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Business cycles, commodity prices and shipping freight rates: Some evidence from the pre-WWI period

by

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Business cycles, commodity prices and shipping freight rates: Some evidence from the pre-WWI period*

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Abstract

The empirical analysis shows that cycles in economic activity are major determinants of the short-run behaviour of shipping freight rates in the years between 1850 and WWI. Consistent with economic theory there is a striking asymmetry between the peaks and troughs of shipping cycles, however. There is often a close timing relationship between the upper turning points of the business cycle, commodity prices and freight rates, which is shown to be particularly tight in the grand peak years of 1873, 1889, 1900 and 1912. On the other hand, the dating of the lower turning points of the freight rate cycles is often more indeterminate, differing considerably between the various trade routes and being generally less well synchronized with the business cycle troughs.

JEL Classification: E32,N71,N73

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1 Introduction

The years 1950 - 1973 constituted the Golden Age of European Growth. It ended in a spectacular boom in output, commodity prices and shipping freight rates.[1] From 1966 to 1973 world seaborne trade increased by 78 per cent. The final year of the boom period, 1973, was indeed 'one of the great years in shipping'.[2] But in few other sectors was the hangover after the high values of the boom period more severe and protracted than in ocean shipping. There was in fact no growth in the volume of world seaborne trade between 1973 and 1988.[3] Freight rates fell faster than anchors to the bottom of the sea, and managed only to stage some short-lived and feeble recoveries in the following decades.

The twentyfive-year period of unusually high growth rates in economic activity starting at mid-century, and ending in a spectacular boom, has a striking parallel exactly a century earlier. In Britain this period is known as the Great Victorian Boom.[4] The mid-19th century golden age culminated in the superboom of 1872-73. According to Lewis (1979, p. 34) this would be the last time for eighty years that all four countries in the 'core' (USA, UK, France and Germany) would be having a construction boom simultaneously.

The early 1870s were heydays of the shipping industry, as the world-wide demand for shipping services surged and freight rates were equally buoyant. Norwegian shipowners, still heavily committed to sailing ships, enjoyed some very prosperous years. A particular example is provided by the records of the 525-ton barque *Ellida,* built in 1867, of which the Bergen shipowner Peter Jebsen was one of the owners. A fairly continuous record of net profits has survived for this ship until she foundered in the Mediterranean in 1891.[5] The vessel participated initially in the Black Sea grain trade with some success, but was shifted into the US east coast grain trade after 1871, where she generated large profits over the next two years. In 1872 and 1873 the net profit rate was in excess of 30 per cent, a dazzling performance which was not to be seen again later in the 1870s.[6]

There is thus no want of anecdotal evidence regarding the coexistence of business cycle booms and periods of extraordinarily high ocean freight rates. How systematic is this relationship? Did the highs and lows in freight rates generally coincide with the business cycle turning points? This issue is basically tantamount to asking how pervasive was the influence of the demand side in the determination of shipping freight rates. Thus, although both demand *and* supply factors obviously influence freight rates in general, we limit the discussion here to the former. Our primary focus is on the degree of correlation and, in particular, the timing of the relationship between cycles in economic activity and in the freight rates.

In this paper we take a preliminary look at the evidence for the pre-WWI period. Like the post-WWII period these years are characterized by increasingly globalized markets. Some local wars were fought; the period had its parallel to the Suez crisis in the Crimean war episode

[1] For an overview of the economic growth of the period see Crafts and Toniolo (1996).
[2] Stopford (1997, p. 63).
[3] Data from *Fearnleys Review* 1975 and 1989.
[4] Church (1975).
[5] This example is provided by Fischer and Nordvik (1986a).
[6] The profits from the Black Sea voyages in 1869 and 1870 were also excellent.

1854-1856, the Russo-Turkish war in 1877 and the South African war in 1900, but apart from these episodes wartime demand for shipping space was not of much importance.

2 The determinants of ocean freight rates

2.1 Theory

In the shipping markets demand is said to be 'volatile, quick to change and unpredictable; supply is ponderous and slow to change'.[7] We need to know a little about which factors are the most important ones in order to relate the shipping cycles to the general cycles in business activity.

World economic activity is by far the most important single influence on the demand for sea transport. In long periods of the postwar years sea trade has been growing significantly faster than industrial production, resulting in a trade elasticity[8] of 1.4 to 1.6. A high trade elasticity is typical of an era of trade liberalization and increasing globalization, as in the pre-WWI and post-WWII periods.[9] It is not a feature of the 1930s, however, when international trade fell relative to domestic output. Thus, even if the proportionality factor may vary over time, world output is the permanent and fundamental factor on the demand side, which engenders a strong positive correlation between freight rates and business cycles. Political disturbances and war episodes may indeed exert a great effect on freight rates when they occur, but these are ephemeral and idiosyncratic, rather than recurrent, events. Long-run trends in the demand for sea transport are also affected by structural changes in world commodity trade, such as changes in the sources from which the supplies of the commodities are obtained.[10] A crucial factor in this connection is the average haul, the average distance over which the commodities are transported, which is also affected by such events as the opening and closure of canals. But these factors belong to the long run and are of less importance in studies focusing on the cyclical movements.

The functional form of the supply curve presents some peculiar features that are of great relevance here.[11] At low levels of freights the supply curve is relatively flat in the short and intermediate run, being bounded downwards by the variable cost of voyages. As the demand schedule shifts to the right due to increased activity, it intersects with a supply curve that begins to slope upwards more and more steeply. There are two basic reasons for this: (1) higher freight rates make it profitable to move ships out of lay-up, and (2) rising freight rates increase the optimal speed of ships (other than sailing ships) and thus the effective supply of shipping space. As full capacity utilization is approached, the supply curve becomes very steep as all available ships are operational and running at full speed. In the long run improvements in shipbuilding technology and port handling are major factors shifting the long run supply curve permanently

[7]Stopford (1997, p. 117). The remainder of this section draws heavily on material presented in this source.

[8]The trade elasticity is the percentage change in sea trade divided by percentage change in commodity output.

[9]Beenstock and Vergottis (1993) note that in the 1870s the demand for ocean transport grew at an average rate of 7.4 per cent per year, which is very high relative to growth rates in the world economy of 2.5 per cent.

[10]A prominent example is provided by the grain import trade to the UK in the second half of the nineteenth century. As from mid-century imports from the Baltic diminished in importance relative to more distant sources in the Black Sea and on the American Atlantic coast. Around 1870 cereals were transported even further, from the US Pacific coast, Australia and India, and, from the late 1880s, Argentina.

[11]See Strømme Svendsen (1958) for an early exposition of the theory of demand and supply.

to the right and thus lowering freight rates.[12] Again, these are long-run trends that do not concern us here; what is of more importance are the decisions relating to scrapping and new investments, because these may depend on business cycle conditions. When freight rates and capacity utilization are high more ships are ordered[13], but new ships can only be delivered after a considerable time lag. In the meantime the demand for sea transport may have fallen, and in that case freight rates may be further depressed when the new tonnage capacity is ready.

In summary, the theory of demand and supply in the freight market gives rise to several hypotheses regarding the relationship between shipping cycles and business cycles. Freight rates are basically procyclical (relative to general business cycles), but the 'horizontal hockey-stick shaped' supply curve means that a given shift in demand may affect freight rates greatly in peak periods, but only weakly in periods of dull trade. This effect may give the shipping cycle a more volatile behaviour in peak periods than business cycle curves normally display. Secondly, both demand and supply of sea transport are positively affected by economic activity, but new capacity can only be created with a time lag once the reserve capacity of the laid-up fleet has been exhausted. With respect to the timing of shipping and business cycles this may introduce a rather drawn-out trough period, as many new ships are launched long after the peak of the business cycle has been passed. Whereas peaks in shipping and business cycles may roughly coincide in time, the theory outlined above suggests that the troughs of shipping cycles occur later than in business cycles.

2.2 Empirical evidence

Econometric studies of demand and supply There is ample empirical support from the postwar period for our first hypothesis regarding the positive correlation between freight rates and economic activity.[14] This feature seems to be well established for the pre-WWI period as well, which is of special interest here. Tinbergen (1959)[15], Isserlis (1938) and Meuldijk (1940) are early examples of such studies.

There is also considerable evidence that new investment in shipping was positively affected by the business cycle with a time lag. The pre-1914 data on the volume of shipbuilding (on the Wear) show how shipbuilding activity picked up during periods of cyclical high freight rates, a relationship which extends to the more recent years.[16] These findings are of considerable interest also from a methodological point of view, particularly the issue of whether business cycles could be most fruitfully modelled as periodic cycles of regular length, or whether cycles were of irregular length. The definition of business cycles introduced by Burns and Mitchell (1946, p. 3), in which business cycles are most fruitfully viewed as 'recurrent, but not periodic',

[12] Such effects are believed to be particularly important in the 19th century, when freight rates showed a secular decline. How much they declined and in which periods are still issues debated among economic historians, however, see North (1958) and Harley (1988).

[13] This is the conventional assumption, but there are indeed examples of reinvestment cycles being generated even in depressed freight markets; in 1983-84 freight rates were low but large orders were placed for new bulk carriers (Stopford (1997, p. 66)).

[14] See inter alia Strandenes (1977), Shimojo (1979), Beenstock and Vergottis (1993) and Stopford (1997).

[15] Originally published in Dutch in 1934.

[16] Stopford (1997, p. 51).

came to be the prevailing view.

The important work on reinvestment cycles in Norwegian shipping by Einarsen (1938) can be seen as being more in the tradition of periodic cycles. He concluded his investigations by stating that 'it is the age of the ship and not the phase of the business cycle that decides when a ship shall be replaced.'[17] On the other hand Meuldijk (1940), who applied what was then the most sophisticated econometric methodology to the problem,[18] found some evidence that business cycle considerations largely determined the replacement demand, rejecting the concept of a fixed typical age limit.

Supporting evidence on the lagged influence of business cycles on shipbuilding is available for several other time periods and markets. Slaven (1980) maintained that in the case of British shipbuilding between 1822 and 1879 the shipbuilding cycle generally lagged the business cycle by one or two years. With respect to the New Brunswick merchant fleet in the early part of the 19th century Sager and Panting (1985, p. 4) note that 'annual changes in new investment in shipping were synchronized quite closely with annual changes in the value of timber exports when shipping investment is lagged by a year'.

Identification of cycles In commenting upon the properties of his freight rate index extending back to 1869 Isserlis (1938) noted that the peaks and troughs of cycles of the new index were in close agreement with the pattern of business cycles established by Pigou (1927). Over the 1869 - 1913 period Isserlis (1938) identified seven peak-to-peak cycles with an average duration of 5.5 years and six trough-to-trough cycles of 4.8 years on average. Using information from market reports, in addition to a visual inspection of the Isserlis index, Stopford (1997) found four cycles before the First World War, when minor cycles were disregarded. This gives an average peak-to-peak duration of 9.8 years.[19] An interesting aspect of the material presented by Stopford (1997) is that shipping cycles preserve many of their salient features over the centuries. Average duration is 7.2 years in the postwar period, corresponding well to the Juglar type of 6 to 9 years of duration, and may well be in line with the evidence from the earlier years as well if some of the minor cycles possibly swamped by a steep downward trend are taken into account.

A more detailed look at the evidence requires a further analysis of many underlying aspects. First, a clarification is needed regarding the cycle concept, whether a classical cycle or a growth cycle (deviation from trend) is envisaged. In the latter case, the statistical method used in estimating the trend of the series needs to be considered. Given the secularly falling freight rates of the nineteenth century, and the tendency to a reversal of the downward trend in the years preceding WWI, this issue may be of empirical importance. Secondly, the criteria for distinguishing minor movements from a cycle should also be addressed. In both instances the same principles should be applied to shipping and business cycles, if data permit. Finally, a critical analysis of the shipping index data should be undertaken.

[17] Einarsen (1938, p. 180).

[18] The 'confluence' analysis of Frisch (1934).

[19] The decision to regard the 1900 - 1912 period as one cycle may be questioned, however, as further discussed below.

3 The data

3.1 Economic activity

An extensive analysis of the turning points of business cycles in the United States was published by Burns and Mitchell (1946), which provided the basis for the National Bureau of Economic Research (NBER) business cycle reference dates. This is still the authoritative source of the timing of US cycles; later research has largely corroborated their findings.[20] Burns and Mitchell (1946) also published historical evidence on business cycles in Britain, France and Germany, although the statistical basis for identifying cycles in these economies was much weaker than for the United States. In this paper it is natural to focus on the British business cycles because the existing data on shipping freights almost exclusively refer to trade routes to or from Britain.

A new monthly business cycle index for Britain beginning in 1850, being based on information on a number of indicators for commodity output, was presented by Klovland (1998). The new index corresponds well to the cyclical pattern established by the NBER, even though the underlying series used to determine turning points differ considerably, particularly before the late 1880s.[21] The cyclical indicator gives 50 per cent weight to railway freight traffic, in addition to data on the tonnage engaged in coastal trade, deflated bank clearings, a volume index of raw materials import as well as several indicators of cotton production. Data on railway freight traffic have a long tradition as a reliable and sensitive cyclical indicator.[22] The UK railway freight traffic series is chosen as the key business cycle measures used here, because it is available on a monthly frequency and is much influenced by the activity in the heavy commodity producing industries.[23]

Figure 1 shows annual cyclical values of the UK indicator and corresponding cycles derived from an index of industrial production in Britain compiled by Crafts et al. (1989). In order to obtain the cycle components log values of the original data series are detrended using the Hodrick and Prescott (1997) filter[24], and then the cycle series are computed as actual minus detrended values. The annual NBER recession periods for the UK as determined by Burns and Mitchell (1946) are shown as shaded areas in the figure.

A visual inspection of Figure 1 reveals that the business cycle pattern for the UK in this period is fairly easily determined, although there are minor differences between the alternative indices regarding some individual cycles. The turning points are listed in Table 1.

[20]Romer (1994) has shown that the NBER probably worked with trend-adjusted data for the pre-WWI period, so that the cycles do in fact correspond to the concept of growth cycles. In the United States the tradition is to study classical cycles, i.e. identifying absolute peaks and troughs of the series without adjusting for trend movements.

[21]The NBER analysis relies heavily on unemployment among the union of iron founders, which represents a small sector of the economy.

[22]See e.g. Hultgren (1948).

[23]In the present context of comparison with cycles in the demand for sea transport, the state of demand for bulky commodities such as coal, iron, timber and other heavy materials is of particular importance. Cotton production was an important industry in Britain, but it was of relatively less significance with respect to generating demand for ocean transport due to its light weight. The cotton series also seems to exhibit a cyclical pattern that was somewhat different from other industries, see Klovland (1998, p. 63).

[24]The smoothing parameter (lambda) in this procedure was fixed at 100 for both series. Other parameter values were considered, but a value of 100 seems to be sufficient to identify the cyclical movements quite well.

The cyclical series (including the NBER turning points) coincide exactly in six trough years (1855, 1858, 1868, 1879, 1886 and 1904) and two peak years (1860 and 1866). The preferred turning points, which are indicated in the far right column of the table, are therefore unproblematic for these years. Information from the underlying monthly reference chronologies of the NBER series and the railway freight indicator[25] is used in pinning down the turning points of the other cycles.

As pointed out by Burns and Mitchell (1946, p. 81) it may sometimes happen that the year in which the turning point of the monthly data series falls is not preserved when the series are aggregated to annual figures. Consequently, knowledge of the underlying monthly turning point may therefore be invaluable in cases where there is conflicting evidence from the annual series. This is illustrated in the three cases where the chosen turning points (UK cycle) differ from the railway freight series: the peak years of 1857 and 1889 as well as the trough of 1908. In all these cases the monthly turning points of the railway freight data do not coincide with those of the corresponding annual series, rather, these are located in the year chosen as the preferred UK cycle, for which there is also evidence from the other cyclical series.[26] Similarly, the monthly NBER turning points are not in 1894 and 1913, as indicated by the annual dates, but in February 1895 and December 1912, respectively. Given the fairly clear-cut evidence from the cyclical data in Klovland (1998, table 3.2), 1895 and 1912 are chosen here.

3.2 Freight rates

Britain was the hub of world trade in this period. This is reflected in the fact that the great majority of freight rate series that are available in the pre-WWI years refer to British outward or homeward trade routes. Ocean transport to or from Britain was even more important to world shipping than her share of world GDP indicates. Britain's strategic geographical position and tradition as a commercial centre ensured that a large re-export trade was run from London.

The index compiled by Isserlis (1938) is still the most widely used general freight rate index of the period. Its shortcomings have been noted by a number of authors.[27] New data on freight rates pertaining to particular trade routes have been published (see below), but no new index which significantly improves upon the Isserlis index seems to have been presented yet.

A critical feature of the Isserlis index is the fact no true annual averages of freight rates were used, only the annual highest and lowest quotations (from the Annual reports circulated by Angier Brothers) were at hand. This fact as well as further weakness were pointed out during the ensuing debate after the paper was read before the Royal Statistical Society in December 1937. It may be noted that even Mr. E. A. V. Angier, whose own family business had supplied the original data, was sceptical of the accuracy of the freight quotations, in particular the homeward freights.[28]

The weighting of the Isserlis index also requires some comments. Although the procedure followed in computing the index makes it difficult to give the exact weights attached to individual

[25]These are listed in Klovland (1998, table 3.2).

[26]The monthly peak dates of the railway freight series are: 1857 January, 1889 December, and 1908 December.

[27]See e.g. Yasuba (1978), Fischer and Nordvik (1986a) and Kaukiainen (1990).

[28]See *Journal of Royal Statistical Society,* 1938, pp. 135-146 for a summary of the discussion on Isserlis' paper.

trades, it seems to be clear that it gives an unduly high weight to the coal trade, as nearly all outward routes are coal freights from Britain. What is even more disturbing is the fact that the weight attached to outward coal freight rates is highly variable in the early years. The index for 1872 gives a weight of 38 per cent to coal, reflecting 11 long-distance coal freight rates which make up the index together with 18 homeward routes to Britain. In 1875 and 1876, however, *no* coal freight quotation is recorded. In 1875 the index value is based solely on 13 homeward routes, 7 of which are from the grain trade. Such discontinuities of the series included are rather problematic with respect to both cyclical behaviour and long-run trends of the index because of the annual chain method used by Isserlis (1938) in constructing his index. In 1900 the composition of the index is more balanced, as there are 44 homeward routes represented (of which 12 grain, 9 minerals, 7 timber and the remainder basically various agricultural commodities) in addition to 18 long-distance coal series.

Another generally used freight index for the period is the one published by North (1958). This index is based on American export weights and trade routes. Harley (1988) has criticized the way cotton freight rates were treated in this index. Unlike other light commodities cotton was quoted by weight, not volume, until late in the nineteenth century. This fact, combined with significant improvements in packing for shipment, which greatly reduce the amount of shipping space occupied by a pound of cotton, creates some uncertainty regarding the validity of the North index.

The potential problems with the general freight indices suggest that some attention should also be directed towards more reliable freight rate series that are available for particular trades. New coal freight series for the period 1850 to 1913 have recently been derived by Harley (1989), using contemporary newspaper sources. These data represent a significant improvement upon previous coal freight series, with respect to quality as well as coverage. The Isserlis data are heavily biased toward the quantitatively less important long distance voyages to Asia and South America, whereas Harley also provides data on the shorter northern European trades, which accounted for about 40 per cent of freight earnings from the British coal export trade.[29]

New series of Baltic timber freight rates have been presented by Fischer and Nordvik (1987) and Harley (1989). Harley (1990) is a useful source for North Atlantic freight rates for grain, flour and provisions, including previously much neglected berth cargo rates.[30] In the New York to Liverpool route the berth rates of the liners came to dominate the grain trade after 1880. But, as Harley points out, tramp cargoes played a more important role in the trade between other ports and in the case of other commodities. The New York to Liverpool grain berth rate fell more than other rates in the half century before the World War I. It is thus not wholly representative of the trend of North Atlantic grain freights, and even less so for freight rates in general. These observations call for using a broad range of freight rate series rather than relying on a single or a few key series.

[29] Harley (1988) provided separate series for the Baltic trade, the British home trade (encompassing European ports from Brest to the Elbe), and European Atlantic ports from Brest to Gibraltar. An alternative data source for the Baltic coal trade is Fischer (1991). Armstrong (1994) presents freight rate series for British coastal coal trade.

[30] Berth cargo on liners is commodities used to fill up surplus cargo space not taken up by the ordinary traffic carried at regular line rates.

There is no doubt that these new freight rate series constitute a useful addition to the the material underlying the Isserlis index, and may even be used in an attempt to construct a provisional alternative series.[31] Harley (1988) pieced together an alternative British based index to the North (1958) American series prior to 1870 by using an equally weighted average of freight rate data on coal, Baltic and North American timber and Black Sea and American grain. Harley's British index was then linked to the Isserlis index in 1870, but was not extended beyond this year because Harley (1988, p. 855) claimed that 'Isserlis's index conforms well to the various partial indices I have constructed and I have not yet undertaken the construction of an alternative.'

3.3 A new UK freight rate index

However, several new freight rate series are now available, largely due to the important contributions made by Harley (1989, 1990). In view of the problematic features of the Isserlis index, particularly in the early years after 1870, it seems worthwhile to try to construct an alternative index for the years from 1869 to 1913 along the principles used by Harley for the previous years. Given the fact that such an index is based on a few data series only, it is not at all claimed that it gives an accurate description of the *trend* movements of freight rates for this period. It is likely, however, that it may be more representative of the cyclical elements of freight markets, particularly in the 1870s. What is most imperative from the point of view of this paper is to avoid the highly variable weighting of the long-voyage coal freight series in the early years implied by the Isserlis index.

A new index representing five equally weighted trade routes has been constructed as follows:

1. UK outward coal [Harley (1989)]
2. New York to UK grain [Harley (1990)]
3. New York to UK flour and provisions [Harley (1990)]
4. Odessa to London grain [Harley (1989)]
5. Baltic to London timber and wood [Harley (1989), Fischer and Nordvik (1986b)]

A new feature of this index is the inclusion of north Atlantic berth cargo rates. The New York to UK grain freight series is constructed by giving a weight of 50 per cent to berth rates and 50 per cent to the well-known tramp cargo route 'Cork for orders' (not available after 1908) and . In consideration of Harley's warning against using the New York to Liverpool berth rate alone as an indicator of general north Atlantic freight rates, the berth rate component uses a weight of 1/2 to New York to Liverpool, and 1/4 each to New York to London and New York to Glasgow. A similar relative weighting is used for the Atlantic freight rates on flour and

[31] Norwegian shipping statistics is a largely unexploited source of freight rate indices. This source gives very detailed information on freight revenues between 1866 and 1875 as well as some years from 1905 to 1912, but contains less useful material for years in between. For attempts at exploiting this material, see Fischer and Nordvik (1986a) and Gjølberg (1979).

provisions, which only utilize berth rates.[32] The Baltic timber and wood index gives a weight of 1/2 to two alternative freight rate series of Cronstadt (St Petersburg) to London deals and 1/2 to timber rates to London from Swedish (Gefle and Sundsvall) and Finnish (Vyborg) ports.[33]

The new index, computed with 1869 as the base year, is shown in Figure 2 and Table 2 together with the Isserlis (1938) index for the years from 1869 to 1913. The new index is linked to the 'British index' constructed by Harley (1988) for the years prior to 1869. It will be seen from Figure 1 that the two indices exhibit broadly similar movements over time, but that the new index shows an even greater fall in freight rates than does the Isserlis index between the early 1880s and 1900. The new index reaches its lowest point in 1904, when freight rates were 35.4 per cent of their 1869 level, whereas the nadir of the Isserlis index is located in 1908, reaching an index value of 45. This is an interesting observation in view of the ongoing debate about the magnitude and timing of the nineteenth century ocean transport revolution.[34] However, too much confidence should not be attached to precise numerical results on trend growth until it is eventually ascertained by a broader based index with a more elaborate weighting scheme.

It may be fair to say, however, that the new index at least *suggests* the possibility that previous indices have underestimated the fall in nominal freight rates between 1870 and the early 1900s. A natural extension of this observation is to ask how much freight rates fell in real terms. In Figure 3 real freight rate indices are shown, using the well known Sauerbeck (1886) commodity price index as a deflator.[35] This is the most satisfactory British commodity price index available for this period, being based on monthly prices of 45 commodities.[36]

The new UK freight rate index in real terms reaches its lowest point of 49.0 in 1907 (1869=100), but is fairly steady at values around 50 in all years from 1906 through 1910. Accordingly, real ocean transport freights were halved between 1870 and 1910, which is somewhat more than previous estimates have shown.[37] Whether it is useful to bring the real freight rate indices into the study of shipping cycles will be discussed below.

4 Shipping cycles

Since our primary focus here is on the cyclical movements of the freight rates of ocean transport we now turn to a discussion of the cyclical components of the freight rate indices in Figure 3, in which the index values have been purged of the trend along the same principles as in the case of business cycles discussed above. The identification of cycles is somewhat more difficult in the case of shipping cycles because there is much less previous research on this topic than is the

[32] No tramp cargo rates seemed to be available for these commodities. There are some gaps in the various berth rate series in the years before 1878, in which cases grain rate quotations have been used as substitutes.

[33] Fischer and Nordvik (1986b) is the source of the timber freight rates. They do not present data after 1908. In the years 1909 to 1913 the Baltic index only reflects the Cronstadt to London rates reported by Harley (1989).

[34] See North (1958), Harley (1980, 1988), O'Rourke and Williamson (1999, ch. 3) and Persson (2002).

[35] Updated figures were regularly published by *The Statist*, for many years computed by Sauerbeck himself.

[36] The extended and revised price index numbers presented in Klovland (1993) were used prior to 1886. This is done because the material underlying the original Sauerbeck index numbers is less complete in the early years. The data used here reflect prices quoted ex duty, as in the original Sauerbeck index number.

[37] O'Rourke and Williamson (1999, p. 35) note that according to the North index transport costs dropped by 41 per cent in real terms between 1870 and 1910.

case with business cycles, where there is established a fairly well defined chronology of turning points. As we are forced to work with annual data only, it is difficult to apply formal statistical criteria regarding the duration and amplitude of cycle phases, as is usual when working with monthly data on economic activity.[38]

Two additional factors complicate the measurement of shipping cycles: first, the fact that great technological advances in shipping technology impart a strong and possibly variable downward trend on freight rates, and secondly, nominal freight rates are of course affected by the long swings in the general price level. Both these factors complicate the task of separating the trend from the cycle movements of the series. We will return to a discussion of the second factor below, when we study cycles in deflated freight rates in order to see whether this changes the cycle chronology established on the basis of nominal freight rates.

4.1 Cycles in freight rate indices

From Figure 3 it will be seen that there are six fairly distinct major peak years in this period: 1854/55, 1861, 1873, 1889, 1900 and 1912. The first cycle is the Crimean war period, which was accompanied by large fluctuations in commodity prices and shipping freight rates. Because the rate of change in prices changed so quickly in this period, and markets were so unsettled, it may be difficult to pin down the cycles in the 1850s without recourse to better data.

The 1861 peak in Harley's 'British index' falls one year after the well established business cycle peak in 1860, a feature which it in fact shares with the American based North (1958) index. The underlying freight rates from various trade routes - the outward coal trade, the Black Sea grain trade and the Baltic timber trade - show rather diverse cyclical movements in the early 1860s, which may be a clue to understanding why the shipping cycle peak does not coincide with the general business cycle peak in 1860.

The four remaining major upper turning points in the pre-WWI period, however, are well synchronized with the peaks of the business cycles. The clearly marked peak years of 1873, 1889, 1900 and 1912 all correspond to unequivocal business cycle peaks. The cycle peaks are all steep, reflecting short periods of surges in the demand for ocean transport. The pattern identified here corresponds well to the basic theory of demand and supply expounded above. When demand is sufficiently high to intersect with the supply of shipping space in the inelastic part of the 'hockey-stick shaped' supply curve, freight rates increase steeply.

With some exception for the 1870s, when the freight markets staged a rebound in 1876 and 1877 after the spectacular 1873 boom, it seems to be a fairly general feature that once the short flurries of highly remunerative freight rates have come to an end, freight rates fall abruptly and then stay at a low level for a significant period of time. In fact, in two cases of major business cycle peaks, 1882 and 1907, it seems that the shipping markets never recovered fully from the depression, showing only a feeble upward movement around the expected boom years. This might be related to the fact that investment in shipping capacity sparked by the previous boom was so large as to accommodate all demand for ocean transport when the next round of increased

[38] For an application of the statistical criteria used in defining cycles, developed by Burns and Mitchell (1946) and Bry and Boschan (1971), to UK data in this period, see Klovland (1998).

economic activity occurred. In this view shipowners had to 'sit out' a cycle until the process of scrapping of inefficient ships and trend growth in world demand had laid the foundation for freight rates to rise again in the next boom.

However, alternative explanations can easily be thought of. The 1880s in particular were a deflationary period with a sustained fall in prices, which could not leave nominal freight rates unaffected. The potential 1882 peak in freights may therefore have been swamped by the general deflationary pressure. It might also be conceivable that ebbs and flows in the rate of technical progress in ship construction may have confounded the cyclical movements of freight rates.

The timing of investment cycles in international shipping seems to lend some credibility to the overinvestment hypothesis in the 1880s. The rate of expansion of the effective tonnage of the UK merchant marine was higher in the early 1880s than in previous decades.[39] In their annual review of the shipping markets in 1890 Messrs Angier Brothers stated that 'four years' severe depression was the result of the 1881 to 1883 overproduction'.[40] From the boom period in the early 1870s to the end of the decade large additions were made to the Norwegian sailing fleet, which was still competitive on long voyages.[41]

Regarding the 'missing shipping' boom of 1907 there is more direct evidence stemming from previous investment behaviour. Stopford (1997, p. 53) notes that in 1906 shipbuilding launches on the Wear reached an all time high, stating that '[c]onsidering the level of freight rates the newbuilding boom is difficult to explain.' A similar expansion peaking in 1906 is found in data for world shipbuilding.[42]

Table 3 gives a list of turning points that have been identified. In general, the peaks of shipping freight cycles seem to match the corresponding business cycle turning points better than do the troughs. Referring to Figure 4 there is a clearly marked trough in 1858, which coincides with the slump following the great commercial crisis of 1857. The lower turning points of the new UK index occur in 1870, 1875, 1885, 1895, 1904 and 1910. Only 1895 and 1904 are business cycle trough years, but 1885 is of course close to the business cycle low of 1886. The three other trough dates are not close to business cycle turning points.

A further indication of the uncertainty regarding the shipping cycle troughs stems from the observation that the two indices shown in Figure 4 in most cases give conflicting evidence as to the short-run movements around the lower turning points. It is not always clear from a visual inspection of the cycles depicted in Figure 4 where the troughs are located. One example is the double-dip of the Isserlis index in 1884 and 1886, straddling the more clearly defined trough of the new UK index in 1885. The different short-run behaviour of the two indices is also evident from the annual rates of change of the two indices found in Table 1. The Isserlis index does indicate a rather shallow trough in 1879, in accordance with the cycle in economic activity, but

[39] The rate of expansion of the UK fleet in the first part of the 1880s was 5.8 per cent per year, in the previous 20 years it had been 4.0 per cent, using a conversion factor of three for steam ship tonnage in computing the total effective tonnage. These figures are derived from the estimates presented by Kiær (1887), director of the Norwegian Central Bureau of Statistics, and the leading statistician of world shipping in the late nineteenth century. (The data are reproduced in Nordvik (1985).)

[40] *The Economist Commercial History and Review of 1890*, February 21, 1891, p. 25.

[41] See Nordvik (1985).

[42] Einarsen (1938, p. 135), Harley (1985).

otherwise it does not correspond fully to the list of business cycle troughs figuring in Table 3. Once again, the fact that the lower turning points on the freight rate curve are less marked than the peaks is what one would expect from theory.

There is also considerable doubt regarding what constitutes a cycle - how distinct must the fluctuations be in order to define the episode as a cycle? Two of the shipping cycles listed in Table 3 are rather weak. As noted above there are no clear-cut shipping cycles corresponding to the 1883 and 1907 business cycle peaks. The Isserlis index has a fairly marked peak in 1881, though, but the new UK index only shows a marginal upward movement in 1880. The Isserlis index has a minor peak in 1907, but cycle movements were rather weak between the super booms of 1900 and 1912. The upper turning points located in 1905 (new index) and 1907 only reflect the fact that freight rates were somewhat less depressed then than in adjacent years.

On the other hand, an extra shipping cycle is identified in the late 1870s. A short cycle with a peak in 1877 is fairly well defined, but it has no counterpart in the business cycle chronology. It may, however, be related to the Russo-Turkish war, which is further discussed below.

Finally, we take a look at the cycles in real freight rates. These are shown in Figure 5, derived in the same way as the nominal cycles, by estimating trend values and subtracting these from the actual values. The often not-so-obvious turning points are given in the final column of Table 3. Three grand peak years, those of 1873, 1889 and 1912, stand out in the real series as well, but otherwise these turning points are farther away from the general business cycle turning points than is the case with nominal freight rates. In general, although a real freight rate series is of great interest to the study of long-run trends, it does not seem to bring any important additional evidence to the cyclical issues studied here.

4.2 Cycles in the various trade routes

An aggregate index may sometimes blur large differences in the short-run behaviour of individual components. It may therefore be of some interest to consider the specific cycles of the five trade routes underlying the new UK index in more detail. These are shown in Figure 6. Table 4 gives an overview of the cyclical turning points.

The issue that we are primarily focusing on here is: how pervasive were demand shocks in shaping the course of freight rates over the cycle? Is the general business cycle pattern systematically reflected in individual freight rates, as we found was the case for the aggregate indices? How important were idiosyncratic shocks in the various trade routes?

The evidence presented here clearly shows that business cycles exerted a decisive influence on all five freight rates series. An inspection of Figure 6 will show that freight rates often reached their local maxima near the business cycle peak years, i.e. at the beginning of the shaded recession periods.

Table 5 presents the correlation coefficients between the cyclical components of the five freight rates, the aggregate freight rate indices and two business cycle indicators. All the five freight rate cycle series were positively correlated with each other and with the business cycle indicators. This is in conformance with our view of the various shipping markets being interrelated and affected by general business conditions. In general, it seems that the two composite freight rate indices, the new UK and the Isserlis index, follow the business cycles more closely than do the individual freight rate series. The Odessa grain trade, in particular, shows rather low correlation coefficients with both business cycles and other freight rate series, which may reflect the peculiar cyclical movements for this series noted below.

The main conclusion must be qualified in several respects, however. It is only the four grand business cycle peaks of 1872/73, 1888/89, 1900 and 1912 that are common to all five shipping routes. The other peak years and the lower turning points are much less consistent across the series. Some trade routes seem to be more persistently influenced by the business cycle than others. The coal trade and the north Atlantic cereals and provision trades are more highly correlated with the UK cycle (rail traffic) indicator and industrial production than the two European routes, the Black Sea and the Baltic trades. From Table 4 it appears that the coal freight cycles in particular were closely linked to the business cycle turning points.

This picture is broadly consistent with our knowledge of how shipping freights were determined in the market place. A basic feature was that the freight rates in the various routes were strongly interrelated, as excess capacity or heavy demand for shipping space in one trade spilled over into other shipping routes. In some trades, such as the coastal coal trade of Britain, vessels were highly specialized.[43] But apart from coastal trade, most ships competed for cargoes in different sailing waters; vessels usually deployed in the Baltic trade might occasionally contract for cargoes to North Sea ports, and long-traders might carry wood cargoes to a European port as the first leg of their Atlantic voyage.[44] However, economies of scale implied that there were limits to how far ships of various types would be substituted for each other on economic grounds. Ships engaged in cross trades were generally larger than those deployed in the North Sea and other European trade, which in turn were much larger than those operating within the Baltic Sea.[45]

Steam ship and sailing ship were in general not fully interchangeable either. Certain waters were unsuitable for sailing vessels (routes via the Suez Canal) or they operated at a severe cost disadvantage because of wind conditions (the Mediterranean). In mid-nineteenth century steam ships were effectively excluded from long voyages because of the need to carry their own fuel. Significant improvements in marine engineering gradually eroded the hegemony of sailing ships in the long trades. The Australian trade, the wheat trade from California and the nitrate trade from the west coast of South America were among the last ones to be conquered, but in these routes sailing ships were still competitive on the eve of World War I.[46]

A particular sort of interrelatedness in shipping freight rate determination stems from the availability or non-availability of a return cargo. The outward coal trade from Britain to the Baltic was intimately attached to the trade in backhaul timber cargoes; when outward coal freight rates to the Baltic declined significantly in the 1890s the British fleet pulled out of the

[43] Harley (1989), Armstrong (1994).

[44] Kaukiainen (1991, p. 150).

[45] Kaukiainen (1991, p. 151) found that in 1875 the average size of Finnish sailing vessels engaged in the coastal trade to Sweden was 66 net tons, within the Baltic 150 tons, in European trade about 400 tons, in the Atlantic cross trade slightly below 600 tons and other world cross trades 775 tons. By the eve of the First World War the average ship size in European waters had not increased markedly, but in the cross trades the size had doubled.

[46] Harley (1971, 1985).

Baltic timber trade.[47] According to economic theory more of the joint costs will be assigned to the leg with the greater demand.[48] In the north Atlantic trade the demand for eastbound shipping space was invariably greater than for westbound, but the increased immigration from Europe to North America in the 1880s shifted some of the joint costs of a round trip Atlantic voyage from the eastbound to the westbound leg. This explains much of the decline in Atlantic freight rates in the 1880s.[49]

Thus shipping freight rates in various trade routes were clearly interrelated in many ways, but still each freight rate was affected by a variety of factors particular to each trade. Wars represent an extreme type of shocks that always exert a heavy influence on shipping freights. The Crimean War in 1854 and the South African War in 1900 both coincide with superbooms in the freight markets. The Russo-Turkish war of 1877 is highly visible in the Odessa to London grain freights, some of the effect of this event is likely to have spilled over into other markets as well. The shipping cycle peak of 1877 is the only episode in the period covered here which does not have a matching business cycle peak. The war event may have been the decisive factor leading to this result.[50]

The freight rate series were also subjected to pairwise cointegration tests, using the Johansen (1991) maximum likelihood procedure. The trace test statistics are reported in Table 6.[51] Testing for cointegration reveals that long-run co-movements between the variables differed somewhat from the short-run cyclical pattern. The Odessa grain freight series showed a somewhat devious cyclical behaviour, but from Table 6 it is seen that this freight rate series is cointegrated with all but one of the other freight rates. The long-run movements of the grain (Odessa and American) and provision freight rate series (4, 5 and 6) appear to be the ones most closely linked to each other, which might suggest that types of cargo as well as geographical areas are the most decisive common factors in the long run. The outward coal freight series is cointegrated with the Odessa grain freights at the five per cent significance level, but not with any other series. There is not much evidence of strong links between homeward and outward freight rates in the long run. The most idiosyncratic long-run behaviour is clearly shown by the Baltic wood trade, which is clearly not cointegrated with any other freight rate series. This result may stem from the structural changes in this market discussed by Fischer and Nordvik (1987), which led to freight rates in various parts of the Baltic region being high relative to the Isserlis index in the 1870s and 1880s, but declining more rapidly than did world freights in the 1890s in all regions of the Baltic .

[47] As the British withdrew from the Baltic trade the Norwegians increased their Baltic fleet in the 1890s, presumably because their sailing vessels could still make a profit in the Baltic trade. See Fischer (1991) on this issue.

[48] Harley (1985).

[49] Harley (1985).

[50] In Table 4 outward coal freights are associated with a peak before the war started, in 1876, but a look at Figure 6 reveals that it is rather weak and might perhaps have been ignored.

[51] Augmented Dickey-Fuller tests showed that all freight rate series (in level form) were non-stationary, all series being integrated of order one. Thus, necessary conditions for two series to be cointegrated are present. It is assumed that there is a linear trend in the data, but no trend in the cointegration equation. The results were obtained using *EViews*, version 4.

4.3 Commodity prices and freight rates in grand peak years

The grand peak years in shipping freights in the period considered here are 1873, 1889, 1900 and 1912. We have seen above that they all correspond to clearly marked peak years of economic activity as well. We end our cyclical narrative of this period by studying the behaviour of two key commodity prices, coal and pig iron, around the peak years. Our main interest is to compare the behaviour of commodity prices and shipping freight rates around the business cycle peaks.

Figure 7 shows end-of-month figures for steam coal and pig iron. The coal prices are West Hartley quoted in London during 1871 - 1875 and 'large steam' quoted in Newcastle in the three other cases. The pig iron quotations are for Middlesborough (Cleveland) pig no. 3.[52] Coal and pig iron prices were strongly procyclical in these episodes, rising steeply during the final stages of the expansion period, and then often collapsing near the business cycle peak.

There is unfortunately no representative monthly freight rate series available, but the scattered evidence there is indicates that freight rates peaked about the same time as economic activity and commodity prices in these episodes. The prices of coal and iron were both at extreme levels in 1873, reflecting the strain on the supply of mineral resources in Britain. In the 1873 boom several freight rates seem to have reached their highest level in the summer and autumn of that year, which is close to the peak of our business cycle indicator in July 1873. According to Norwegian consular reports summarized in Kiær (1877) freight rates on timber and wood from Finland (Vyborg) to London and from Quebec to London both peaked in the autumn months.[53] Grain freight rates from New York to the UK peaked in the summer of 1873 at 10 shillings per quarter wheat, receding to 9 shillings in September and October. The monthly wheat freight rate series from San Francisco to Liverpool reproduced in Davis (1894) shows that the highest rate was obtained in July 1873.

The 1873 peak is of much higher amplitude in the new UK index than in the Isserlis index. This observation is consistent with the view of Fischer and Nordvik (1986a), who argue that the Isserlis index grossly underestimates the 1873 peak, basing their evidence on north Atlantic trade routes.[54] One important source of this discrepancy is the outward coal freight series, which peaked in 1872, and which have a large weight in the Isserlis index around 1873.

In 1889 freight rates in various trades were reported to have remained at a high level during most of the year according to Norwegian consular reports.[55] This view was for example expressed by the consul in San Francisco regarding the wheat trade from California to the UK and the timber trade from Puget Sound; the same statement can be found in the report from Melbourne regarding wool, coal, sugar and copra trades. Reports from Königsberg on the Baltic

[52]Prices, shown on the vertical scales, are quoted in (decimal) shillings per ton. Price quotations are from *The Economist*, *Iron and Coal Trades Review* and *Colliery Guardian*.

[53]Autumn rates were usually somewhat higher than spring and summer freight rates due to weather conditions (higher insurance costs) in these trades, but the increase in the autumn of 1873 was larger than normal seasonal variations.

[54]Their evidence primarily refers to freight rates on eastbound routes from the United States contained in Matthews (1979) and Norwegian shipping statistics.

[55]See *Uddrag of Aarsberetninger fra de forenede Rigers Konsuler for aaret 1889*, published by the Norwegian government, Kristiania (Oslo) 1890.

grain and wood trade and from New York on a variety of freight rates, including general cargo, petroleum, cargo and berth rates on grain, flour and provisions, give much the same impression. However, outward rates from Amsterdam fell markedly in the final quarter of the year due to an excess of shipping space offered, and from Hull it was reported that there was an abrupt decline in freight rates that was likely to be sustained for some time. In their annual survey Angier Brothers referred to the 'sudden relapse of all freights' in the early spring of 1890.[56]

There is thus some evidence that shipping freight rates behaved much like economic activity and prices in this cycle. Iron prices were more than doubled during 1889 but fell steeply from the business cycle peak at the end of 1889. Coal prices also rose significantly in the final phase of the boom, but remained quite firm during the year 1890 as well. The Isserlis and the new UK indices agree on the steep decline in 1890, indicating a fall of 16 to 22 per cent in freight rates between 1889 and 1890, but they show different behaviour in 1889. The new UK index increases by 12 per cent in 1888 and by a further 10 per cent in 1889, in which year the Isserlis index falls slightly. The latter phenomenon seems rather peculiar in view of the reports on shipping freight rates referred to above.

Coal and pig iron prices declined by 50 per cent in a few months after the business cycle peak was reached in the middle of 1900. The year 1901 marks the largest percentage decline in the freight rate indices of the whole period covered here, from 29 to 34 per cent. In an annual review of the freight market the London firm John White reports that '[o]utwards, coal freights at the close of 1900 had begun to decline, which has since continued in all directions, and with the exception of the Brazils and River Plate are 30 per cent lower than they were a year since.'[57] Commodity prices and shipping freight rates thus share the same steep rise and fall in this cycle, with freight rates perhaps lagging by a few months.[58]

In shipping markets the results of the year 1912 were described as being 'beyond the dreams of avarice'.[59] According to the new UK index freight rates increased by 25 per cent in 1912, which came on top of an almost equally large increase in the preceding year. Once again there is much evidence that business activity, commodity prices and freight rates all peaked at about the same time, in the second half of 1912. The British coal strike in March 1912 unsettled both shipping and commodity markets, but once this dispute was over, prices of coal and pig iron were very buoyant, reaching their highest levels around the turn of the year. The various business cycle indicators tabulated in Klovland (1998) suggest that the most likely date of the business cycle peak is September 1912. A number of key freight rate series peaked during the three months between September and November 1912.[60] But, as in the case of commodity prices, freight market quotations were very firm in the first half of 1913 as well.

[56] *Commercial History and Review of 1890, The Economist* February 21, 1891, p. 25.

[57] *The Economist Commercial History and Review of 1901, The Economist*, February 22, 1902, p. 30.

[58] The war demand for shipping services may have interfered with the business cycle impact in this case.

[59] *Commercial History and Review of 1912, The Economist,* February 22, 1913, p. 455.

[60] September 1912 registered the highest freight rates on outward coal to Mediterranean ports and homeward sailing rates from nitrate ports of the west coast of South America; October saw the highest homeward rates on grain (berth rate) and cotton from the United States, grain from the Black Sea and coal to Rio and River Plate; finally, in November, peaks of freight rates on wood from North America and sailing ship cargoes from Australia were recorded. This information on world shipping markets is extracted from the Norwegian weekly financial newspaper *Farmand.*

The annual freight rate indices in Table 2 indicate a 14 per cent decline in 1913. It is typical that, once general economic activity is no longer increasing, such factors as political unrest and less than expected transport demand from particular destinations[61] systematically eroded the market sentiment, inexorably setting freight rates on a downward course. In addition, during 1913 the depressing influence of new tonnage capacity was felt more and more.[62] These features are no surprise to students of shipping cycles, and were presumably not so to experienced shipowners on the eve of WWI either - they had seen it all before.

5 Concluding remarks

The empirical analysis shows that cycles in economic activity are major determinants of the short-run behaviour of shipping freight rates in the years between 1850 and WWI. Consistent with economic theory there is a striking asymmetry between the peaks and troughs of shipping cycles, however. There is often a close timing relationship between the upper turning points of the business cycle, commodity prices and freight rates, which is shown to be particularly tight in the grand peak years of 1873, 1889, 1900 and 1912. On the other hand, the dating of the lower turning points of the freight rate cycles is often more indeterminate, differing considerably between the various trade routes and being generally less well synchronized with the business cycle troughs.

Our knowledge of the course of pre-WWI freight rates is imperfect. There is still considerable controversy over the extent of the secular decline in the costs of ocean transport in this period, and there is only fragmentary evidence on freight rate data at the monthly frequency. Further insight into issues related to the determination of long-run trends and cyclical behaviour in shipping markets is therefore crucially dependent on new efforts to improve existing indices of freight rates.

[61] In 1913 the River Plate and the United States markets in particular brought disappointments.
[62] *Farmand*, 20 December 1913.

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Table 1. Business cycle chronology for the UK.

Peak (P) or Trough (T)	NBER annual dates	Railway traffic	Industrial production	UK cycle dates chosen
P	NA	1854	1853	1854
T	1855	1855	1855	1855
P	1857	1856	1857	1857
T	1858	1858	1858	1858
P	1860	1860	1860	1860
T	1862	1862	1863	1862
P	1866	1866	1866	1866
T	1868	1868	1868	1868
P	1873	1873	1872	1873
T	1879	1879	1879	1879
P	1883	1883	1882	1883
T	1886	1886	1886	1886
P	1890	1891	1889	1889
T	1894	1895	1893	1895
P	1900	1900	1899	1900
T	1904	1904	1904	1904
P	1907	1907	1907	1907
T	1908	1909	1908	1908
P	1913	1912	1913	1912

*N*OTE: The NBER annual turning points for Britain are taken from Burns and Mitchell (1946, p. 79). The data on industrial production are from Crafts, Leybourne and Mills (1989), the construction of the railway freight traffic indicator is explained in Klovland (1998).

Table 2. Shipping freight rate indices 1869 - 1913.

Year	Isserlis index	New UK index	Rate of change Isserlis index	Rate of change new UK index
1869	100	100.0	NA	(-3.1)
1870	103	98.0	3.0	-2.0
1871	102	106.8	-1.0	8.5
1872	103	108.8	1.0	1.9
1873	117	131.5	12.7	19.0
1874	108	101.3	-8.0	-26.1
1875	99	95.9	-8.7	-5.5
1876	98	106.7	-1.0	10.7
1877	99	105.1	1.0	-1.5
1878	91	95.2	-8.4	-10.0
1879	85	86.6	-6.8	-9.4
1880	87	84.6	2.3	-2.4
1881	87	78.5	0.0	-7.5
1882	81	72.1	-7.1	-8.5
1883	75	67.5	-7.7	-6.5
1884	64	61.0	-15.9	-10.2
1885	63	54.6	-1.6	-11.1
1886	59	54.6	-6.6	0.1
1887	65	52.4	9.7	-4.1
1888	76	59.3	15.6	12.3
1889	75	65.5	-1.3	9.9
1890	64	52.6	-15.9	-21.9
1891	63	52.4	-1.6	-0.4
1892	55	44.7	-13.6	-15.8
1893	60	43.6	8.7	-2.5
1894	58	42.2	-3.4	-3.3
1895	56	40.5	-3.5	-4.0
1896	56	45.4	0.0	11.3
1897	56	47.8	0.0	5.2
1898	68	50.9	19.4	6.3
1899	65	46.1	-4.5	-9.9
1900	76	54.4	15.6	16.5
1901	57	38.7	-28.8	-33.9
1902	49	36.4	-15.1	-6.2
1903	49	37.6	0.0	3.1
1904	49	35.4	0.0	-6.0
1905	51	39.3	4.0	10.6
1906	52	38.8	1.9	-1.3
1907	54	40.0	3.8	3.0
1908	45	37.0	-18.2	-7.9
1909	46	39.0	2.2	5.3
1910	50	40.1	8.3	2.7
1911	58	51.1	14.8	24.4
1912	78	65.7	29.6	25.0
1913	68	56.8	-13.7	-14.5

*N*OTE: Rates of change are computed as compounded annual rates. Harley's (1988) 'British index' is used to compute the rate of change between 1868 and 1869.

Table 3. Shipping cycle chronology for the UK.

Peak (P) or Trough (T)	UK business cycle dates	new UK index	Isserlis index	real UK index
P	1854	1855	1855	1855
T	1855			
P	1857			
T	1858	1858	1858	1858
P	1860	1861	1861	1861
T	1862			
P	1866			
T	1868	1870	1869	1866
P	1873	1873	1873	1873
T		1875	1875	1874
P		1877	1877	1876
T	1879	1879	1879	
P	1883	1880	1881	
T	1886	1885	1886	1885
P	1889	1889	1889	1889
T	1895	1895	1892	1893
P	1900	1900	1900	1898
T	1904	1904	1902	1902
P	1907	1905	1907	1905
T	1908	1910	1909	1910
P	1912	1912	1912	1912

*N*OTE: Prior to 1870 turning points of the shipping cycles are based on Harley's (1988) 'British index'. The real shipping cycles are inferred from the new UK index deflated by Sauerbeck wholesale prices.

Table 4. Shipping cycle chronology for the UK. Various trade routes.

Peak (P) or Trough (T)	UK business cycle dates	Outward coal	Odessa grain	American grain	American provisions	Baltic wood
P	1866	1864	1865	1868	NA	1864
T	1868	1869	1868	1870	NA	1869
P	1873	1873	1872	1873	NA	1873
T		1875	1874	1875	NA	1875
P		1878	1877	1877	1880	1878
T	1879		1878	1879		
P	1883		1881	1883		
T	1886	1884	1885	1884	1887	1884
P	1889	1888	1888	1889	1889	1888
T	1895	1892	1892	1894	1895	1892
P	1900	1900	1900	1900	1900	1900
T	1904		1906	1902	1901	
P	1907			1905	1906	
T	1908	1908		1910	1911	1908
P	1912	1912	1912	1912	1913	1912

*N*OTE: Data on American flour and provisions freight rates are available for 1874 and 1875, and continuously from 1878 onwards. The turning points of this series are rather uncertain in the first years thereafter.

Table 5. Correlation coefficients between cyclical components of business cycle indicators and freight rates 1869 - 1913.

Data series	1	2	3	4	5	6	7	8	9
1 Rail freight traffic	1.0								
2 Industrial production	0.70	1.0							
3 New UK freight index	0.56	0.46	1.0						
4 Isserlis freight index	0.57	0.55	0.81	1.0					
5 Coal freights outward	0.47	0.52	0.67	0.80	1.0				
6 Odessa grain	0.21	0.29	0.44	0.39	0.36	1.0			
7 American grain	0.55	0.43	0.93	0.73	0.57	0.28	1.0		
8 American provisions	0.48	0.32	0.89	0.62	0.46	0.11	0.86	1.0	
9 Baltic wood	0.39	0.27	0.83	0.65	0.39	0.20	0.73	0.77	1.0

Table 6. Pairwise cointegration tests between freight rate series 1869 - 1913.

Data series	1	2	3	4	5	6	7
1 New UK freight index	-						
2 Isserlis freight index	20.4	-					
3 Coal freights outward	9.4	11.4	-				
4 Odessa grain	15.8	18.9	16.6	-			
5 American grain	15.0	22.7	10.5	18.3	-		
6 American provisions	17.6	21.3	11.7	20.3	32.4	-	
7 Baltic wood	7.0	9.3	9.6	9.3	7.4	7.6	-

NOTE: This table reports pairwise cointegration tests based on the trace statistics of the Johansen maximum likelihood procedure. The 5 and 1 per cent critical values are 15.4 and 20.0, respectively. Test statistics above the critical values indicate that the null hypothesis of no cointegration must be rejected.

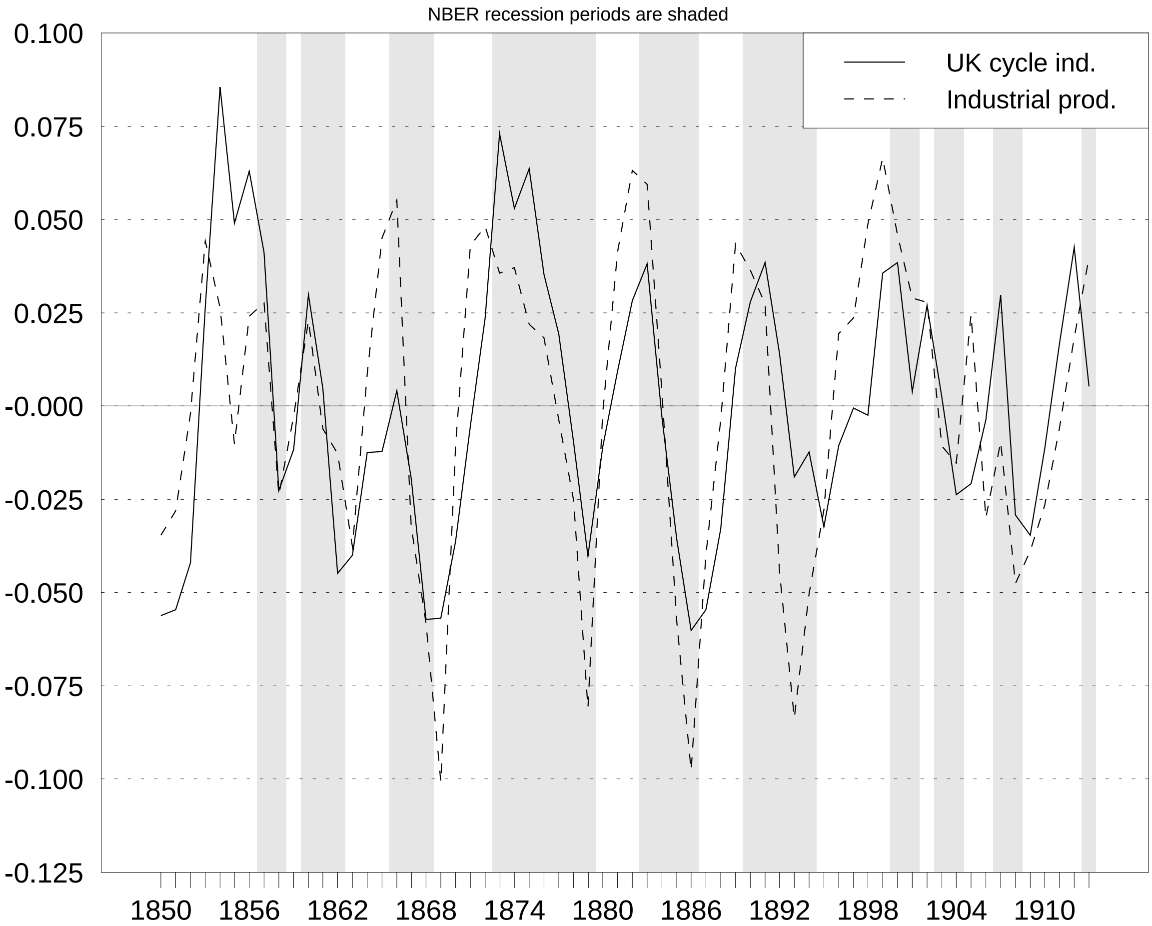

Figure 1: *Business cycle turning points in Britain*

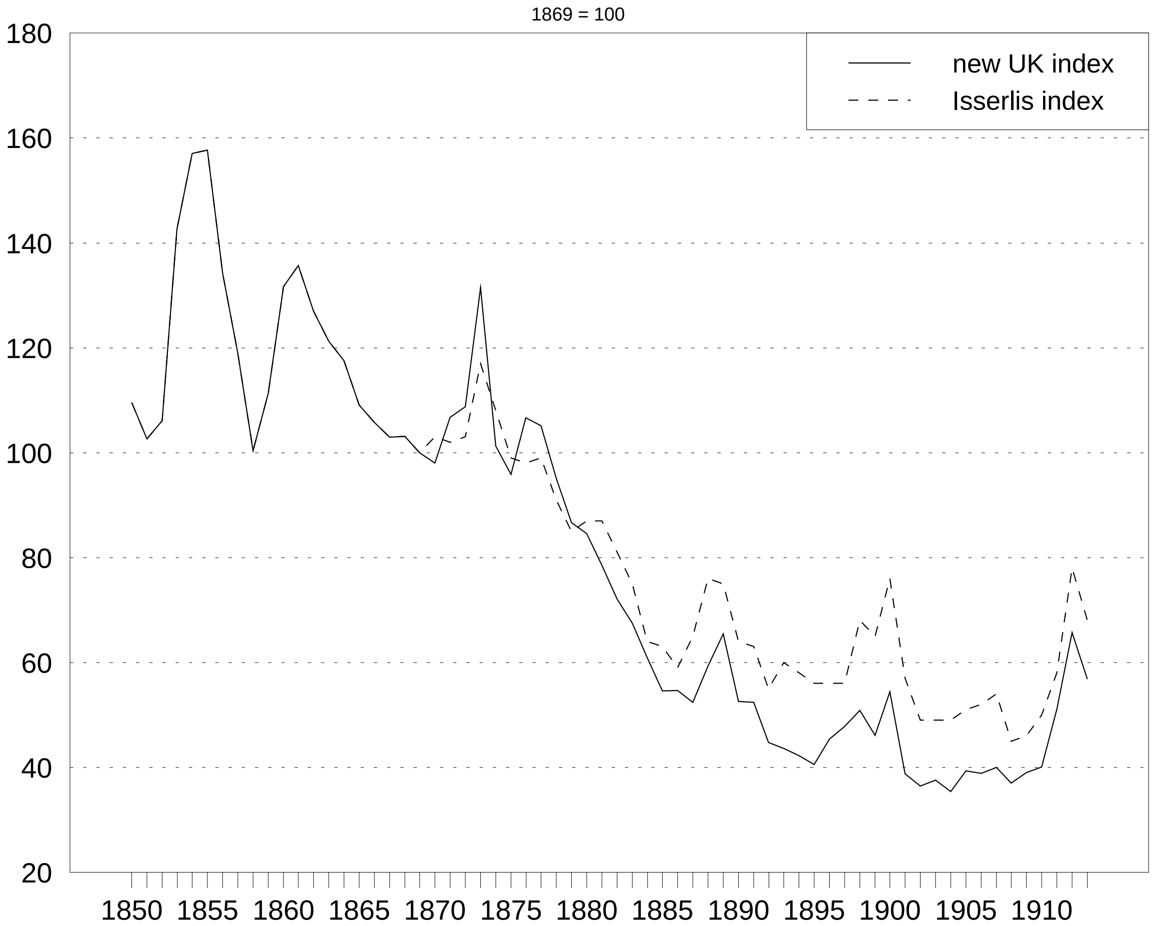

Figure 2: *Nominal shipping freight rate indices 1850 - 1913*

Figure 3: *Deflated shipping freight rate indices 1850 - 1913*

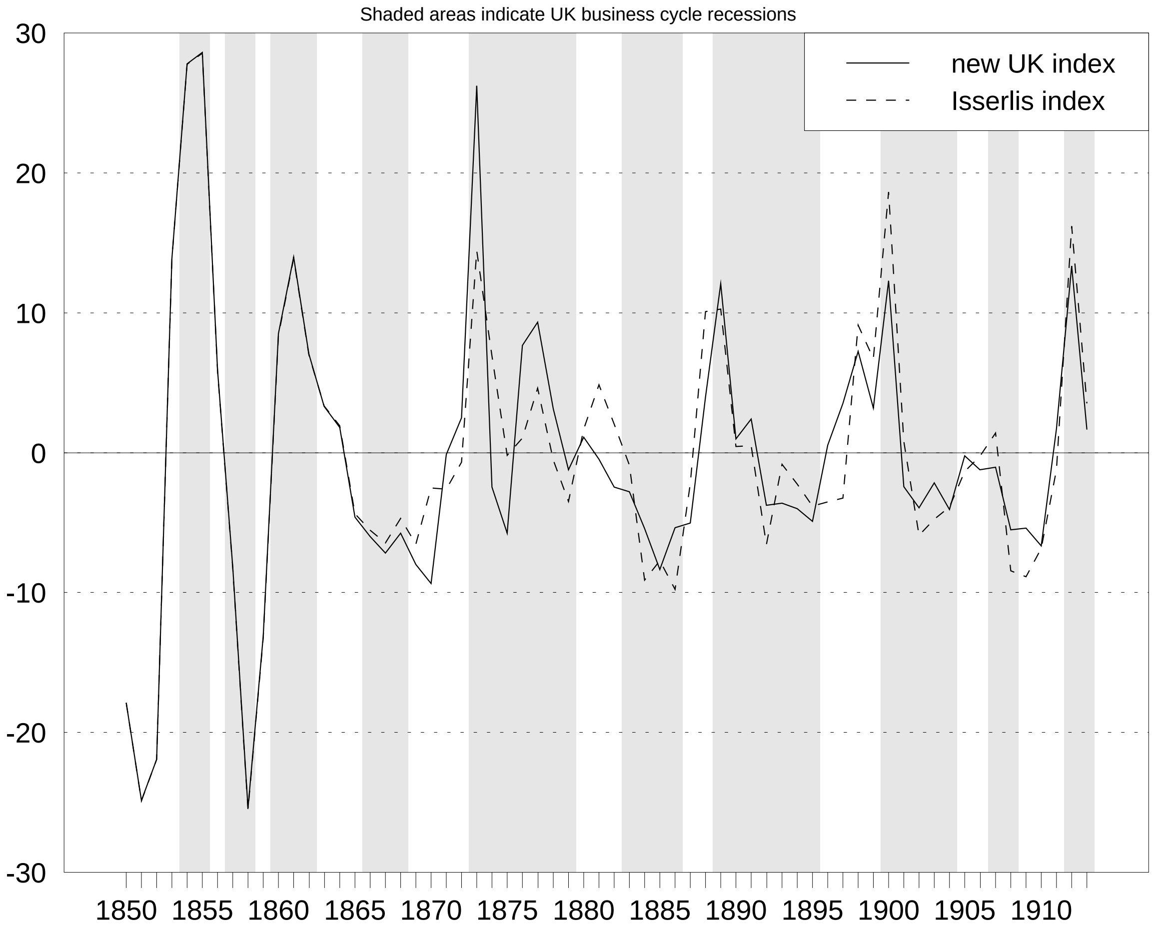

Figure 4: *Shipping cycles 1850 - 1913*

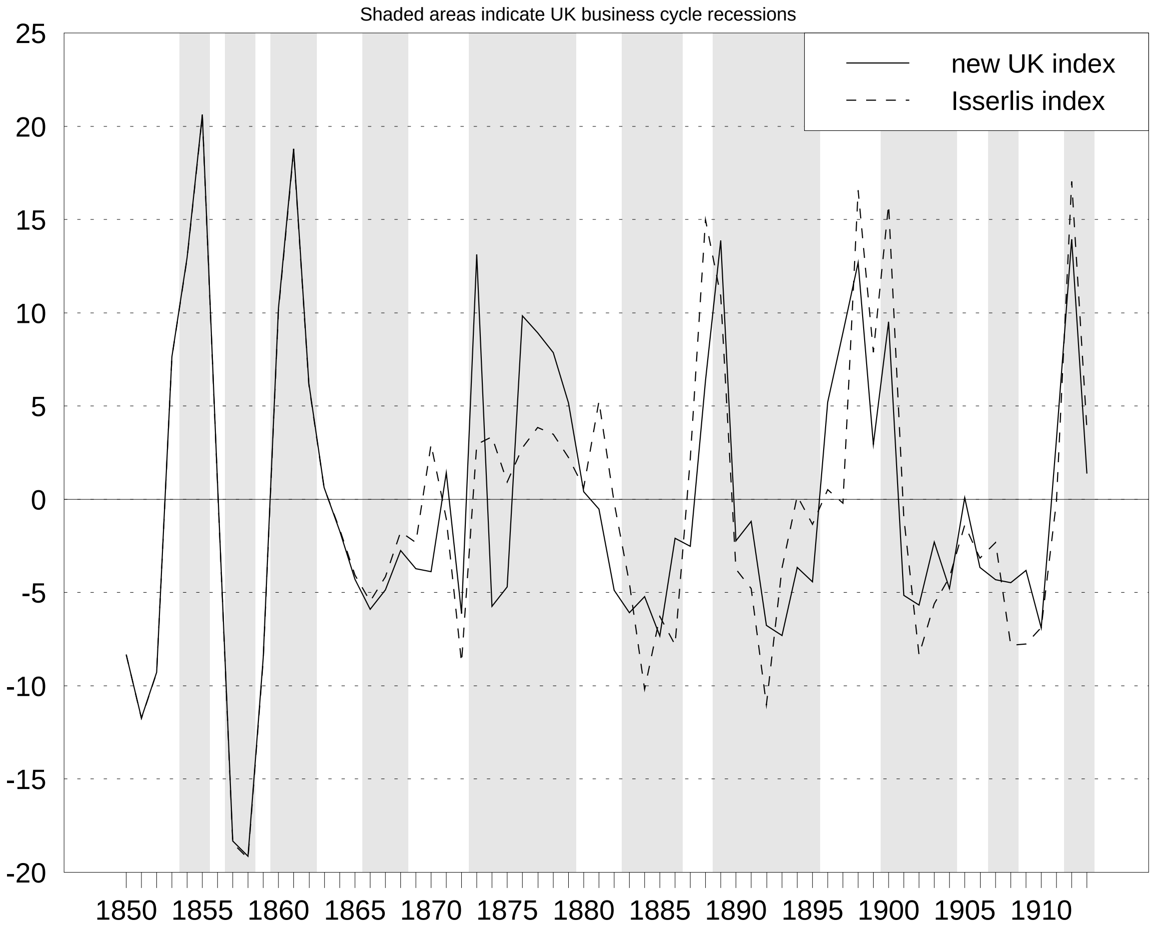

Figure 5: *Real shipping cycles 1850 - 1913*

Shaded areas indicate UK business cycle recessions

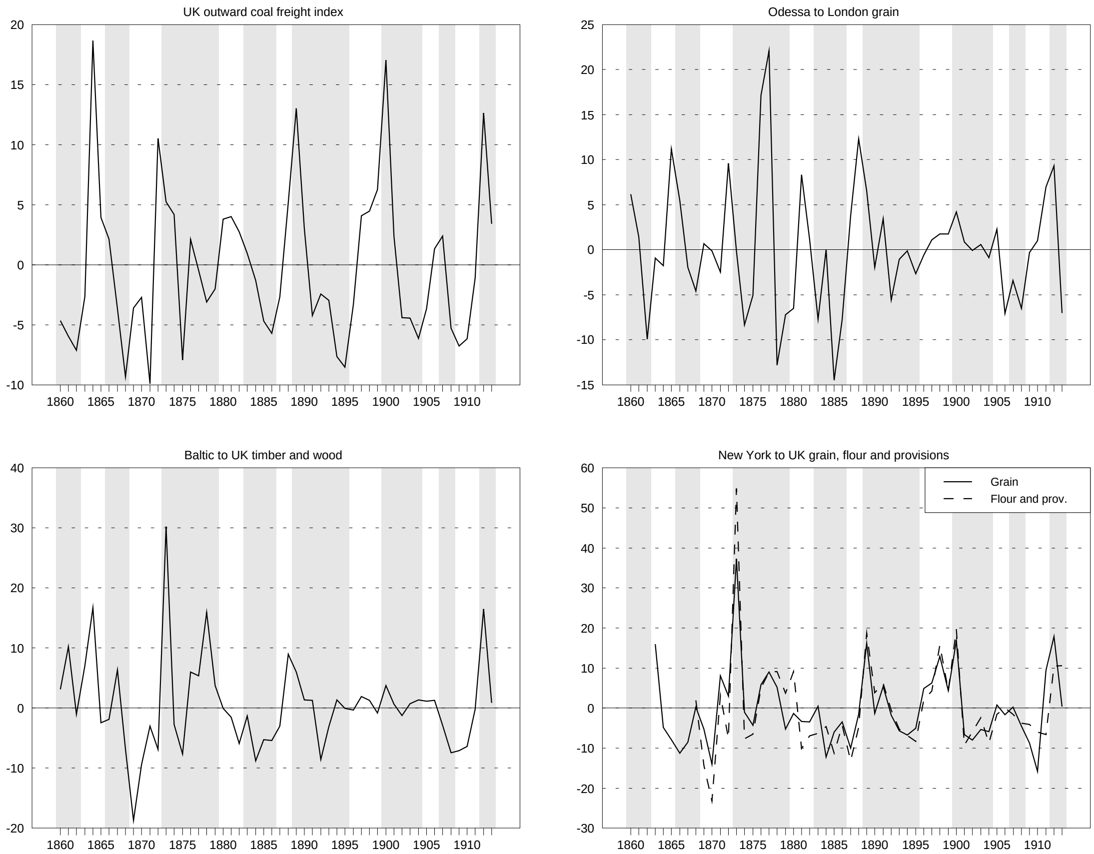

Figure 6: *Shipping cycles in various trades 1860 - 1913*

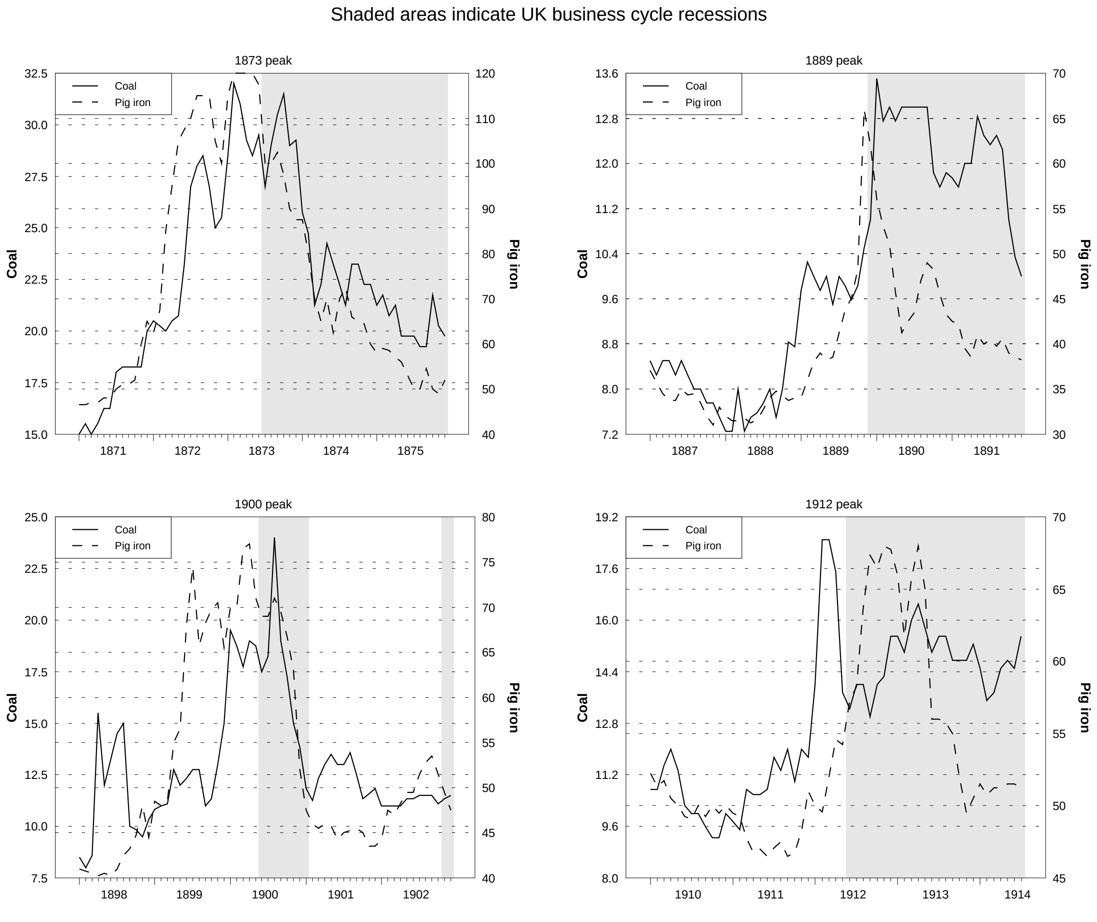

Figure 7: *Commodity prices around grand peak years*