start, peak, and end dates for commodity price booms. Collectively, this suggests much shorter years to peak and cycle lengths than in the case of commodity price cycles with the majority of commodity price booms peaking within one year from their start and the majority of commodity price booms being 0 to 1 years in length. What is also very clear is that commodity price booms are associated with much more pronounced deviations from long-run trends in real prices than would be suggested by the evidence on commodity price cycles alone: the majority of booms are associated with spikes in real prices of 25 to 75% with values in excess of 300% not being unheard of.

As before, we also characterize systematic differences in these commodity price booms across time. A battery of regressions were run using three of their features (years to peak, boom, and cumulative deviation) as dependent variables and a set of indicator variables capturing two different time periods, namely from 1914 to 1945 (interwar) and from 1946 to 2015 (post-World War II). Thus, the period from 1850 to 1913 (pre-World War I) acts as the omitted category. In terms of statistically significant results, the interwar and post-World War II eras saw higher values for boom length at 1.15 and 1.38 years ($\hat{\beta}_0 + \hat{\beta}_{IW} = 0.83 + 0.32;\ \hat{\beta}_0 + \hat{\beta}_{PWWII} = 0.83 + 0.55$), respectively. Likewise, the interwar and post-World War II eras witnessed larger cumulative increases in real prices from the beginning of the boom to the peak of 53.06% and 54.69%, respectively ($\hat{\beta}_0 + \hat{\beta}_{IW} = 42.38 + 10.68;\ \hat{\beta}_0 + \hat{\beta}_{PWWII} = 42.38 + 12.31$). These results immediately suggest that periods of freely floating nominal exchange rates have historically been associated with larger and longer real commodity price booms.

Turning to the evidence on commodity price busts, we identify and enumerate six features of busts across the 40 commodities, namely their start date, peak date, end date, years to trough, bust length, and the cumulative (negative) deviation from the long-run trend and medium-run cycle in real prices from the beginning of the bust to the trough. Figures 26 through 31 display the histograms for these six features of the 276 complete commodity price busts pooled across the seven product categories. Briefly summarizing, we find that the 1920s, 1930s, 1980s, and 2000s gave rise to the majority of the start, peak, and end dates for commodity price busts. The figures suggest similar dynamics as commodity price booms with the majority of commodity price busts reaching their trough within one year from their start and the majority of commodity price busts being 0 to 1 years in length. What is also very clear is that commodity price busts are likewise associated with very pronounced deviations from long-run trends and medium-run cycles in real prices: the majority of busts are associated with a cratering in real prices of 15 to 30%.

A final battery of regressions were run using three of their features (years to trough, cycle length, and cumulative deviation) as dependent variables and a set of indicator variables capturing two different time periods, namely from 1914 to 1945 (interwar) and from 1946 to 2015 (post-World War II) with the period from 1850 to 1913 (pre-World War I) acts as the omitted category. In this case, the interwar and post-World War II eras distinguished themselves with lower associated values for the cumulative deviation from trend and cycle at -35.15% and -30.16%, respectively $(\hat{\beta}_0 = \hat{\beta}_{PWWI} = -27.51;\ \hat{\beta}_{IW} = -7.64;\ \hat{\beta}_{PWWII} = -2.65)$. Thus, the last 100 years have witnessed larger real commodity price busts—in addition to booms—than the past.

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 medium- and long-run, subject as these real commodity price booms and busts are to dramatic price increases and declines. This is seemingly a situation which has only become exacerbated over time and likely promises to do so in the future.

7. Implications of Commodity Price Booms and Busts

In light of these results, it may be worth our while to consider the broader implications of commodity price booms and busts. In particular, can we push these results even further and more closely examine the presumed link between commodity price booms and busts 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: (1) determining the patterns of commodity production across countries and time; and (2) determining what constitutes an economy-wide commodity price shock, whether boom or bust.

In this regard, the following pieces of antipodean evidence are submitted for consideration. Currently, aluminum, beef, copper, cotton, gold, iron ore, lead, natural gas, nickel, petroleum, silver, sugar, tin, wheat, wool, and zinc represent 125.80 billion AUD, or roughly 48%, of Australian goods and services exports. What is more, these have also historically been the mainstays of Australian exports. And while an earlier literature has established a link between the business cycle and export cycles in particular commodities (Cashin and McDermott, 2002b), here it is possible to combine information on Australian export shares for a number of commodities over time with the previously described indicators of real commodity price booms and busts.[10] Specifically, we define an economy-wide commodity price shock as the export-share weighted sum of commodity booms and busts which ranges from 0 to 1 by construction. Figure 32 plots these series from 1900 to 2010. Using a value of 0.50 for the export-share weighted sum as a threshold, we find that over these 111 years Australia experienced six large commodity price booms—from 1917 to 1919, from 1936 to 1937, from 1950 to 1951, from 1973 to 1974, in 1995, and in 2010—and six large commodity price busts—from 1913 to 1914, in 1921, from 1931 to 1932, from 1946 to 1947, from 1970 to 1971, and in 2001.

Supplementing the data from Barro and Ursua (2008), we can also document deviations of Australian real GDP from its rolling ten-year trend over this same period. That is, the first observation represents the deviation in that which is observed for real GDP in 1900 from that which is predicted from its linear trend from 1890 to 1899. Likewise, the last observation in this series represents the deviation in that which is observed for real GDP in 2010 from that which is predicted from its linear trend from 2000 to 2009. Figure 33 depicts the evolution of this series, capturing both the long sub-par growth experience associated with World War I, the Great Depression, and the immediate post-World War II periods and the above-trend growth episodes of the 1920s, late 1930s, and 1950s. Informally then, the timing of commodity price booms and busts seems to correspond to upswings and downswings in these deviations from trend growth.

Taking a slightly more formal approach, we can simply regress the deviations in annual real GDP from its ten-year trend on the series for commodity price booms and busts. Doing so yields a coefficient on commodity price booms of 0.77 with a standard error of 2.10 and associated p-value of 0.722 and a coefficient on commodity price busts of -5.79 with a standard

[10] These exports shares were calculated from Lougheed (2007) and the Australian Bureau of Agricultural and Resource Economics and Sciences.

error of 2.68 and associated p-value of 0.035. Taken literally, these results suggest that the transition from relatively placid conditions in global commodity markets for Australian exports to a full-blown commodity price boom is associated with a positive but statistically insignificant 0.77% deviation in real GDP from its ten-year trend. Likewise, the transition from relatively placid conditions in global commodity markets for Australian exports to a full-blown commodity price bust is associated with a negative and statistically significant 5.77% deviation in real GDP from its ten-year trend.

Undoubtedly, much more work could and should be done on 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 treatment of the nexus among commodity price booms and busts, commodity price volatility, and economic growth (Jacks *et al*., 2011).

8. Conclusions and Future Prospects

Drawing motivation from the current debate surrounding the likely trajectory of commodity prices, this paper has sought to forward our understanding of real commodity prices in the long-run along two dimensions. First, the paper has provided a comprehensive body of evidence on real commodity prices for 40 economically significant commodities from 1900. Second, the paper has provided a consistently-applied methodology for thinking about their long-run evolution. In so doing, it suggests and documents a complete typology of real commodity prices, comprising long-run trends, medium-run cycles, and short-run boom/bust episodes. The findings of the paper can be summarized as follows. First, real commodity prices have been modestly on the rise from 1900. Second, there is a pattern—in both past and present—of commodity price cycles which entail decades-long positive deviations from these long-run trends with the latest set of cycles likely at their peak. Third, these commodity price cycles are punctuated by booms and busts which are historically pervasive, exacerbated during periods of freely floating nominal exchange rates, and are highly relevant for the growth experience of commodity exporting nations.

At the same time, this paper remained relatively silent about real commodity prices as they relate to future prospects for the global economy. However, there are two consistent messages on this issue which emerge from this paper. First, much of the academic and policy literature has tended to over-emphasize the behavior of real commodity prices in both the very distant and very recent past. For all the differences in periodization, this literature has cumulatively arrived at the conclusion that real commodity prices exhibit distinctly downward trajectories. In this regard, the experience of the 1990s and early 2000s should be put in perspective: the levels of real commodity prices seen in this period are anomalous as they represent multi-year—and in some instances, multi-decade—lows.

Finally, greater volatility is a slightly more certain prospect for real commodity prices in the future. As this paper has clearly documented, periods of freely floating nominal exchange rates have been associated with longer and larger real commodity price booms and busts. And these booms and busts were, in turn, strongly associated with higher commodity price volatility—on this point, see Jacks (2013). It remains to be seen whether anything can be done to mitigate this volatility in a coordinated fashion either through market or policy mechanisms, but this volatility will certainly continue to affect the growth prospects of nations, particularly those which are commodity exporters and which have relatively low levels of financial development.

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Appendix I

This appendix details the sources of the real commodity prices 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; 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. The relevant references are:

Grilli, E.R. and M.C. Yang (1988), "Primary Commodity Prices, Manufactured Goods Prices, and the Terms of Trade of Developing Countries: What the Long Run Shows." *World Bank Economic Review* 2(1): 1-47.

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A more detailed enumeration of the sources for each individual series is as follows.

Aluminum: 1900-2010, GY and PNR; 2011-2015, UNCTAD.

Barley: 1850-1869, SS; 1870-1959, Manthy, R.S. (1974), *Natural Resource Commodities - A Century of Statistics*. Baltimore and London: Johns Hopkins Press; 1960-2015, WB.

Bauxite: 1900-2015, USGS.

Beef: 1850-1899, SS; 1900-1959, GY; 1960-2015, WB.

Chromium: 1900-2015, USGS.

Coal: 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; 1880-1948, Carter, S. *et al*. (2006), *Historical Statistics of the United States, Millennial Edition*. Cambridge: Cambridge University Press; 1949-2010, United States Energy Information Administration; 2011-2015, *BP Statistical Review of World Energy 2015*.

Cocoa: 1850-1899, Global Financial Data; 1900-1959, GY; 1960-2015, WB.

Coffee: 1850-1959, Global Financial Data; 1960-2015, WB.

Copper: 1850-1899, SS; 1900-2010, GY and PNR; 2011-2015, 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; 2000-2015, United States Department of Agriculture National Agricultural Statistics Service.

Cotton: 1850-1899, SS; 1900-1959, GY; 1960-2015, WB.

Cottonseed: 1874-1972, Manthy, R.S. (1974), *Natural Resource Commodities - A Century of Statistics*. Baltimore and London: Johns Hopkins Press; 1973-2015, National Agricultural Statistics Service.

Gold: 1850-1999, Global Financial Data; 2000-2015, Kitco.

Hides: 1850-1899, SS; 1900-1959, GY; 1960-2015, UNCTAD.

Iron ore: 1900-2015, USGS.

Lamb: 1850-1914, SS; 1915-1970, GY; 1971-2015, WB.

Lead: 1850-1899, SS; 1900-2010, GY and PNR; 2011-2015, UNCTAD.

Manganese: 1900-2015, USGS.

Natural gas: 1900-1921, Carter, S. *et al*. (2006), *Historical Statistics of the United States, Millennial Edition*. Cambridge: Cambridge University Press; 1922-2015, United States Energy Information Administration.

Nickel: 1850-2010, USGS; 2011-2015, IMF.

Palm oil: 1850-1899, SS; 1900-1959, GY; 1960-2015, WB.

Peanuts: 1870-1972, Manthy, R.S. (1974), *Natural Resource Commodities - A Century of Statistics*. Baltimore and London: Johns Hopkins Press; 1973-1979, National Agricultural Statistics Service; 1980-2015, WB.

Petroleum: 1860-2000, Global Financial Data; 2001-2015, IMF.

Phosphate: 1880-1959, Manthy, R.S. (1974), *Natural Resource Commodities - A Century of Statistics*. Baltimore and London: Johns Hopkins Press; 1960-2015, WB.

Platinum: 1900-1909, USGS; 1910-1997, Global Financial Data; 1998-2015, Kitco.

Pork: 1850-1851, Cole, A.H. (1938), *Wholesale Commodity Prices in the United States, 1700-1861: Statistical Supplement*. Cambridge: Harvard University Press; 1852-1857, Bezanson, A. (1954), *Wholesale Prices in Philadelphia 1852-1896*. Philadelphia: University of Pennsylvania Press; 1858-1979, Global Financial Data; 1980-2015, IMF.

Potash: 1900-2015, USGS.

Rice: 1850-1899, SS; 1900-1956, GY; 1957-1979, Global Financial Data; 1980-2015, IMF.

Rubber: 1890-1899, Global Financial Data; 1900-1959, GY; 1960-2015, WB.

Rye: 1850-1851, Cole, A.H. (1938), *Wholesale Commodity Prices in the United States, 1700-1861: Statistical Supplement*. Cambridge: Harvard University Press; 1852-1869, Bezanson, A. (1954), *Wholesale Prices in Philadelphia 1852-1896*. Philadelphia: University of Pennsylvania Press; 1870-1970, Manthy, R.S. (1974), *Natural Resource Commodities - A Century of Statistics*. Baltimore and London: Johns Hopkins Press; 1971-2015, National Agricultural Statistics Service.

Silver: 1850-2015, Kitco.

Steel: 1850-1998, USGS; 1999-2015, WB.

Sugar: 1850-1899, SS; 1900-1959, GY; 1960-2015, WB.

Sulfur: 1870-1899, Manthy, R.S. (1974), *Natural Resource Commodities - A Century of Statistics*. Baltimore and London: Johns Hopkins Press; 1900-2010, USGS.

Tea: 1850-1899, SS; 1900-1959, GY; 1960-2015, WB.

Tin: 1850-1899, SS; 1900-2010, GY and PNR; 2011-2015, 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, Millennial Edition*. Cambridge: Cambridge University Press; 1900-1959, GY; 1960-2015, WB.
Wheat: 1850-1999, Global Financial Data; 2000-2015, United States Department of Agriculture National Agricultural Statistics Service.
Wool: 1850-1899, SS; 1900-1979, GY; 1980-2015, IMF.
Zinc: 1850-2000, Global Financial Data; 2001-2015, IMF.

Table 1: Value of Production across Commodities in 2011			
Commodity	Production in 2011	Units of measurement	Value of production (b 2011 USD)
Animal products			**528.46**
Beef	62.54	Million tonnes	252.79
Hides	6.12	Million tonnes	5.02
Lamb	8.16	Million tonnes	54.14
Pork	110.27	Million tonnes	216.52
Energy products			**4180.65**
Coal	7.70	Billion tonnes	566.82
Natural gas	3.28	Trillion cubic m.	457.03
Petroleum	4.00	Billion tonnes	3156.81
Grains			**801.99**
Barley	133.05	Million tonnes	27.57
Corn	883.46	Million tonnes	206.59
Rice	722.76	Million tonnes	398.75
Rye	12.82	Million tonnes	5.57
Wheat	704.08	Million tonnes	163.50
Metals			**2133.32**
Aluminum	44.40	Million tonnes	110.91
Chromium	7.18	Million tonnes	19.97
Copper	16.10	Million tonnes	146.51
Lead	4.70	Million tonnes	11.21
Manganese	16.00	Million tonnes	18.76
Nickel	1.94	Million tonnes	44.42
Steel	1.49	Billion tonnes	1746.65
Tin	244.00	Thousand tonnes	6.70
Zinc	12.80	Million tonnes	28.20
Minerals			**419.04**
Bauxite	259.00	Million tonnes	8.00
Iron ore	2.94	Billion tonnes	339.25
Phosphate	198.00	Million tonnes	36.61
Potash	36.40	Million tonnes	26.45
Sulfur	70.50	Million tonnes	8.74
Precious metals			**154.67**
Gold	2.66	Thousand tonnes	110.94
Platinum	484.00	Tonnes	22.09
Silver	23.30	Thousand tonnes	21.65
Soft commodities			**503.34**
Cocoa	4.05	Million tonnes	12.08
Coffee	8.28	Million tonnes	38.53
Cotton	27.67	Million tonnes	92.10
Cottonseed	48.84	Million tonnes	15.56
Palm oil	48.98	Million tonnes	55.12
Peanuts	37.87	Million tonnes	79.00
Rubber	10.98	Million tonnes	52.98
Sugar	172.15	Million tonnes	98.68
Tea	4.27	Million tonnes	12.48
Tobacco	7.57	Million tonnes	33.94
Wool	1.07	Million tonnes	12.88

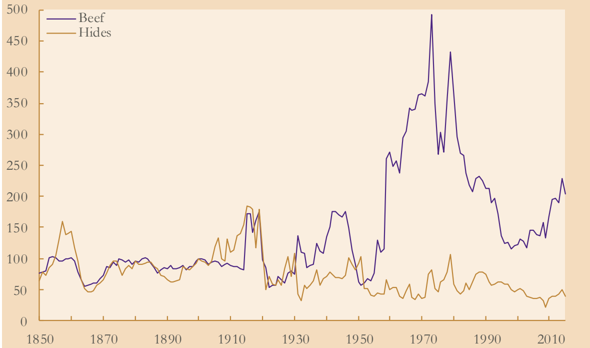


Figure 1a: Real Animal Product Prices, 1850-2015 (1900=100)

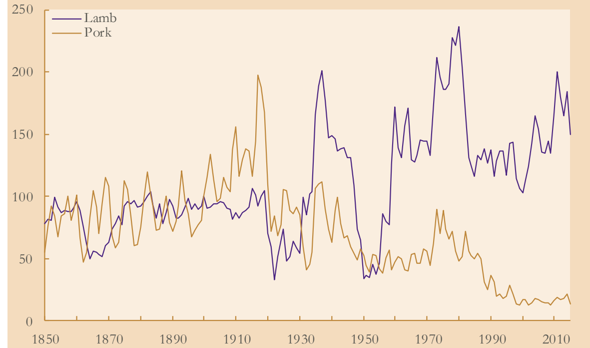


Figure 1b: Real Animal Product Prices, 1850-2015 (1900=100)

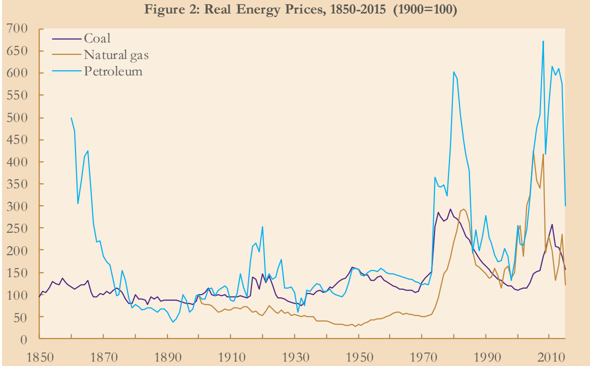


Figure 2: Real Energy Prices, 1850-2015 (1900=100)

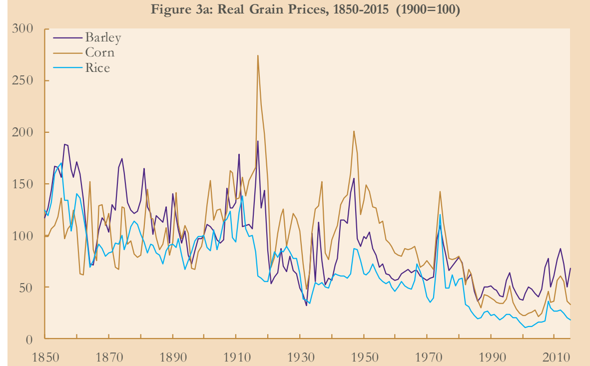


Figure 3a: Real Grain Prices, 1850-2015 (1900=100)

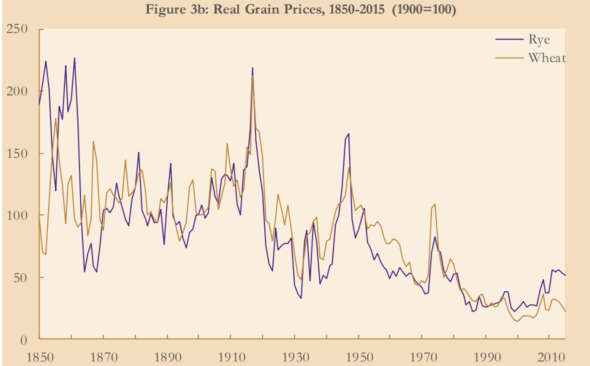


Figure 3b: Real Grain Prices, 1850-2015 (1900=100)

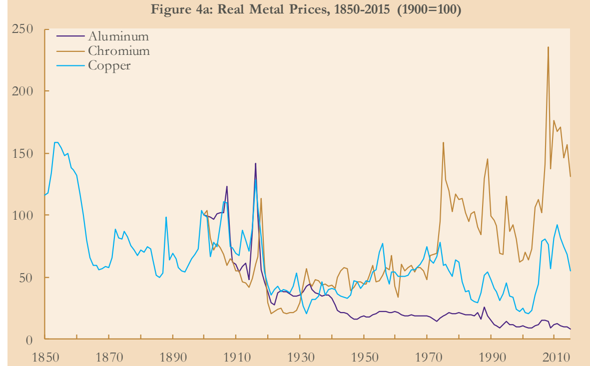


Figure 4a: Real Metal Prices, 1850-2015 (1900=100)

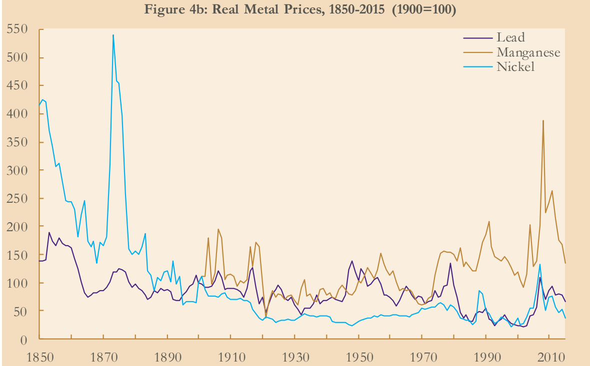


Figure 4b: Real Metal Prices, 1850-2015 (1900=100)

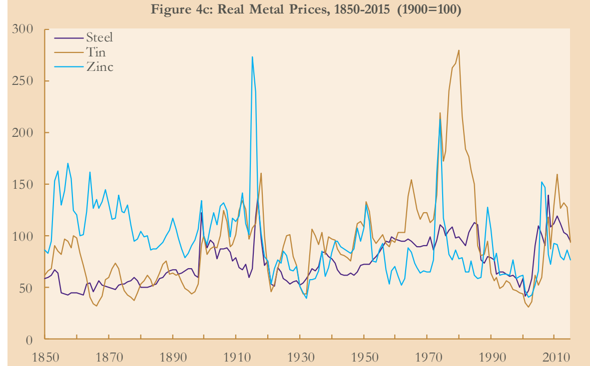


Figure 4c: Real Metal Prices, 1850-2015 (1900=100)

Figure 5a: Real Mineral Prices, 1880-2015 (1900=100)

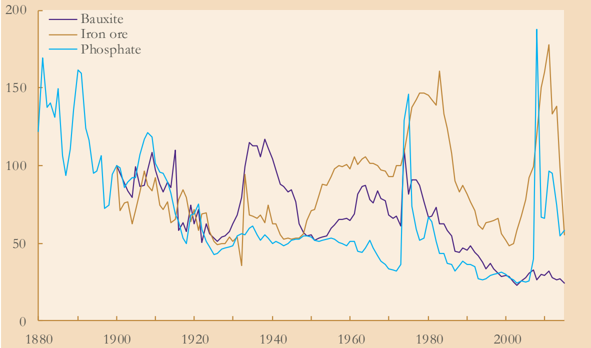


Figure 5b: Real Mineral Prices, 1870-2015 (1900=100)

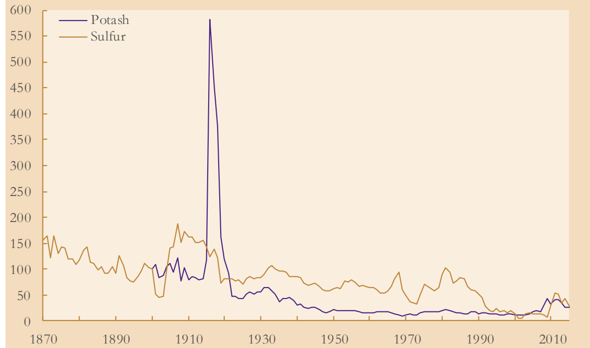


Figure 6: Real Precious Metals Prices, 1850-2015 (1900=100)

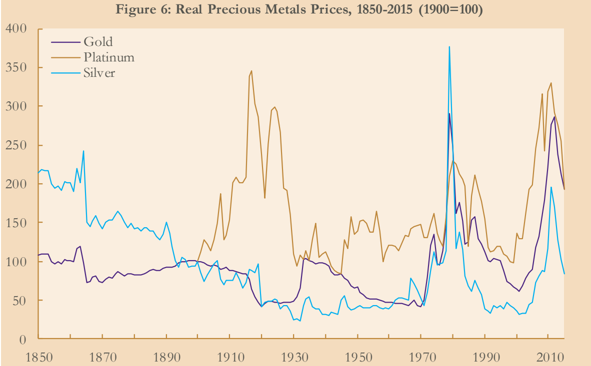


Figure 7a: Real Soft Commodity Prices, 1850-2015 (1900=100)

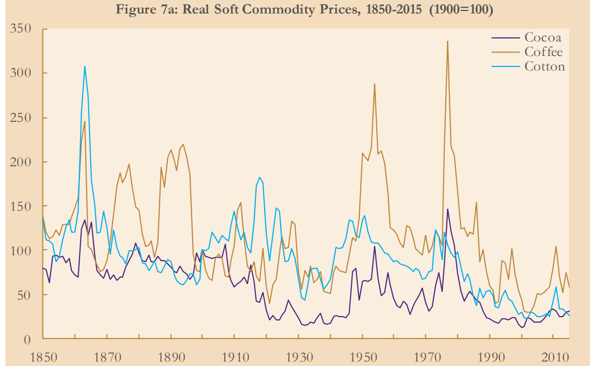


Figure 7b: Real Soft Commodity Prices, 1850-2015 (1900=100)

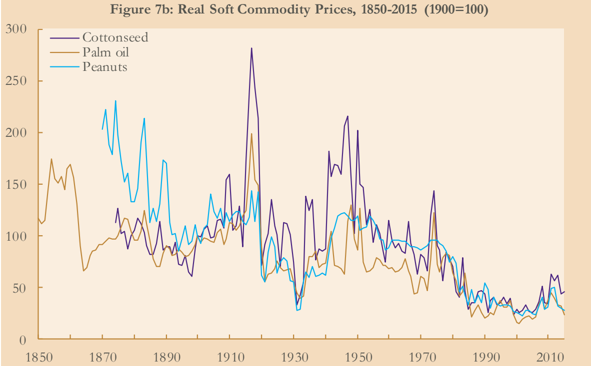


Figure 7c: Real Soft Commodity Prices, 1850-2015 (1900=100)

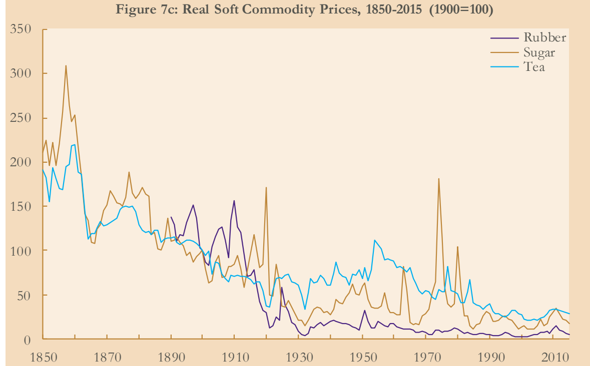


Figure 7d: Real Soft Commodity Prices, 1850-2015 (1900=100)

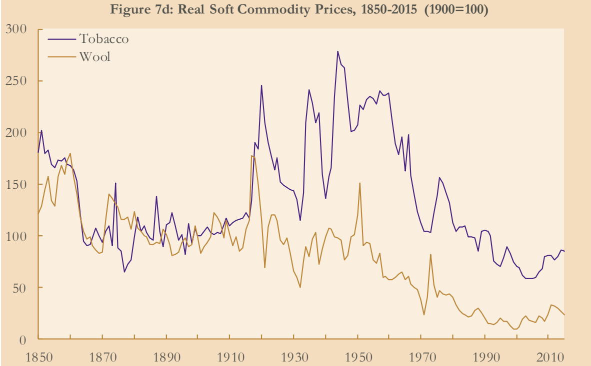
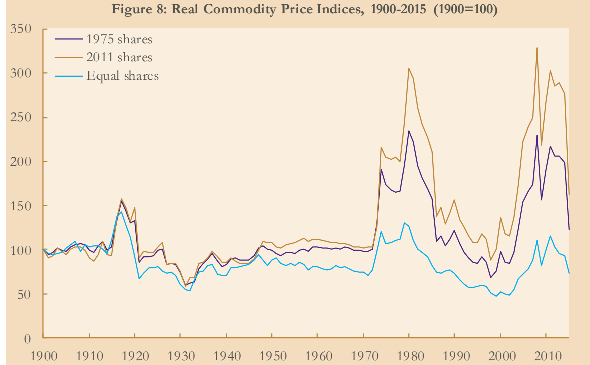


Figure 8: Real Commodity Price Indices, 1900-2015 (1900=100)



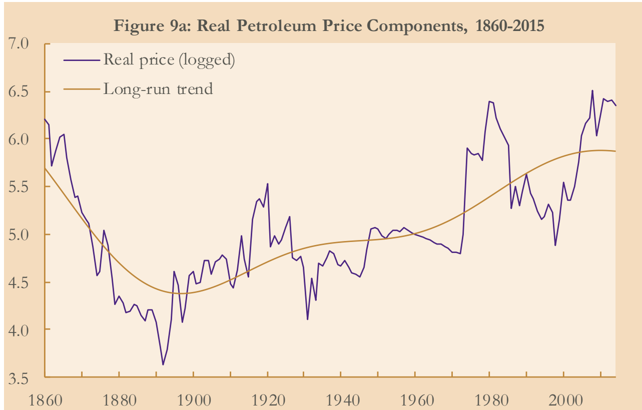


Figure 9a: Real Petroleum Price Components, 1860-2015
Real price (logged)
Long-run trend
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
1860 1880 1900 1920 1940 1960 1980 2000

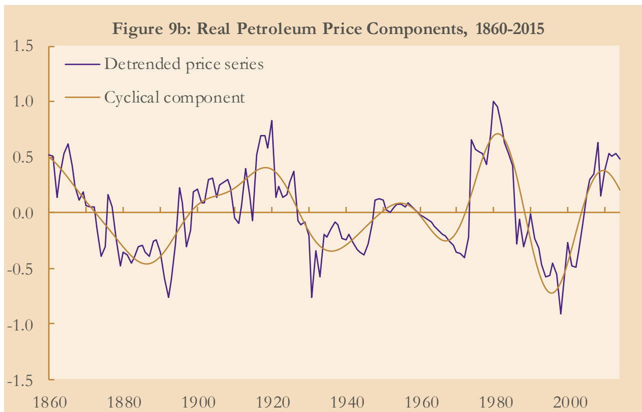


Figure 9b: Real Petroleum Price Components, 1860-2015
Detrended price series
Cyclical component
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1860 1880 1900 1920 1940 1960 1980 2000

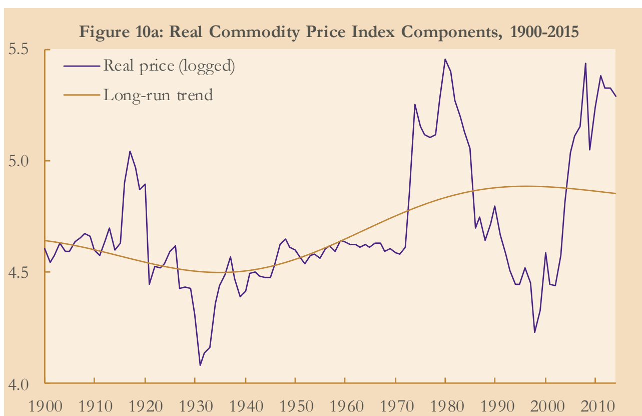


Figure 10a: Real Commodity Price Index Components, 1900-2015
Real price (logged)
Long-run trend
5.5
5.0
4.5
4.0
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

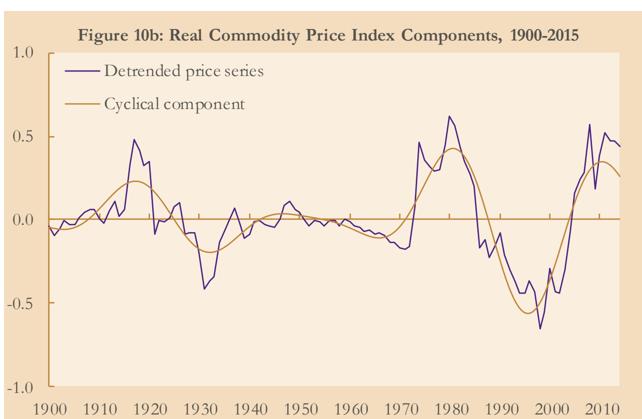


Figure 10b: Real Commodity Price Index Components, 1900-2015
Detrended price series
Cyclical component
1.0
0.5
0.0
-0.5
-1.0
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

Table 2: Cumulative Changes in Prices Relative to Estimated Long-Run Trend

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	122.85	81.84	12.94	-31.69
Hides	-41.93	-56.82	-27.72	-21.53
Lamb	91.68	63.43	47.06	4.27
Pork	-76.55	-86.42	-76.96	-67.97
Energy products				
Coal	53.92	71.25	23.33	-3.96
Natural gas		92.27	369.68	79.05
Petroleum		339.45	151.67	82.04
Grains				
Barley	-52.88	-43.74	-24.11	-4.04
Corn	-68.02	-71.79	-73.10	-54.42
Rice	-85.16	-80.47	-72.27	-59.18
Rye	-74.39	-58.63	-42.93	-4.87
Wheat	-79.22	-81.35	-76.59	-58.81
Metals				
Aluminum		-89.88	-56.86	-47.31
Chromium		59.59	172.52	48.82
Copper	-53.89	-28.52	6.72	0.27
Lead	-59.50	-33.59	-37.81	-12.96
Manganese		40.68	78.73	29.88
Nickel	-88.13	-50.17	14.76	-8.19
Steel	65.98	20.45	11.21	-3.95
Tin	30.62	8.37	-27.88	-32.03
Zinc	-27.32	-28.99	-4.51	-4.11
Minerals				
Bauxite		-72.72	-67.15	-62.53
Iron ore		-24.08	-10.92	-38.62
Phosphate		-50.25	-4.65	9.37
Potash		-78.68	8.11	90.95
Sulfur		-79.33	-72.69	-56.84
Precious metals				
Gold	65.44	94.75	169.02	104.11
Platinum		46.13	54.44	51.08
Silver	-63.47	-25.16	67.05	11.84
Soft commodities				
Cocoa	-68.71	-67.59	-39.09	-51.62
Coffee	-59.44	-51.94	-56.10	-59.47
Cotton	-79.13	-70.42	-73.13	-63.33
Cottonseed		-59.99	-68.55	-41.44
Palm oil	-79.32	-73.72	-69.21	-54.81
Peanuts		-75.50	-71.99	-63.34
Rubber		-95.45	-63.49	-44.43
Sugar	-91.43	-81.82	-55.70	-49.60
Tea	-85.36	-69.12	-65.31	-53.16
Tobacco	-53.60	-23.43	-64.90	-41.60
Wool	-84.23	-78.67	-77.03	-45.15

Figure 11: Real Commodity Price Sub-indices, 1900-2015 (1900=100)

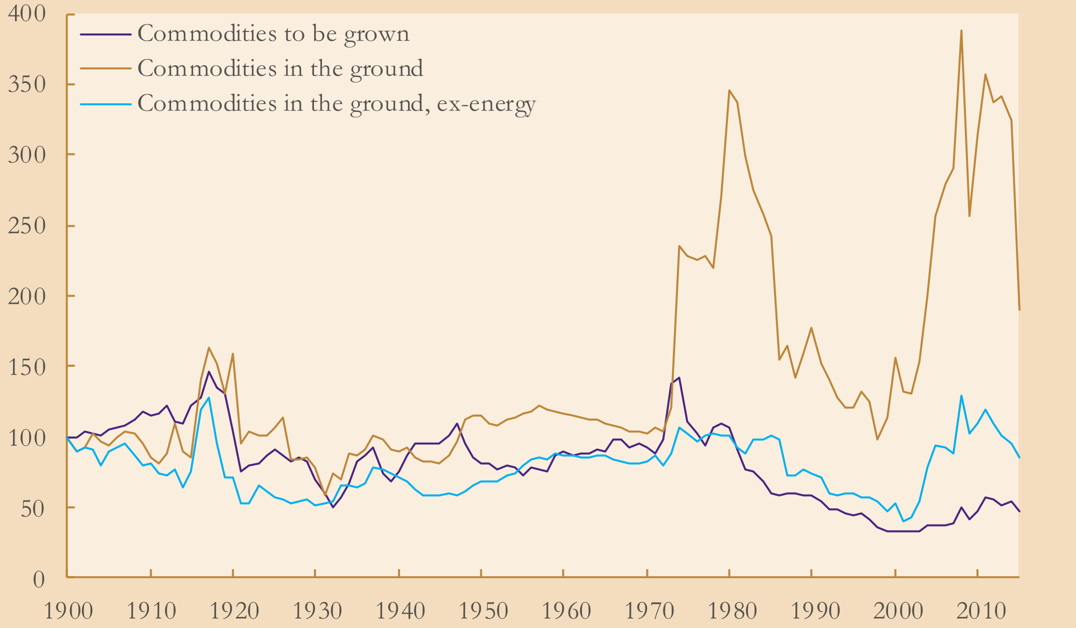


Figure 12: Frequency of Commodity Price Cycle Start Dates

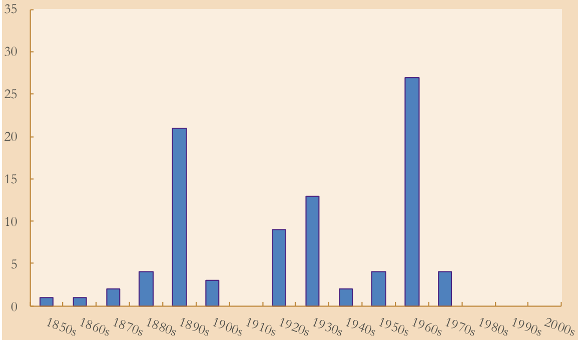


Figure 13: Frequency of Commodity Price Cycle Peak Dates

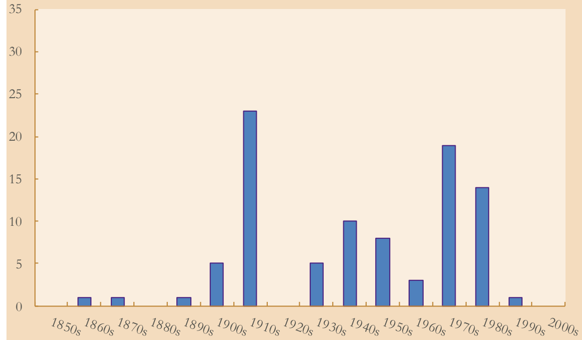


Figure 14: Frequency of Commodity Price Cycle End Dates

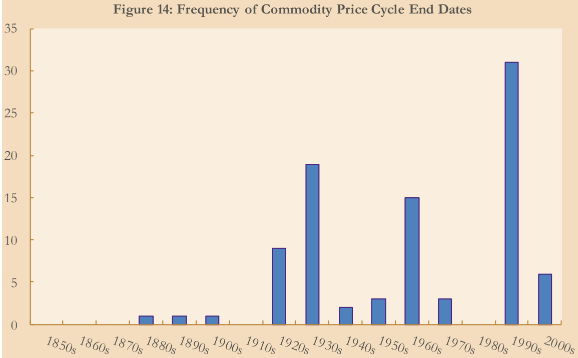


Figure 15: Frequency of Commodity Price Cycle Years to Peak

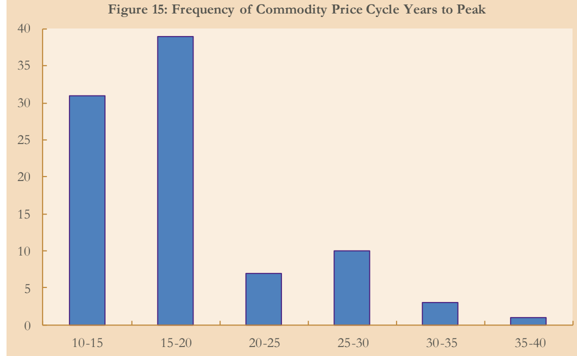


Figure 16: Frequency of Commodity Price Cycle Length in Years

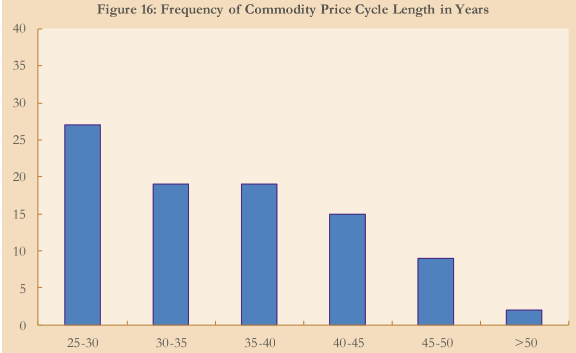
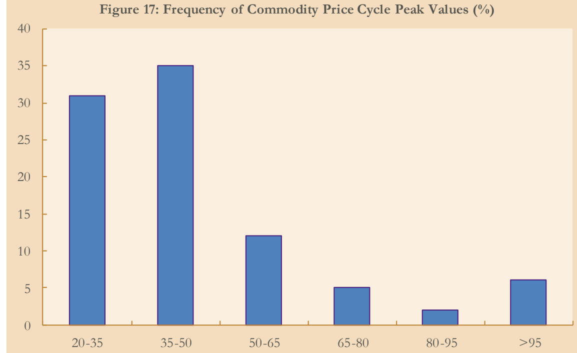


Figure 17: Frequency of Commodity Price Cycle Peak Values (%)



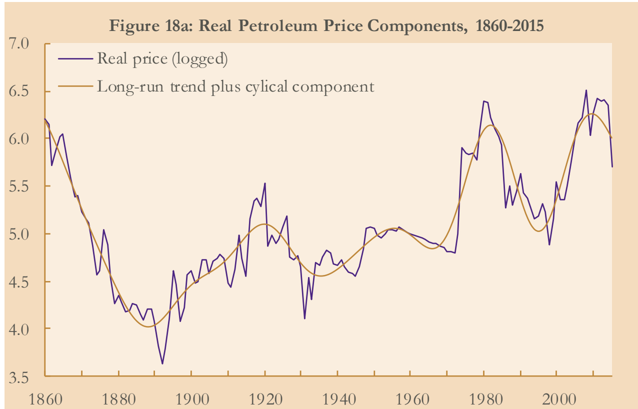


Figure 18a: Real Petroleum Price Components, 1860-2015

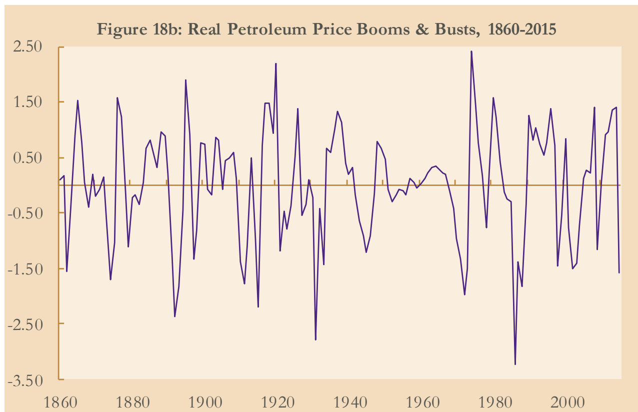


Figure 18b: Real Petroleum Price Booms & Busts, 1860-2015

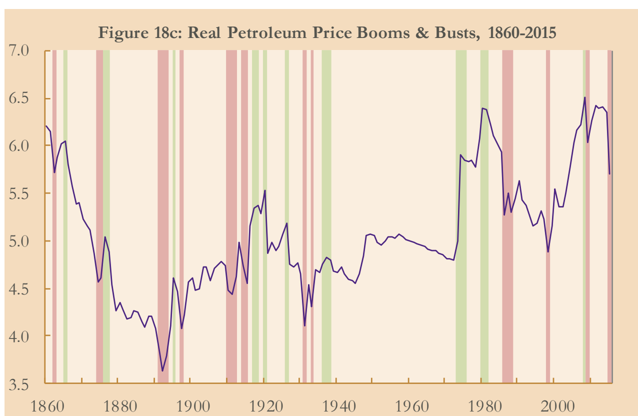


Figure 18c: Real Petroleum Price Booms & Busts, 1860-2015

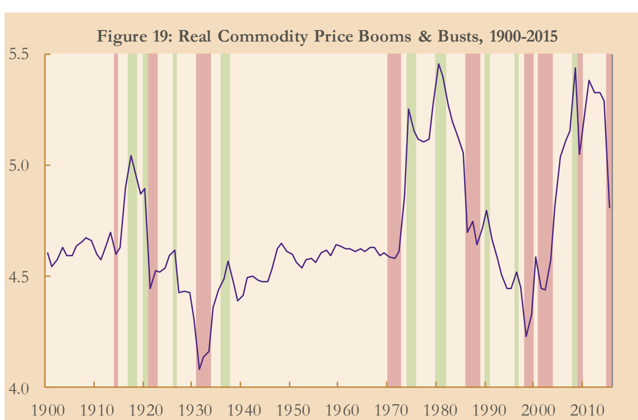


Figure 19: Real Commodity Price Booms & Busts, 1900-2015

Figure 20: Frequency of Commodity Price Boom Start Dates

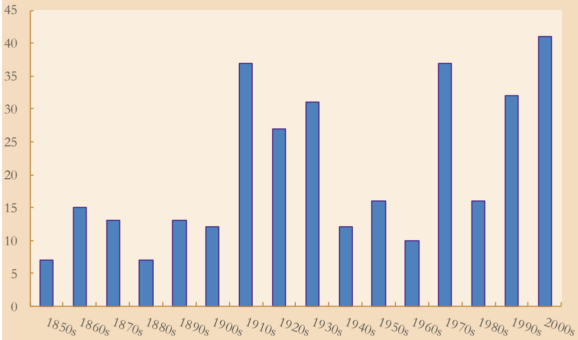


Figure 21: Frequency of Commodity Price Boom Peaks

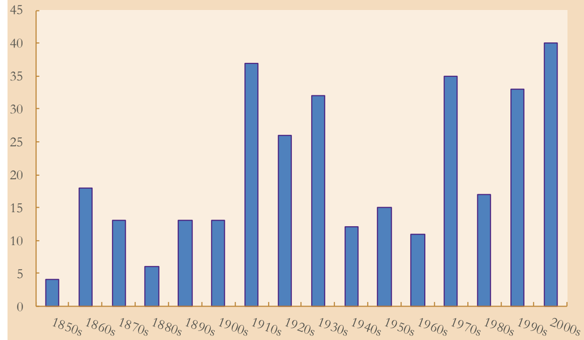


Figure 22: Frequency of Commodity Price Boom End Dates

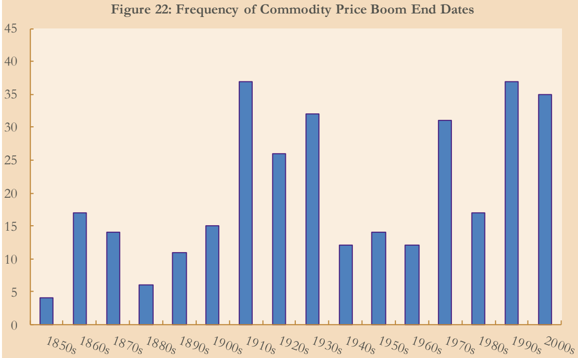


Figure 23: Frequency of Commodity Price Boom Years to Peak

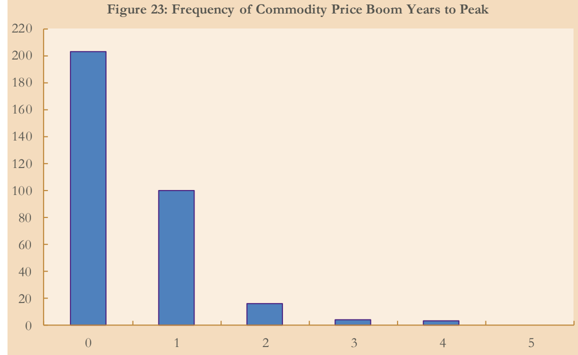


Figure 24: Frequency of Commodity Price Boom Lengths in Years

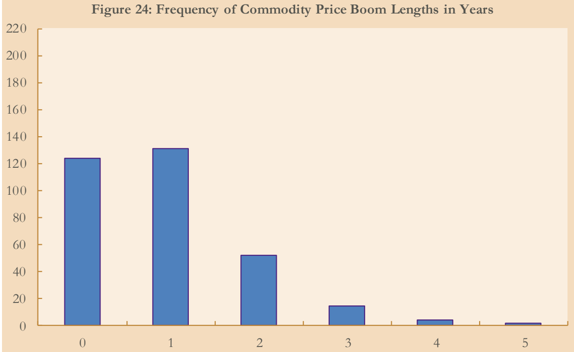


Figure 25: Frequency of Commodity Price Boom Increases (%)

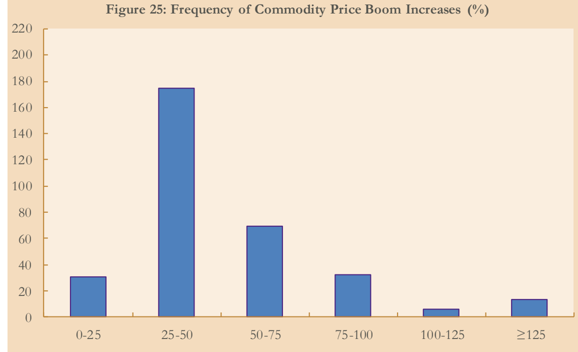


Figure 26: Frequency of Commodity Price Bust Start Dates

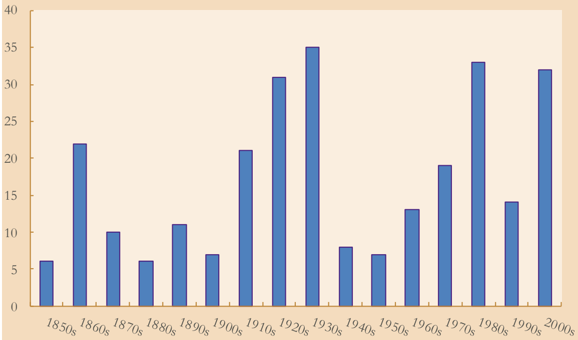


Figure 27: Frequency of Commodity Price Bust Troughs

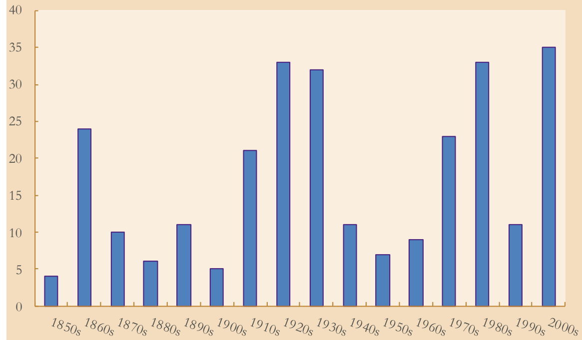


Figure 28: Frequency of Commodity Price Bust End Dates

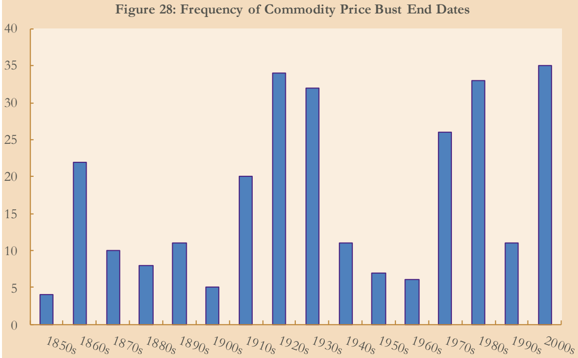


Figure 29: Frequency of Commodity Price Bust Years to Trough

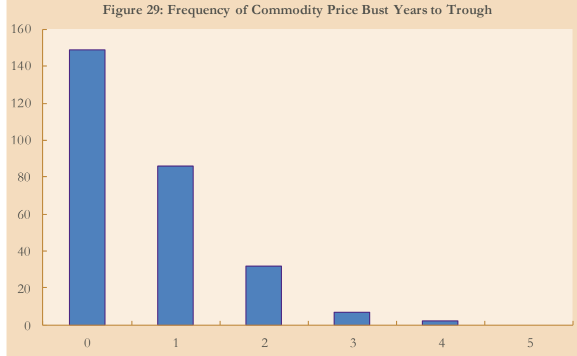


Figure 30: Frequency of Commodity Price Bust Lengths in Years

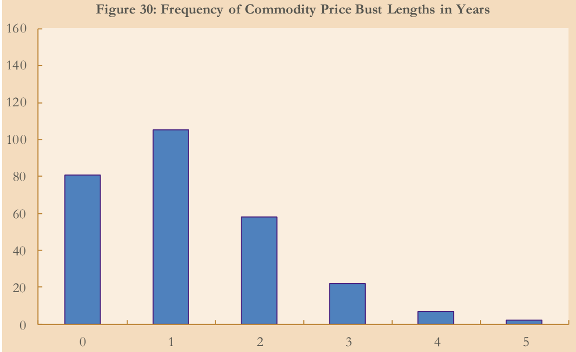
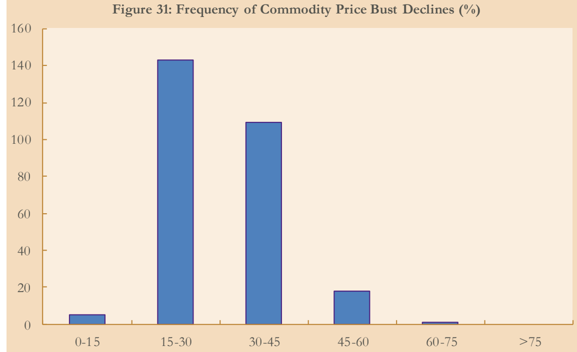


Figure 31: Frequency of Commodity Price Bust Declines (%)



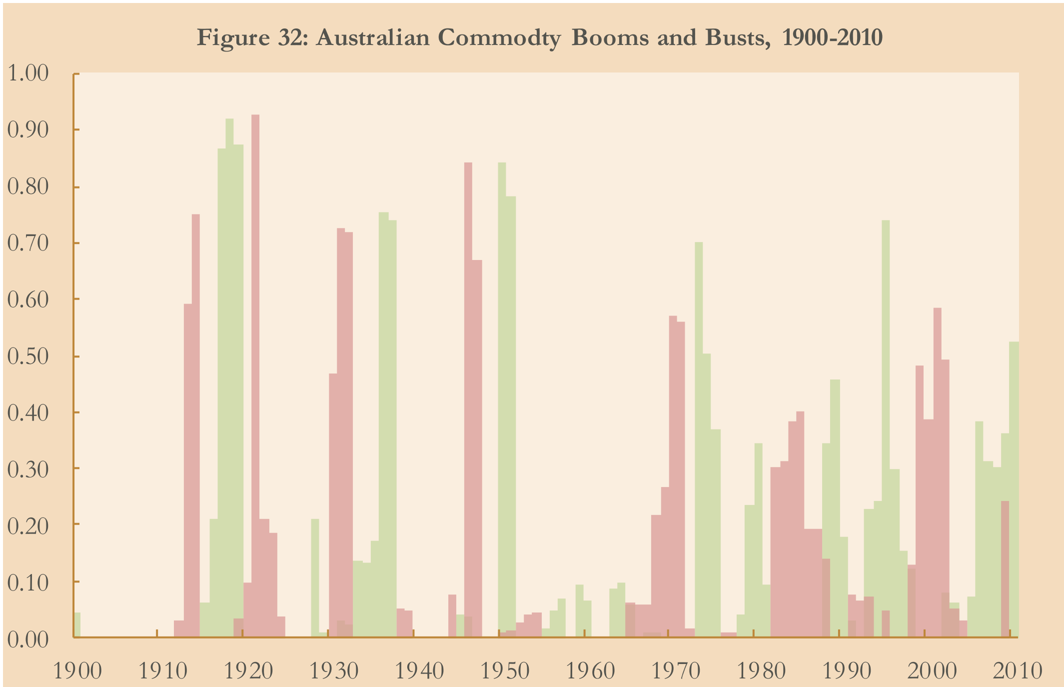


Figure 32: Australian Commodty Booms and Busts, 1900-2010
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

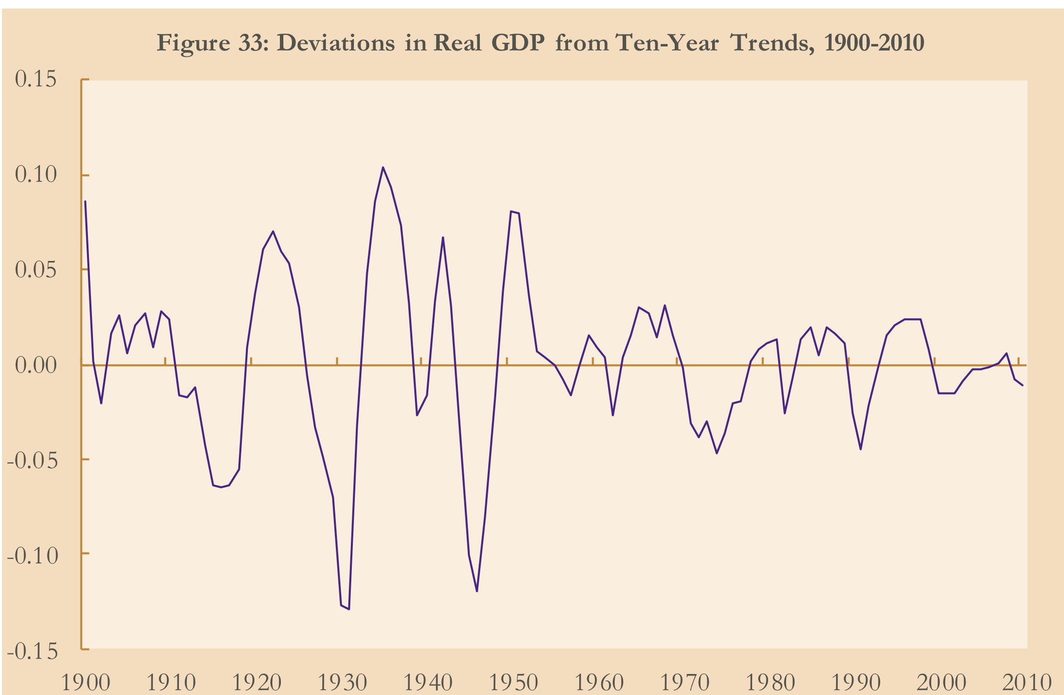


Figure 33: Deviations in Real GDP from Ten-Year Trends, 1900-2010
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010