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Discussion paper

New evidence on the causes of the fluctuations in ocean freight rates in the 1850s: harvest failures, business cycles, and the Crimean War

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New evidence on the Causes of the Fluctuations in Ocean Freight Rates in the 1850s: Harvest Failures, Business Cycles, and the Crimean War*

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Abstract

This paper takes a critical look at the hypothesis that the Crimean War was the main cause of the surge in ocean freight rates in the first part of the 1850s. The analysis is based on newly constructed monthly data on world freight rates in the 1850s. A new type of freight rate index, referred to as a *repeat sailings index*, is presented, which is similar to a type of index frequently applied to house prices. An econometric model of the determination of freight rates is estimated on monthly data from the 1850s, from which it is possible to disentangle the effects on freight rates due to the various demand and supply factors, including the Crimean War. It is found that harvest failures, business cycles, the supply of tonnage and the Crimean War all significantly affected freight rates in this period. The Crimean War may have accounted for a quarter of the surge in freight rates in the years prior to the outbreak of the War; once the War broke out in March 1854, however, it was of less importance.

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1 Introduction

The international grain trade was an important source of demand for ocean transport in the nineteenth century. Around 1850 the main sources of supply of grain for the countries of northern Europe were the Baltic, the Black Sea and eastern seaboard of North America.[1]

In 1854 the Black Sea became a theatre of war. In September 1854 British and French forces clashed with the Russian army in the Crimea and began a siege of Sevastopol that was to last for eighteen months. But even as the ill-fated Charge of the Light Brigade was launched and the subsequent main battle at the Inkerman heights took place, merchant sailing vessels laden with grain and oilseeds were crossing the Black Sea bound for northern Europe. A ban on grain exports from Russian ports had been introduced in the spring when war was declared, but wheat was still being exported from the Danubian region throughout 1854; from the Russian ports of Odessa and in the Sea of Azov numerous cargoes of oilseed were being shipped in neutral vessels as late as the autumn of 1854.[2]

However, the war events interfered greatly with the export of wheat from the ports around the Black Sea and led to strongly rising ocean freight rates. In October 1854 the freight rate paid per quarter of wheat from the Danube equalled 20.5 shillings (*20 s. 6 d.*), twice the rate common in the years around 1850, which was around 10 shillings.[3] But freight rates on grain from the Black Sea had been even higher earlier in the year; in March and April 26.5 shillings per quarter had been fixed for wheat cargoes from Galatz and Ibrail to the UK. Average coal freight rates from Tyne to Constantinople rose from £ 13.0 in 1852 to £ 41.5 in 1854.

Such fancy rates paid to and from the Black Sea in 1854 are well documented in the history of shipping.[4] These facts may also have led to a belief that the Crimean War was the primary reason that ocean freight rates in general were high in the middle of the 1850s. Although the existing data series on ocean freight rates from the 1850s are somewhat incomplete, there is indeed sufficient evidence to suggest that freight rates were high all over the world, particularly in the middle of the decade.[5]

This paper takes a critical look at the hypothesis that the Crimean War was the main cause of the surge in ocean freight rates in the first part of the 1850s. The analysis draws on new evidence on the actual course of freight rates all over the world in the 1850s. A new monthly index of freight rates based on a weighted average of freight rates from 14 inward trade routes, has been derived elsewhere.[6] These data provide the basis for the analysis of the freight rate fluctuations in this decade. An econometric model of the determination of freight rates is estimated on monthly data from the 1850s, from which it is possible to disentangle the effects on freight rates due to the various demand and supply factors, including the Crimean War.

[1] Harley (1980).

[2] Sixty vessels, mostly laden with linseed from the Sea of Azov, reached UK ports in the last three months of 1854. The details of each shipment can be found in *British Parliamentary Papers 1854-55, vol. L, paper 113.*

[3] The freight rates cited here are from Klovland (2006).

[4] The evidence on freight rates in the mid 1850s collected by Tooke and Newmarch (1857) has been the basis for much of the subsequent literature, in particular the discussion in Hughes (1960). See also Lindsay (1874, pp. 352-357). The most comprehensive discussion is to be found in Worm-Müller (1950).

[5] Such evidence has been presented by North (1958) and Harley (1988).

[6] Klovland (2006).

Figure 1. Growth rates of effective world tonnage and the share of steam 1845-1862

2 The shipping world of the 1850s

2.1 The supply of new tonnage

Figure 1 shows annual growth rates of world's effective tonnage from 1845 to 1862.[7] These estimates are made assuming that one steam ship ton is equivalent to 3 sailing ship tons.[8] The world's merchant marine had been expanding at a rate around 4 percent per year since 1846, but in 1853 the rate of expansion in shipbuilding surged to 8 percent per year. In Britain the greatly increased activity remained at a high level through the early part of 1856, after which it collapsed.[9] It is believed that the fluctuations in shipbuilding in the 1850s reflect, with some lag, the freight rate movements of the period.[10]

[7]The world tonnage estimates are based on the international shipping statistics compiled by the Central Bureau of Statistics of Norway in the 1870s: *Statistique Internationale. Navigation Maritime,* vol. I, Christiania (Oslo) 1876; *Tabeller vedkommende Handelsflaaderne i Aarene 1850-1886*, Christiania 1877. See also Fischer and Nordvik (1986).

[8]Graham (1956, p. 86) was of the opinion that a conversion factor of three was only reasonable after the introduction of the triple expansion engine after 1885, but a conversion factor of three still seems to be the conventional assumption for this period, see e.g. Kaukiainen (1991, p. 201).

[9]Hughes (1958, p. 210)

[10]This is the view taken by Hughes (1960, pp. 207-214).

Sailing ships still dominated much of the carrying trade in the 1850s.[11] Their dominance on the long distance trade routes was undisputed, but the new iron-screw steamers had made a sizeable impact on the Baltic and Mediterranean trade routes by the end of the 1850s.[12] Figure 1 also shows that the share of steam ships in the world's effective tonnage rose from 8.9 at the end of 1849 to 17.6 percent a decade later. Much of the steam ship capacity was engaged in passenger and subsidized mail traffic, however.[13] It was typical that the sailing packets between New York and Britain had lost the bulk of cabin passenger and fine freight to the steam liners following the commencement of a regular New York to Liverpool line service by the Cunard line in 1848, but heavy freight was still the domain of the sailing packets in the 1850s.[14]

2.2 The demand for shipping services

The preconditions for a significant expansion in world trade were unusually bright in the early 1850s. In Britain the Corn Laws and the Navigation Act had been repealed by the beginning of the decade and there was a general trend towards reduced tariffs. The trade expansion did indeed manifest itself, although there was a temporary setback in the middle of the decade due to the Crimean War. It resulted in a remarkable increase of shipping activity in the 1850s; the amount of tonnage with cargoes entered into Britain and cleared from British ports increased by 73.3 per cent over the decade. This represents an annual growth rate of 5.5 per cent, which is in line with the 4.9 per cent growth rate of world tonnage discussed above. On this basis a contemporary observer remarked that the decade of the 1850s was 'perhaps the most remarkable in the trading history of any country'.[15]

Which were the main trade routes of the world's merchant marine and what kind of cargoes were carried over the oceans in the 1850s? Table 1 presents estimates of the distribution of freight earnings by trade routes and cargoes in 1857. Import quantities (including re-exports) were collected for 72 commodities and distributed by country of shipment and by type of cargo. All bulky goods that were imported in any significant quantity were included. A representative freight rate for each country of shipment and type of cargo to the UK was then stipulated on the basis of actual freight rates in 1857.[16] Estimates of freight earnings are finally obtained by multiplying the import volumes by the relevant freight rates. This is a more informative measure of the demand for ocean transport than the tonnage of cargoes entered because it also reflects the distance over which the goods were carried.

The data in Table 1 clearly reflect the dominant position of the North Atlantic trade, which accounted for about 30 percent, more than half of which is due to the Canadian timber trade.[17] Trade

[11] Graham (1956).

[12] There are somewhat conflicting views regarding to what extent steamers had taken over these trade routes, see Clapham (1932, p. 63) and Hughes (1958).

[13] Graham (1956).

[14] See Albion (1938, pp. 253-272) on the competition between 'canvas and steam' in the packet and steamer line services. Inspection of the freight rate columns of the *New York Times* reveals that around 1860 it was particularly provisions (meat, cheese and lard) that went by steam. Steam freight rates usually exceeded the rates for sailing ships by a wide margin.

[15] Glover (1863).

[16] The base year of 1857 was chosen because it seems to be the most 'normal' year as to trade flows of the mid and late 1850s in several respects; 1854 to 1856 are excluded because of the blockade of Russian imports during the Crimean War, and in 1858 grain imports from the United States were unusually low and ceased almost entirely in 1859.

[17] In the 1850s the North American timber trade still enjoyed tariff privileges relative to European timber on the British market. The colonial preference was removed in 1860, after which the share of Canadian timber on the British market

Table 1. Inward freight earnings by trade routes and cargoes in 1857.

Trade routes	Share	Cargoes	Share
Baltic grain	7.4	Timber and wood	27.3
Baltic wood	4.0	Grain and flour	18.7
North Sea wood	1.8	Oil seeds	4.5
White Sea	1.8	Animal foodstuffs and fats	0.8
Mediterranean	4.6	Sugar	15.3
Black Sea	5.0	Tropical foods and beverages	2.9
North America wood	16.3	Cotton	9.7
North America cotton	6.0	Non-cotton textile materials	2.8
Atlantic North America grain	7.4	Fertilizers	9.3
Atlantic Central America	9.7	Metals, ores and chemicals	3.2
Atlantic South America	3.4	Oils and resinous products	2.8
Far East	22.4	Miscellaneous non-foods	2.7
Pacific	10.2		
Total	100.0	Total	100.0

NOTE: The shares are derived on the basis of the volume of imports to the UK in 1857 distributed by country of shipment and by commodity, respectively. The import volumes were then multiplied by closely matching freight rates prevailing in 1857 to arrive at estimates of gross freight earnings.

on East India, China and other Asian countries required much shipping capacity in the 1850s because of the heavy imports and the long voyages around Cape Good Hope. The trade routes labelled Far East represent 22.4 percent of the total. We also note the relatively significant shares of the Pacific, where guano cargoes from the Chincha islands of Peru was the dominant trade, and Central America with its sugar and tropical timber trade. Grain and wood from northern Europe demanded 15 percent of the carrying capacity, while the Mediterranean and Black Sea accounted for about 10 percent of the total.

Looking at the distribution of shipping freights by types of cargo it is seen that the timber trade was quantitatively the most important, representing 27.3 percent of the estimated freight earnings. The grain trade, including the closely affiliated oil seeds trade, accounts for 23.2 percent. Timber, grain and seeds thus engaged a little more than 50 percent of the capacity of the carrying trade. Other important trades in this period comprised sugar with 15.3 percent and cotton and fertilizers which each had a share of nearly 10 percent. The important position of timber and grain cargoes was a permanent feature of the shipping trade in the entire period until WWI; by 1913 their share of imports into the UK was still about one half, representing about 47 per cent of the basis of the weight of imports.[18]

fell considerably, see Potter (1955).

[18]See the Final Report of the Departmental Committee on Shipping and Shipbuilding, *British Parliamentary Papers (1918), vol. XIII.*

3 New indices of ocean freight rates

There is no satisfactory general index of ocean freight rates for the 1850s. The well-known data originating from the circulars of the London shipbroker firm of Angier Brothers, which have been the basis of much of the early work on pre-WWI freight rate movements, only extend back to 1869.[19] The North American export freight rates derived by North (1958, 1965) and the British coal freight rate series constructed by Harley (1989) both cover the middle of the nineteenth century and are among the major contributions to our knowledge of the long-term development of ocean freight rates. However, satisfactory freight data on homeward (to Britain) trade routes are much harder to obtain for the nineteenth century in general and, apparently, particularly for the middle of the century; in fact, there are significant gaps for the 1850s in the key time series derived mainly from British consular reports presented in Harley (1988, 1989).

There is some fragmentary evidence on the extremely high freight rates during the Crimean War, but the only well-known source of continuous freight rate series on a higher frequency than one year from this period seems to be Tooke and Newmarch (1857, pp. 318-322). The quarterly data on general cargo rates from London to New York, Calcutta and Melbourne extend from January 1852 to October 1856. These data were graphed and extensively discussed in the pathbreaking study of the British economy in the 1850s by Hughes (1960). Although Hughes' discussion was carefully balanced as to the causes of the surge in freight rates starting in 1853, the data provided in Tooke and Newmarch (1857) are too incomplete to form the basis of a full assessment of the forces driving the freight rate cycles of the 1850s. As will become evident below, homeward freight rates behaved differently from outward rates and there were significant differences between the various trade routes.

By utilizing new data sources and applying a new method of index construction it has been feasible to derive 14 monthly inward (mainly to Britain) indices and 14 outward coal export indices covering the period from January 1848 to December 1861.[20] The new sources comprise data from various shipbrokers' circulars and market reports in contemporary Norwegian, British and American newspapers, from which a large sample of monthly freight rate observations was collected.[21]

Even though the sample of freight quotations at hand is fairly large there is a fundamental problem which all previous researchers attempting to construct indices of freight rates have struggled with so far: how to cope with the fact that nearly all available time series of individual freight rates do have gaps. The problem becomes particularly acute in the case of monthly data. Given these problems I suggest using a type of index extensively employed in the construction of house price indices, where it is referred to as a *repeat sales* index.[22] This index has been developed for a market where the price of each object is quoted infrequently and at irregular intervals, which is typical of the house market.

[19] The data were published in Fairplay in 1920, and later used by Isserlis (1938) to construct an annual index of freight rates beginning in 1869. Recently Mohammed and Williamson (2004) have presented new indices using these data with some supplements.

[20] The data and the indices are explained in detail in Klovland (2006).

[21] Norwegian newspapers provide a particularly rich source of freight rate data for this period. Several London shipbrokers published their trade circulars there, including the firm of Goodliffe & Smart, whose fortnightly circulars were published – with some gaps particularly in the early years – in some of the main Norwegian newspapers from October 1849 to April 1861. Other main sources include *The New York Times* (beginning 1852), *Mitchell's Maritime Register* (beginning 1856), *Newcastle Courant, Newcastle Guardian,* and *The Economist.*

[22] The method was first launched by Bailey et al. (1963). One of the key house price indices in the United States, the Case-Shiller home price index, is based on this principle.

A similar situation characterizes the ocean freight market: a quotation for any specific voyage with a particular cargo (referred to here as a *sailing*) is in most cases only available for some months of the year during the most active export season. With a large number of time series available for each of the 28 subindices, each containing numerous gaps, any method involving splicing a few of the key time series is unsatisfactory and would in practice discard much useful information. In analogy with the house price index the new index is labelled a *repeat sailings index*.

Formally, the index is derived from estimating the model

$$\ln(p_{it}) - \ln(p_{i,t-j}) = \gamma_2 D_{i2} + \gamma_3 D_{i3} + \ldots + \gamma_t D_{it} + \ldots + \gamma_T D_{iT} + \varepsilon_{it}$$

where p_{it} is the freight rate of a particular sailing i (for example per quarter wheat from New York to Liverpool by sailing ship) at time t; similarly, $p_{i,t-j}$ is the freight rate pertaining to exactly the same sailing j months earlier; D represents a set of dummy variables that take a value of 1 at time t, a value of -1 in month $t-j$ when the last sailing took place and zero elsewhere (so that $D_{it} = 1, D_{it-j} = -1, D_{it-s} = 0$ for $s \neq 0$ or $s \neq j$); ε_{it} is an error term. The estimates of the vector of γ-parameters can be obtained by standard regression methods. The final stage is then to compute the values X_t of the *repeat sailings index* for each observation of the sample running from $t = 2$ to T as[23]

$$X_t = 100 \cdot \exp(\gamma_t)$$

The new aggregate inward and outward (coal) subindices are shown in Figure 2 for the period from January 1848 to December 1861. Monthly values of the total inward and outward indices can be found in Table 2 for the period July 1852 to June 1856. This table also includes monthly values of some of the subindices, which will be discussed more fully later. The estimated freight earnings referred to above (see Table 1) were used to weight the 14 inward indices together.[24] A similar procedure based on the geographical distribution of British coal exports in 1860 and actual coal freight rates to the various regions in the same year was applied to the outward index. The new indices shown in Figure 2 leave no doubt that there were spectacular cyclical fluctuations in ocean freight rates in the 1850s.

[23]Here, the first observation is used as the basis of the index, but this is arbitrary.

[24]In the cases where there are gaps in some of the subindices values have been interpolated before aggregating. Such gaps are mainly caused by the suspension of shipments during the winter season in northern waters.

Figure 2. Ocean freight indices January 1848 - December1861

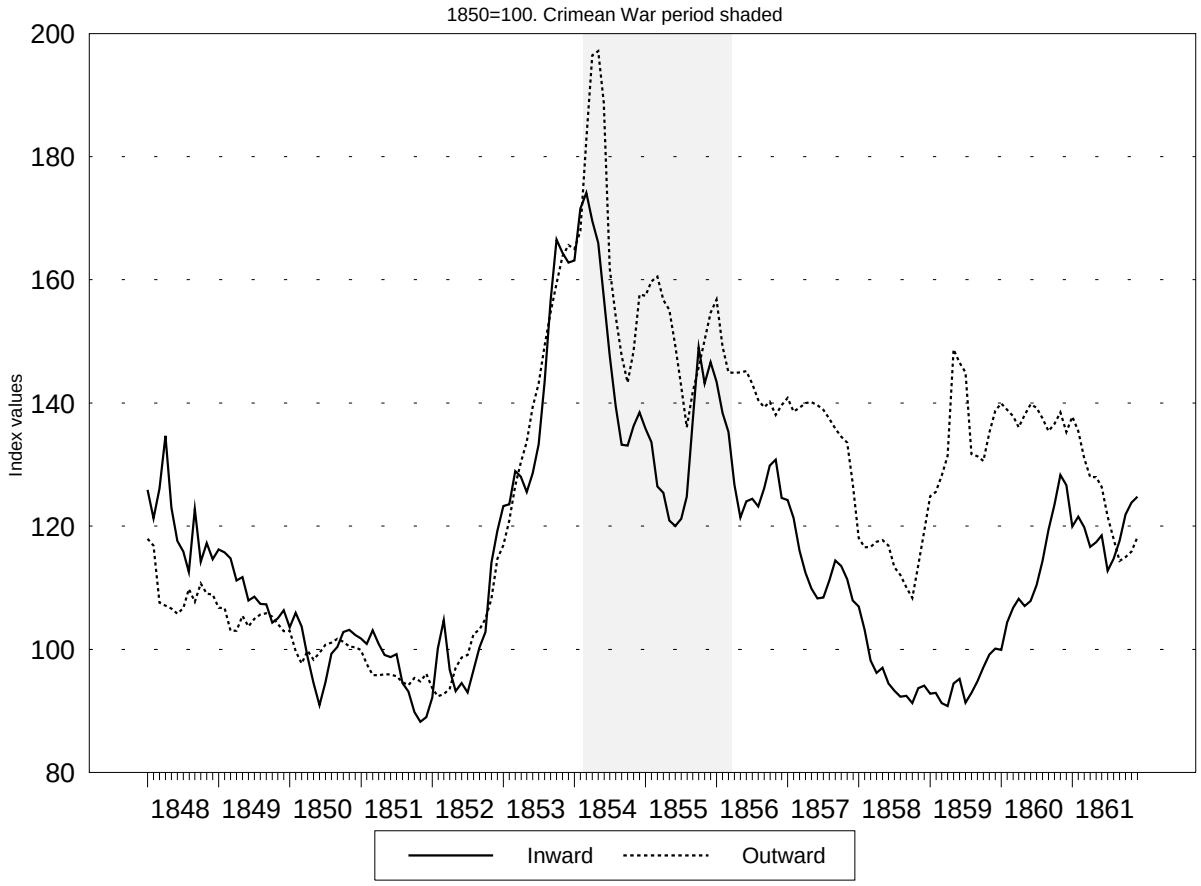


Table 2. Monthly index numbers of freight rates July 1852 - June 1856

Average of 1850 = 100

	Inward indices				Outward indices	
	Total	Black Sea	Mediterr-anean	North America grain	Total	Black Sea
Jul 1852	93.0	114.8	114.3	80.3	99.0	83.6
Aug 1852	96.7	123.9	114.7	78.2	102.5	85.7
Sep 1852	100.3	134.1	113.7	93.3	103.2	87.7
Oct 1852	102.8	138.8	108.6	108.8	105.0	88.0
Nov 1852	114.1	151.9	113.2	125.8	108.2	88.4
Dec 1852	119.3	158.7	122.3	139.4	114.7	83.9
Jan 1853	123.3	157.9	129.3	161.9	116.9	83.7
Feb 1853	123.5	160.9	130.3	153.5	120.9	84.1
Mar 1853	128.9	156.3	131.9	151.9	126.6	86.4
Apr 1853	128.0	159.6	135.1	131.5	130.3	84.0
May 1853	125.5	171.3	135.3	90.8	133.7	87.6
Jun 1853	128.6	203.7	141.5	97.5	139.4	93.0
Jul 1853	133.3	237.2	146.4	113.6	143.2	98.9
Aug 1853	143.4	271.7	154.2	124.2	149.3	99.7
Sep 1853	156.6	286.1	166.4	160.4	154.7	99.1
Oct 1853	166.5	315.0	176.3	184.6	159.4	101.6
Nov 1853	164.4	320.2	180.2	206.1	163.8	104.1
Dec 1853	162.8	308.8	176.9	194.4	165.7	111.0
Jan 1854	163.2	283.8	179.1	182.1	165.0	123.4
Feb 1854	171.6	280.5	187.5	200.8	167.9	136.4
Mar 1854	174.1	237.1	169.0	183.8	182.8	229.9
Apr 1854	169.6	232.5	144.7	172.9	196.5	300.9
May 1854	166.0	224.3	117.2	160.8	197.2	277.7
Jun 1854	157.2	199.2	112.1	128.1	188.8	283.4
Jul 1854	147.7	199.5	116.2	121.1	161.8	231.8
Aug 1854	139.5	182.3	119.2	130.7	154.1	209.0
Sep 1854	133.2	185.0	125.3	142.8	147.7	205.2
Oct 1854	133.1	185.8	127.3	113.7	143.3	217.6
Nov 1854	136.3	199.6	133.4	122.2	148.4	253.0

Table 2. Monthly index numbers of freight rates July 1852 - June 1856

Average of 1850 = 100

	Inward indices				Outward indices	
	Total	Black Sea	Mediterr-anean	North America grain	Total	Black Sea
Dec 1854	138.5	216.6	131.7	105.7	157.6	291.7
Jan 1855	135.9	204.1	123.4	110.6	157.4	275.7
Feb 1855	133.6	187.8	124.4	108.3	159.7	293.5
Mar 1855	126.4	177.8	124.0	106.9	160.5	279.7
Apr 1855	125.4	169.1	119.0	112.0	156.7	272.4
May 1855	120.9	160.5	111.7	99.1	155.1	270.2
Jun 1855	120.0	171.2	109.9	89.8	149.3	246.6
Jul 1855	121.2	176.6	108.3	109.2	142.7	223.8
Aug 1855	124.8	179.9	109.6	130.2	136.1	215.8
Sep 1855	137.1	181.8	115.0	154.2	141.8	247.9
Oct 1855	149.0	178.7	121.8	198.0	145.8	282.1
Nov 1855	143.2	165.0	127.7	188.3	150.2	287.6
Dec 1855	146.6	173.6	125.6	183.7	154.6	299.3
Jan 1856	143.5	165.8	120.0	177.8	156.8	300.6
Feb 1856	138.4	154.8	115.7	149.2	149.2	277.4
Mar 1856	135.3	132.5	120.0	152.8	145.0	267.6
Apr 1856	126.7	120.9	114.7	121.5	144.9	230.8
May 1856	121.4	107.4	119.5	106.0	144.9	205.0
Jun 1856	124.0	117.5	120.7	121.7	145.2	205.3

Freight rates were declining from 1848 towards a trough occurring in 1851, early in the year in the case of coal freights, in the final part of the year in the case of inward freight rates.[25] Then followed a period of sustained rise in all freight rates that created one of the most famous shipping booms of the nineteenth century. This boom is traditionally associated with the Crimean War. However, the new total indices show clearly that the freight rates were rising already by 1852, gaining considerable momentum during 1853 and peaking in the early months of 1854, just as the war started – in March 1854 in the case of inward freights and in May 1854 in the case of coal shipments from Britain. Freight

[25]The weakness of the inward freight rates in the autumn of 1851 did not affect all subindices, but it was fairly widespread; it was particularly the Far East routes, the North American wood trade, the guano trade from the Pacific coast of South America and the Baltic grain trade that contributed to the marked dip in the index.

rates were in decline for several years after the peak in 1854. The trough was reached in the second half of 1858 or early in 1859 for inward rates.

A provisional conclusion is that the timing of the index movements is difficult to reconcile with the hypothesis that the Crimean War was the only, or even the primary, direct cause of one of the great shipping booms, basically because freight rates began to fall about the same time as war was declared. Of course, anticipations of war may still have affected the rise of freight rates prior to the war, and this hypothesis will be discussed in more detail below. We now turn to an analysis of the role played by the war and other important factors affecting the demand for and supply of shipping services in this period.

4 Factors that can explain the freight rate movements

We now turn to a discussion of the factors that are believed to have played an important role in shaping the freight rate movements of the 1850s. A key issue in this connection is what caused the spectacular rise and subsequent fall in freight rates in the period from 1853 to 1856 – can it all be traced down to the Crimean War or did other factors cause it?

4.1 The business cycle

In Britain the first half of the 1850s were characterized first by a period of recovery from the great commercial crisis of 1848, which subsequently gave way to a strong business cycle upswing. According to Hughes (1960, p. 28) from the summer of 1852 there was a strong boom period that reached its peak in the third quarter of 1853. Two of the monthly business cycle indicators constructed by Klovland (1998) shown in Figure 3 confirm this view: the rail freight revenues, which reflect fluctuations in the activity of domestic manufacturing and mining, rose markedly from the summer of 1852 to a peak in March 1854; the real export series present a more volatile picture, but clearly shows a booming export trade in 1853 and the early months of 1854.[26] Many economic indicators were falling in Britain in 1854, and a business cycle trough in December of that year was identified by the National Bureau of Economic Research.[27] It thus appears that the freight rate movements coincided fairly well with the business cycle fluctuations in the early 1850s.

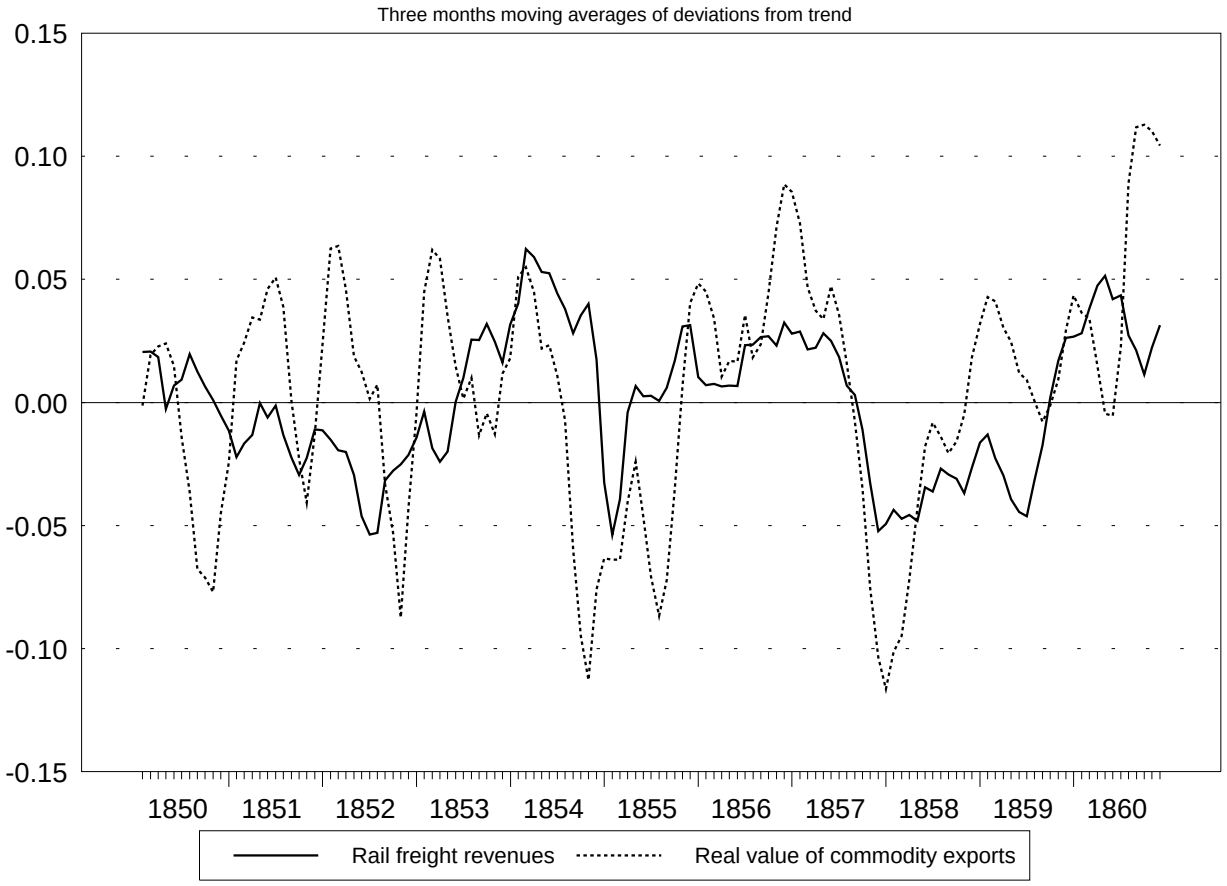
In 1856 a great revival of British exports set in, and a wave of postwar business optimism created a strong economic upswing, culminating in 1857 - a year of great commercial crisis both in Europe and the United States. In Britain export volumes fell steeply in 1857 and the strains on the domestic economic activity became evident early in the year.[28] Although the indicators in Figure 3 must be considered as indicative only, they broadly conform to the established view of the business cycle chronology of the 1850s.

[26]The railway freight returns were used by contemporary observers as a key indicator of the state of the home trade and conforms well to the NBER dating of business cycles for Britain, see Hultgren (1953) and Klovland (1998). Data on real exports were constructed by deflating monthly export values of nine groups of commodities by matching monthly price indices, see the appendix in Klovland (1998) for details.

[27]See Burns and Mitchell (1946, p. 79) and Hughes (1960, pp. 27-29).

[28]Hughes (1960) provides a masterly narrative of the fluctuations in trade and industry in Britain in these years. According to the business cycle chronology the US economy peaked in June 1857, see Moore and Zarnowitz (1986).

Figure 3. Monthly business cycle indicators for the UK 1850 - 1860



In contrast to the 1853 boom, the ocean freight rate series seem to be little affected by the strong business cycle movements in 1857; the inward freight rate index was falling after a mild upturn late in 1856. On the other hand, the business cycle depression in 1858 is consistent with the falling freight rates in that year.

Hughes (1960, p. 207) emphasized the role of the business cycle in explaining the surge in ship-building and freight rates in 1853 and 1854, which is consistent with the view presented here. On the other hand, the next business cycle boom, in 1857, does not fit into this picture; hence, there must be additional explanatory factors that must be taken into consideration.

4.2 The importation of grain and flour

After the repeal of the Corn Laws in 1846, which was fully effective only from February 1849[29], fluctuations in the domestic grain harvest could be counterbalanced by the importation of grain and flour at a lower cost than previously. The quantity of wheat imported into Britain in the period 1850-1854 increased by 59 per cent compared to the previous five-year period. The unusually wet sowing and harvest seasons of 1852-1853 led to a surge in wheat imports in 1853, 28 per cent higher than the previous record level of 1849. From 1854 and throughout the decade grain harvests were closer to normal. The next really bad harvest occurred in 1860, when grain imports surpassed the 1853 quantity by 20 per cent.[30]

The increase in grain imports obviously required more tonnage, but the effective demand for shipping capacity also depended on where the grain was sent from. The distribution of imports across countries of origin could vary quite much from one season to another, depending on the relative abundance of harvests in the various exporting regions. In addition, the pattern of imports was severely disrupted by the war in the years 1854 to 1856.

In 1850 and 1851 much wheat was coming to Britain from the 'old sources', as defined by Fairlie (1965): French Atlantic ports, northern Europe and the Baltic, which implied a relative low demand for tonnage, given the volume of aggregate imports. By contrast, in 1856 the 'new sources' dominated; the Black Sea, eastern Mediterranean and, in particular, North America were large suppliers of wheat, which reinforced the strong demand for carrying capacity stemming from a substantial increase in aggregate imports.

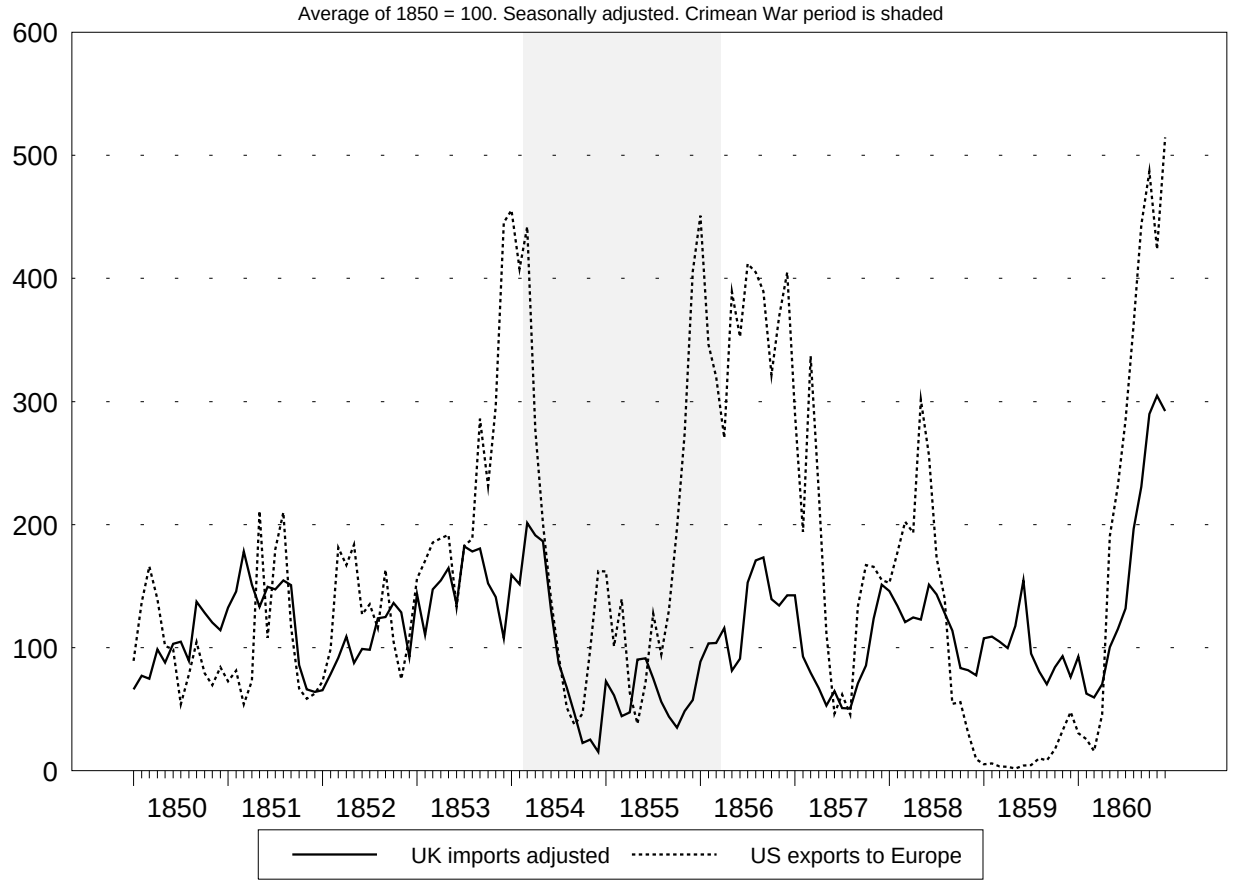
In order to take into account the changing distribution of the origin of wheat and flour imports a monthly index of import volumes weighted by a tonnage factor for each country was constructed. The aggregate monthly import quantity is known for the whole period, but the complete distribution across exporting countries is only available from 1856 on a monthly basis. In order to obtain monthly data for previous years annual import shares were then applied to the aggregate monthly imports, after taking into account the separately derived monthly figures on imports from the United States described below. The tonnage factor was computed from relative freight rates on wheat and flour in the years 1852 and 1857.[31] The weighted index, which is referred to here as the sailing-day adjusted

[29] From this date there was only a 'registration duty' of one shilling per quarter of imported wheat, see Tooke and Newmarch (1857, p. 433).

[30] Wheat imports are taken from Mitchell (1988). Information on grain harvests is from Jones (1964). See also Fairlie (1969) and Vamplew (1980) for annual estimates of grain sales.

[31] The underlying data are from Klovland (2006).

Figure 4. Grain and flour: Sailing-day adjusted UK imports and US exports to Europe



grain and flour imports, is shown in Figure 4.

Grain and flour from the eastern seaboard of the United States was a potentially very large, but highly variable, source of supply.[32] Judging from relative freight rates the cost of transport from New York was about 40 per cent lower than from Odessa, but at least 60 per cent higher than from the old sources of northern Europe. Therefore, a higher proportion of imports of cereals from the United States usually implied an increased demand for shipping capacity.

When harvests were good in North America and bad in Britain and on the Continent exports of cereals from the United States and British North America could take a dramatic upturn; it was five times as large in 1856 as in 1855, it rose from being negligible in 1859 to the highest figure recorded until then in 1860. A monthly time series of the volume of wheat, flour and maize exports to the United Kingdom and the European Continent is also shown in Figure 4. This variable has been computed from figures on US exports of breadstuffs that usually were presented every fortnight in *The Economist* beginning in June 1848.[33] Data on exports to the Continent, which also included rye,

[32]The exports of wheat from San Francisco did not gain momentum until the final years of the 1860s, see Davis (1894).

[33]The data were shown as export figures for the various grain and flour categories accumulated within each harvest season, starting on 1 September each year. The monthly time series estimates of grain imports from the United States take into account a lag of one to three months corresponding to the time that elapsed between the grain leaving US ports and entering the market in Britain. The lag weights were determined by regressing the UK Board of Trade figures on imports from the United States on the export figures on data starting in January 1856.

were not published before the 1853 harvest season. This implies a level shift to the series in September 1853, which should be borne in mind when referring to the data. It appears that harvests were fairly good in France and neighbouring countries in the early years of the 1850s, however, so that exports to the Continent may be assumed to have been rather small in this period.[34]

The two curves shown in Figure 4 are interesting because they may go some way towards explaining the freight rate movements in the period under review. In particular, the buoyancy of freight rates in 1853, 1856 and 1860 are all accompanied by marked upswings in grain and flour imports to the UK and the Continent. The steeply falling imports of cereals during 1854 may also represent a crucial element in the explanation of why freight rates fell like a stone once the Crimean War was declared. On the other hand, we see from Figure 2 that freight rates were still declining throughout most of 1858 in spite of fairly vigorous importation of grain.

4.3 The Australian Trade

Contemporary sources put great emphasis on the role played by the surge in trade with Australia, which began in the summer of 1852 following the gold discoveries in 1851. According to the circular of Glover Brothers, dated 31 December 1854, this 'led to an era of high freights and plentiful employment of shipping, which cleared off all surplus tonnage', but '[f]rom about July [1854] Australia ceased to be an extraordinary absorbent of tonnage.'[35] This two-year period corresponds rather closely to the time period during which our new freight rate indices exhibit extreme values.

Quantifying the Australian trade effect is somewhat problematic. One attempt is shown in Figure 5, which graphs the ratio of coal freight rate indices from the Tyne and Wales to Australian ports relative to the weighted world average of coal freight index.[36] The coal trade in all directions shared in strongly rising freight rates from the summer of 1852, but in the case of Australia the peak level was reached much faster, coming in the early months of 1853. The high level of freight rates to Australia was largely sustained over the next 12-month period.[37] This gives rise to the relative freight rate series in Figure 5, which seems to reflect quite well the timing of the surge in the trade with Australia. This indicator is 1.00 in February 1852, rising to 1.75 twelve months later; from February 1853 it fell almost every month until reaching a low in May 1854.

4.4 The Crimean War

Using the term 'The Crimean War of 1854-1856' is not unproblematic because the starting date may depend on the national perspective.[38] From a Russian or Turkish perspective it would be more appropriate to say that the war either started in July 1853, when Russia crossed the border to the Danubian principalities of Moldavia and Wallachia, or in October 1853, when Turkey declared war on Russia and hostilities in the Danubian region commenced.[39] At sea acts of war in the Black Sea

[34] In the years 1848 to 1852 France, Holland, the Hanse Towns and Germany were relatively large exporters of wheat to the UK. See also the evidence on harvests on the Continent cited in Fairlie (1969, p. 104).

[35] An excerpt is reprinted in Tooke and Newmarch (1857, pp. 321-322).

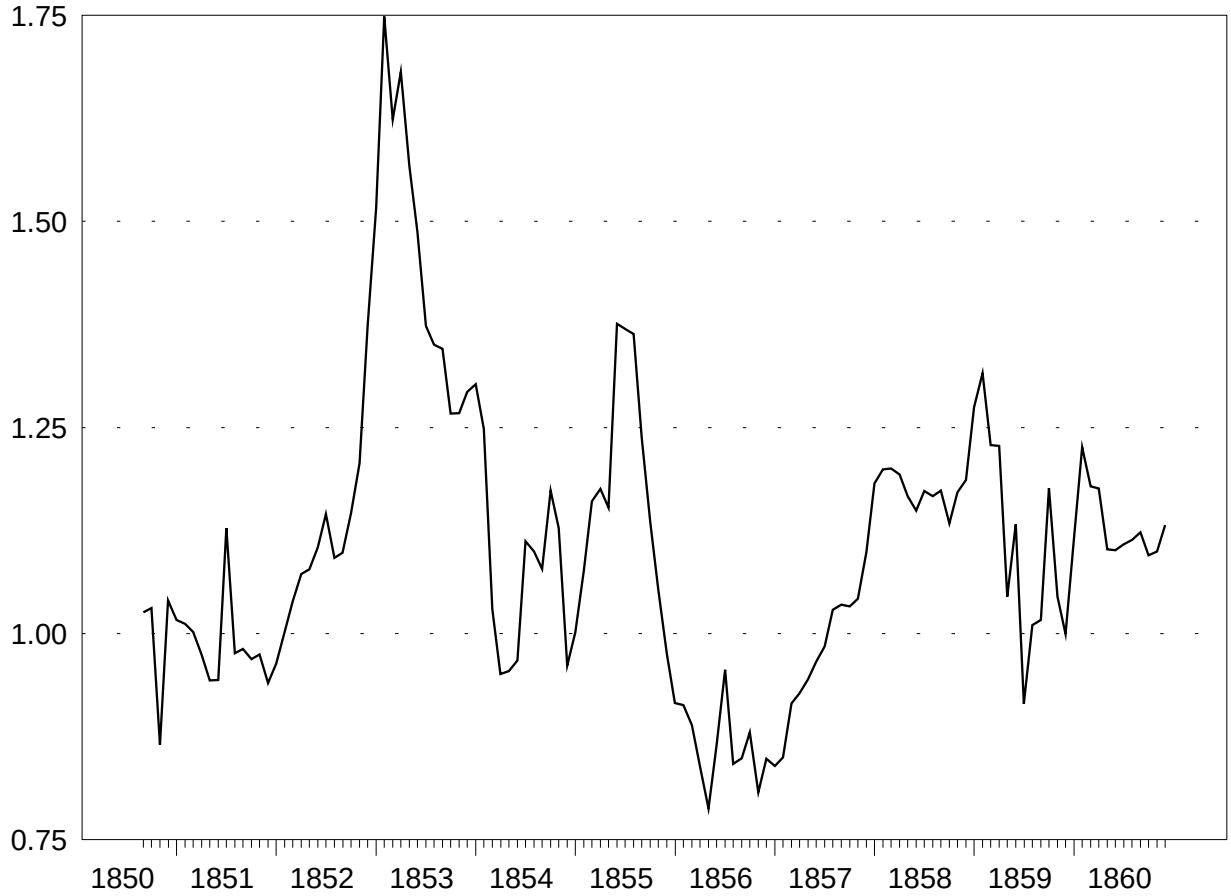
[36] Both indices set the averages of monthly figures in 1850 equal to 100.

[37] The quarterly general cargo freight rates to Melbourne in Tooke and Newmarch (1857, p. 319) present much the same picture.

[38] This point is underlined by Fletcher and Ishchenko (2004, pp. xi-xiv).

[39] Fletcher and Ishchenko (2004, pp. 29-41).

Figure 5. Coal freights: Australian ports relative to world index



had definitely begun by the last day of November 1853 when Russia destroyed the Turkish flotilla at Sinope.[40] In January 1854 the joint British and French fleet entered the Black Sea, at the end of March war against Russia was formally declared, but the invasion of the Crimea did not take place until September 1854. The formal declaration of war usually defines the beginning of the Crimean War, which is also adopted here, but the preceding events must clearly be taken into account in discussing the effects of war on shipping activity and freight rates. It is also essential to note that while the main theatre of war operations was the Crimea there were also scattered incidents of war in the Baltic and in the Caucasus and, as noted above, skirmishes on the Danube from October 1853.

The effects of the Crimean War on the freight rates of the 1850s can be divided into two main categories: the direct effects on the demand for shipping services from the government's transport requirements during the war and several types of indirect effects, both before and during the war. The anticipations of war may have precipitated grain imports in 1853; increased war risk affected freight rates directly in the Black Sea and in the eastern part of the Baltic; the blockade of Russian ports and the Russian embargo on grain exports diverted prewar trade flows.

4.4.1 Harvest failure, the price of wheat and the impending war

Russia (chiefly Black Sea ports), Prussia, North America and France were the largest suppliers of foreign wheat to Britain in the early 1850s. As the likelihood of war in the Black Sea increased during 1853, the prospects of supplies being cut off from one of the main suppliers, Russia, was certainly one of the factors that may have contributed to an upward pressure on the price of wheat in Britain.

If this was the major factor we have an indirect channel through which the coming war affected the freights rates. When the price of wheat soared in Britain a natural response would be an acceleration of shipments of wheat from the Black Sea, thus increasing the demand for shipping space and increasing freight rates.

In contrast to the direct effects of the Crimean War discussed below this hypothesis gets the timing right - the great boom in freight rates took place before the war, in 1853, not at the time when the war was declared (March 1854) or when hostilities between Russia and England and France began (September 1854). To evaluate the hypothesis we therefore need to look at what actually happened to wheat prices and grain imports in these years. Figure 6 shows the market price of wheat in London[41] and the seasonally adjusted volume of grain and flour imports to Britain in the 1850s.[42]

From a relatively stable level around 45 shillings per quarter the price of wheat rose dramatically from the summer of 1853, reaching 83 shillings in January 1854 and culminating at 85 shillings in May and June.[43] The price stayed at a relatively high level through 1856. We also note from Figure 6 that there was indeed strongly rising grain imports during the whole of 1853, remaining high in the first

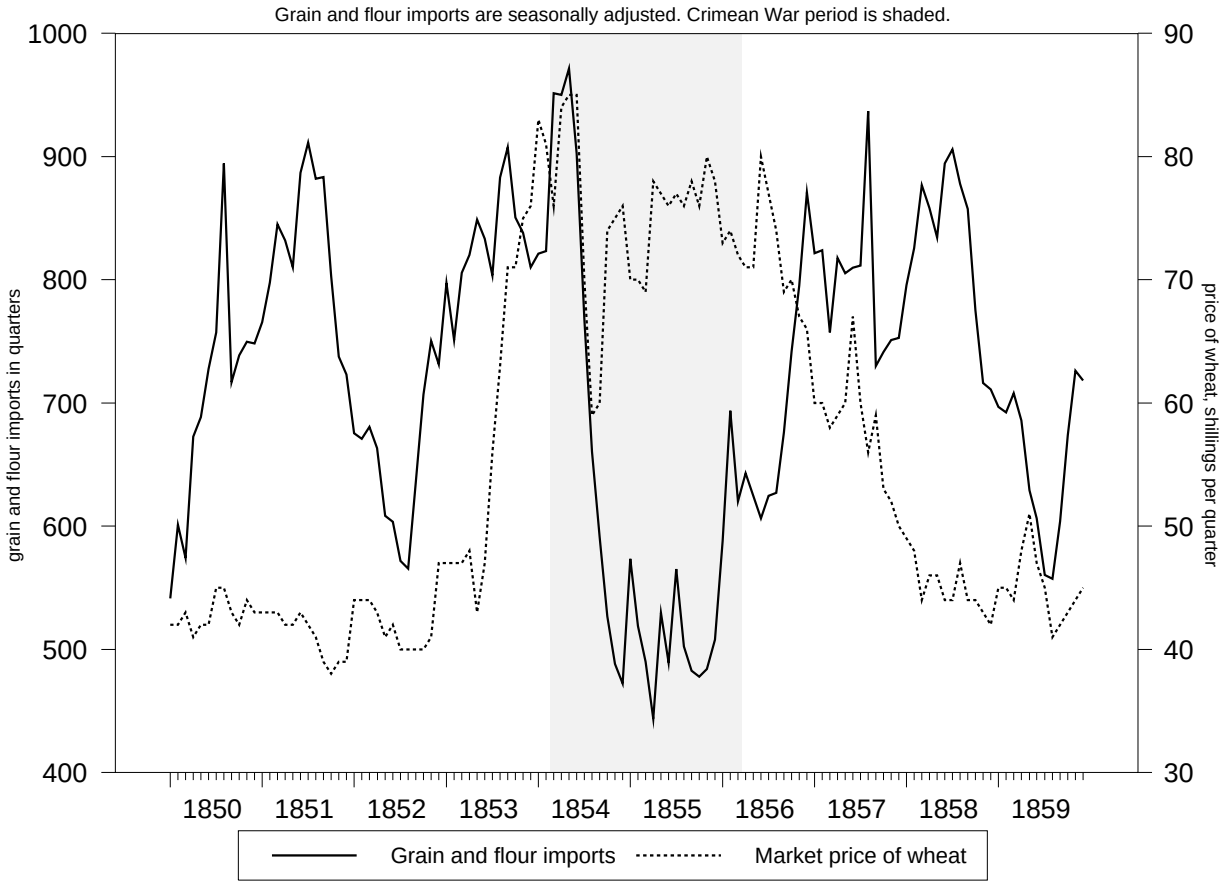
[40] According to Royle (2000, p. 93) '[i]f any one event was destined to propel Britain into war it was the action at Sinope'.

[41] The wheat price series represents the top price of Kent and Essex red wheat as quoted at the London grain market. The source is *Mark Lane Express.*

[42] Figure 6 shows monthly volumes of the total imports of wheat and other grains as well as flour (converted from hundredweights to quarters by a ratio of 0.2857), taken from the monthly trade returns published in *The Economist.*

[43] The Gazette average price, which is commonly used as an indicator of wheat prices, presents much the same picture, but the level of prices is generally slightly lower. The top price of red wheat shown here is preferred because it is presumably less affected by fluctuations in quality across good and bad harvest seasons.

Figure 6. Grain imports and the market price of wheat in London 1850-1859



half of 1854, but collapsing in the middle of 1854.

A key question which thus needs to be examined further is the role of the impending war in causing the rising wheat prices, grain imports and ocean freight rates. The view taken here is that it is likely that the anticipations of war did play a role, but it was probably *not* a major one; it is more likely that the primary cause of the rising wheat prices was the bad domestic harvests of 1852 and 1853, the effects of which were reinforced by the deficient wheat harvest in France in the latter year. In Britain the harvest of 1852 brought an under-average crop of wheat; the poor sowing in the wet autumn of 1852 exacerbated the shortages of wheat in 1853.[44] Market observers predicted already in March 1853 that 'the next crop will be one of the smallest in quantity we have had for many years past...'[45] and by September it was estimated that 'the wheat crop of Great Britain is at least *one fourth* short of an average.'[46]

Large supplies of wheat had been sent from the Black Sea in the first part of 1853, but later in the year shipments to Britain were on a considerably reduced scale despite large quantities of grain stored in Black Sea ports. The reason for this was the great scarcity of available shipping space in spite of strongly increased freight rates. The failed harvest in France, which usually was a net exporter of wheat to Britain, played a key role here. 'France continues to outbid us', claimed *The Farmer's Magazine* in their review of the corn trade of November 1853, adding that 'by far the greater portion of the shipments from the Black Sea have, during the last three months, been for Marseilles.'[47]

There is not much evidence that the greatly increased wheat imports during 1853 were stored for speculative purposes, which would be consistent with a hypothesis of shipments primarily initiated by anticipations of war. The quantities of wheat sales in the 'inspected markets' in England and Wales tabulated in Vamplew (1980) show that the volume sold in 1853 was only 70 per cent of that in 1852, which was a fairly normal year. Applying the ratio of 2.8 used by Fairlie (1969) to arrive at an estimate of the shortfall of the total wheat harvest gives a figure of 4080 (thousands of) quarters.[48] The quantity of wheat imported in 1853 was 4915 quarters, an increase of 1855 quarters; thus wheat stocks must have been run down rather than increased. This is consistent with reports in the autumn of 1853 stating that stocks in warehouses were 'only moderate' and that '[b]y far the greater portion of the import has gone into consumption almost as soon as it has been received.'[49]

4.4.2 The anticipation of war

In the first half of 1853 the freight markets exhibited increasing buoyancy, with a particular focus on Australia. In their market report of 20 January 1853 Goodliffe and Smart (hereafter *GS*) claimed that '[T]he Australian trade is of course the chief feature of interest at the present moment, and gives the tone to the market throughout.'[50] By March trade was reported to be increasing in nearly all

[44] Jones (1964, p. 169).
[45] *The Farmer's Magazine*, vol. 3, 1853, p. 371.
[46] *The Farmer's Magazine*, vol. 4, 1853, p. 378.
[47] *The Farmer's Magazine*, vol. 4, 1853, p. 559.
[48] Note that these figures refer to England and Wales only whereas import figures are for the whole of UK.
[49] 'Review of the corn trade during the month of September' in *The Farmer's Magazine*, vol 4, 1853, p. 379.
[50] The fortnightly freight market reports circulated by the London shipbroker firm of Goodliffe and Smart are an invaluable source of the market sentiments in the 1850s. Some of the original reports from 1850 through 1854 can be found in the British Newspaper Library in London; many more have been preserved in translated form in the Norwegian newspaper *Morgenbladet* throughout the decade.

directions: the Baltic Trade was brisk, a good steady business was conducted with South America, freights from the West Indies had an upward tendency and guano freight rates from the Chincha Islands were firm. In addition, it was reported that '[V]ery large orders are now held for timber ships from the North American ports, and even advanced rates have failed to bring forward an adequate supply of tonnage.'[51] The only exception was the East Indian homeward freights which were affected by a large number of ships engaged in the outward Australian trade seeking return freights from East India.[52] It is thus evident that the increased demand for transport, and the consequent rise in freights, arose from a general increase in trade, which at this stage was not related to the war issue.

The first war-related news that really affected market prospects arrived at the end of May 1853. In their report of 26 May Goodliffe and Smart added a last-minute note that the withdrawal of the Russian ambassador from Constantinople had been confirmed by a telegraphic despatch, which led to an 'increased desire ...to get tonnage from the Black Sea and Danube.' From then on the impending war provided a further factor affecting the freight markets.

The impact of the political uncertainty on freight rates must be viewed in connection with the growing concern over the domestic wheat harvest. On June 23 *GS* reported: 'The general scarcity of suitable tonnage for the grain trade has become so great that in some instances freights have advanced 10 - 15 % during the past fortnight, whilst from those ports principally affected by impending hostilities we may quote a rise upwards of 20 %.' If there had been a normal harvest it is unlikely that the effect on freight rates had been so great. In fact, the rumours of war had a depressing influence on the prospects of trade in general, apart from the grain trade, which might have had a dampening effect on the market later in the year.[53] On the other hand, the costs of transport increased due to an extra premium of insurance for war risk, which by midsummer amounted to 3 per cent in the Black Sea and 1 to 2 per cent in the Baltic.[54]

As the scramble for wheat intensified in the autumn of 1853 freight rates rose further. The increasing likelihood of a harvest failure in Britain as well as in France, the small grain stocks in the Baltic and the Pasha's ban on wheat exports from Egypt after the end of November created an acute shortage of tonnage that spilled over to all other trade routes.[55] The main sources of supply left were the Black Sea and North America, which entailed longer transport routes than on average in a normal year.

The effects on freight rates in 1853 from the impending war should therefore be seen mainly as being conditional on the harvest failure – importers of grain were extremely anxious to get the grain transported out of Russian ports as quickly as possible, almost at any cost. In this regard the war did not create an additional demand for tonnage within the perspective of the harvest season but it brought it forward in time. The increased demand for tonnage arising directly from the transport of troops and provisions during a coming war did not seem to be a major issue before government contracts for shipping capacity actually were made and coal freights surged upwards early in 1854.

[51] *GS*, 18 March 1853.

[52] See in particular *GS*, 23 June and 21 July 1853. The weakness of the homeward East Indian trade in 1853 is confirmed by the indices in Klovland (2006). The inward freight rate index from that region in 1853 is the lowest of all the 14 trade routes, being estimated at 112 (with 1850 equal to 100) against a weighted average of of 140.

[53] On 29 September *GS* noted that freights were checked by the 'threatening aspect of political affairs'.

[54] *GS* 23 June 1853.

[55] *GS* 29 September and 13 October 1853.

Towards the end of 1853 the war risk had become so great that shipments of grain were considerably reduced in scale. Some charters were closed with ships under neutral flag in the winter months of 1854, but by the middle of March shipments of wheat from Odessa ceased as the hope that a neutral flag would ensure protection from the embargo was waning.[56] Shipments from the Danube still went on, however.

4.4.3 The government's demand for transport

The first contracts with ships intended to transport troops, munitions and provisions to the Crimea were signed in the middle of January 1854. The tonnage of ships engaged by the government as regular transports between the UK, Mediterranean ports and the Crimea can be calculated from published sources.[57] Figure 7 shows the net tonnage of sailing and steam ships employed in these services from January 1854 to April 1856.[58] The sample underlying these figures contains 314 ships, most of which were chartered from the general merchant marine, but there were also some steam ships previously employed in mail services. Initially the bulk of contracts were for sailing ships, but steam capacity was increasing fast from the late autumn of 1854, surpassing sailing ships from January 1855. The maximum of tonnage engaged, looking at the total of steam and sail, was reached in June. During the second half of 1854 and throughout the year 1855 the government's demand for transport remained at a high level. After the war ended in March 1856 the tonnage under contract fell rapidly.

Hughes (1960, p. 210) states that '[t]hese demands made upon the merchant fleet raised freights and induced further shipbuilding.' It is difficult to argue against this statement in general, but it is in some contrast to the fact that freight rates fell from the spring of 1854, just as the transport capacity engaged by the government was increased strongly. A qualified view is offered by Tooke and Newmarch (1857, p. 318) who notes that the effect on the freight market was very marked in the early part of 1854, but 'it subsided rapidly after the summer'. But the tonnage under government contract was even greater in the second half of 1854 and throughout 1855, when freight rates were considerably lower.

4.5 The supply of tonnage

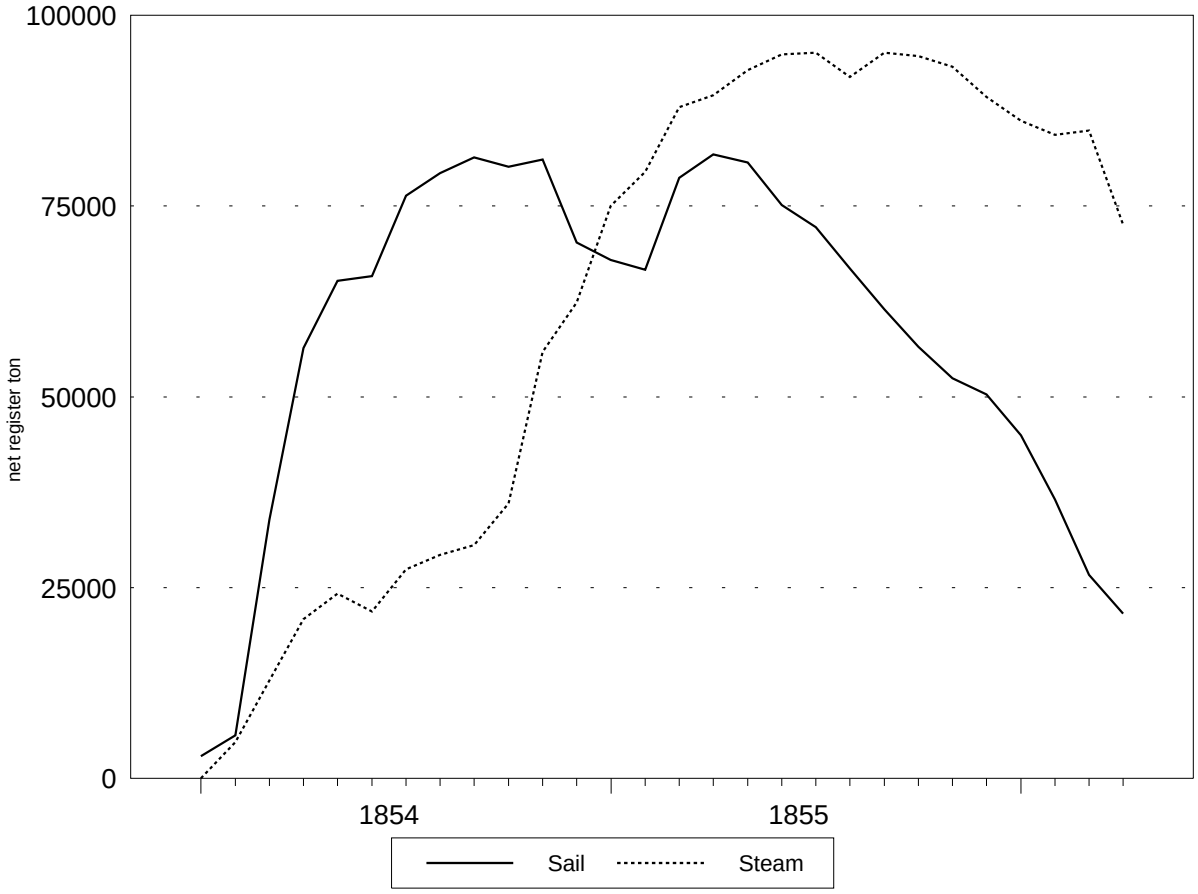
So far we have identified several factors on the demand side that may account for some of the more spectacular short-term fluctuations in freight rates in the 1850s. Nevertheless, it may be difficult to find an explanation of the continuing fall in freight rates in the last half of the decade by reference to demand side factors alone. When analyzing the longer swings of the freight rate data a more explicit focus on the available tonnage is called for.

[56] *GS* 2 March 1854.

[57] The main sources used are *British Parliamentary Papers 283 (1854/1855) and 385 (1856)*, see also *24 (1854/1855)* and *517 (1854/1855).* These sources give a complete listing of the individual ships engaged in regular transports, with information on contract period, tonnage and freight rates per month. Ships engaged in single voyages from one port to another in the Mediterranean or Black Sea are not included.

[58] The most relevant and comparable capacity measure is net register ton. For sailing ships only gross tonnage were given, but according to Kaukiainen (1995) 90 per cent is a fairly robust estimate of the ratio of net to gross tonnage for sailing ships. In the sources net tonnage is stated for the majority of steam ships. For the remainder of steam ships calculations of net tonnage were based on an estimated relationship between net and gross measures, using a sample of 69 ships in *British Parliamentary Papers 517 (1854/55).* The mean ratio of net to gross is 70.5 per cent, which is consistent with the data in Kaukiainen (1995) starting in 1870.

Figure 7. Net tonnage of ships engaged by the British government in the Crimea



Hughes (1960, pp. 207-214) argues that the high freight rates caused by the 1851-1853 trade boom and the Crimean War were the primary causes of the surge in shipbuilding in Britain in the two following years. The increase in shipbuilding activity is a natural supply response to a rate increase, operating with a lag due to the nature of shipbuilding and capacity problems.

As can be seen from Figure 1 above world tonnage also increased strongly in these years, a trend which continued almost unabated to 1857. The temporary reversal of the falling freight rates late in 1855 and early in 1856 may perhaps have induced a belief in a continuation of the remunerative freight rates experienced in the previous years.

The government demand for ships for the Crimea declined in 1855, in particular this applied to sailing ships, see Figure 7 above. Thus Hughes (1960, pp. 212) noted that '[t]he increase in tonnage completed by 1855 led to an increase in ships available for the foreign trade'. As a consequence 'the sudden availability of shipping resulted ... in falling freight rates.'[59]

When the trade boom collapsed in 1857 the expansion in world tonnage that continued until 1857 had obviously created much excess capacity in ocean transport. In spite of a fairly normal trade in cereals and improving business cycle conditions towards 1859, the freight market was still depressed in 1859, particularly the homeward trade. Thus, the supply side seems to hold a key to understanding the course of freight rates in the second half of the 1850s.

5 An econometric model of freight rates in the 1850s

5.1 The theory model

The discussion above has pointed to a number of factors that may have affected nominal freight rates in the 1850s. Analyzing the potential explanatory variables one by one has its obvious limitations, however, and needs to be supplemented by a model that allows for the simultaneous impact of all factors. For this purpose a simple freight market model in the spirit of the pioneering econometric analysis by Tinbergen (1934) is used here.[60]

The supply of freight services q^s (implicitly measured as ton-miles) is assumed to be determined by the level of world tonnage K and real freight rates F/P

$$q^s = \alpha_0 + \alpha_1 \ln K + \alpha_2 \ln(F/P)$$

For a given level of real freight rates the supply naturally increases with the available tonnage; for a given level of tonnage it is assumed that an increase in freight rates creates an impetus to attract ships out of lay-up and into active service.[61]

The specification of the demand side will be discussed in more detail below; in general terms the

[59] Hughes (1960, pp. 213).

[60] The model was published in Dutch by Tinbergen in 1934. The version used here is adapted from the survey in Beenstock and Vergottis (1993).

[61] Note that because the freight rates of this study exclusively refer to sailing ships the price of bunkers (coal), which belongs to the supply equation for steam ship freights, is excluded here.

demand for freight services is affected by a vector of demand side variables X[62]

$$q^d = \beta_0 + \beta_1 X$$

By setting demand equal to supply we can solve the model for the nominal freight rate index F as

$$\ln F = \gamma_0 + \ln P - \gamma_1 \ln K + \gamma_2 X$$

where $\gamma_0 = (\beta_0 - \alpha_0)/\alpha_2$, $\gamma_1 = \alpha_1/\alpha_2$, and $\gamma_2 = \beta_1/\alpha_2$. The model predicts that nominal freight rates should be proportional to the price level P. To be consistent with the model the estimated equation should therefore allow for a price level coefficient of unity. For a given price level nominal freight rates decrease as tonnage K increases, whereas an increase in the demand for ocean transport increases freight rates.

Tinbergen estimated his model on data from the period 1870 to 1913. His empirical findings were consistent with the model as specified here, although he did not consider price level effects. On the other hand his empirical model showed a positive influence of coal prices on nominal freight rates, which is of course as expected as the sample period comprised the heydays of steam ships.

5.2 Empirical specification of the model

Because the main purpose of this paper is to explain the cyclical fluctuations of the 1850s we abstract from the secular growth in world trade (affecting variables included in X) and the world fleet in specifying the model. World tonnage (both sailing ships and the efficiency adjusted tonnage of steam ships) as defined in section 2.1 was regressed on a linear time trend in order to remove secular growth. These data refer to end-of-year estimates; to obtain monthly figures the data were linearly interpolated between year-ends.[63] This variable serves as the empirical specification of K. This variable is consequently rather crudely measured, but there is no possibility of obtaining information on intrayearly variations in the completion of newly built ships or in the stock of laid-up ships in this period. Still, this variable reflects quite well the marked cyclical swings in world tonnage that Hughes (1960) argued played an important role in the freight markets of the 1850s; in particular, it reflects the build-up of capacity in the middle of the decade, culminating in 1857. This is the only variable for which we do not have genuine monthly data, but the data problem may be less serious in this case because the tonnage variable only enters the long-run part of the model as specified below.

The price level P is measured by the monthly British commodity price index with weights according to the Sauerbeck wholesale price index presented in Klovland (1993).

The vector X comprises the following demand factors:

- $CYCLE$ is a composite variable that reflects both the domestic cyclical indicator and real

[62] We follow Tinbergen (1934) in assuming that demand side is perfectly inelastic with respect to freight rates. This is in fact also a standard assumption in the econometric modelling of present day freight markets, see Beenstock and Vergottis (1993, p. 72).

[63] In the empirical model the monthly values derived in this way were entered with a lag of three months, which seemed to produce the best fit. This allows for any delays in getting the newly built ships into active service.

exports of non-cotton goods from Britain discussed in section 4.1.[64] Empirical analysis showed that a variable that picks up the change in the business cycle in a five month period around the current month, measured from month $t+2$ to month $t-2$, provided the best fit.

- $CORN$ is included with a view to represent grain imports. Two such measures were discussed in section 4.2; one defined as a sailing-day (as an approximation to ton-miles) adjusted demand for shipping capacity arising from the importation of wheat and flour into Britain, another measure reflected the exports of wheat, maize and rye from the eastern seaboard of the United States to Britain and the European continent. These variables turned out to affect the freight rates index positively but were not individually significant, which is as might be expected because they are partly overlapping. Consequently, these two measures were combined to one indicator in a similar way to the $CYCLE$ variable. In this case a *lead* of two months was chosen as it gave the best fit. This is consistent with the argument that ships had to be chartered some time before the grain arrived in Britain; the volume of grain imports in, say, November is assumed to reflect the demand for grain charters in September.

- AUS is the variable discussed in section 4.3 reflecting the impact of the special Australian trade.[65]

- $GOVSHIP$ is the tonnage of sailing ships engaged by the British government during the Crimean War, lagged one month.[66]

- $ANTWAR$ is a dummy variable defined as unity from June 1853 to March 1854 and zero elsewhere. This variable is included with a view to reflect the anticipations of war in the build-up to the actual outbreak of the war. The weakness of this specification is of course that this dummy variable can in principle pick up the effects of any other factor not included in the equation.

5.3 The estimation results

Because some of the variables in the model are non-stationary the estimation of the model has to proceed in two steps. Standard unit root tests showed that the inward freight rate index F, the price level P and world tonnage K were non-stationary.[67] First, a cointegrating relationship is established between the non-stationary variables. The freight rate index, the price level and world tonnage were found to be cointegrated, using the Johansen maximum-likelihood procedure (standard errors in parentheses)

$$\ln F = \ln P - \underset{(-0.0806)}{0.5661} \cdot \ln K + \underset{(-0.00041)}{0.00015} \cdot TREND + 0.2298$$

[64] This variable is actually measured as the equally weighted sum of the railway freight receipts and the volume of non-cotton exports, both in logarithmic terms.

[65] This variable was set equal to its neutral value of 1 from July 1854, in line with the evidence discussed in section 4.3.

[66] Including the contracted steam ship tonnage did not materially affect the estimation results.

[67] Augmented Dickey-Fuller tests indicated that these variables were integrated of order one.

The sample runs from March 1850 through December 1860. The coefficient on the price level was constrained to unity, which was easily accepted by the data.[68] The trace statistic indicates two cointegrating equations at the 1 per cent significance level, the max eigenvalue test gives the same result at the 5 per cent level. Thus the long-run part of the model firmly establishes a negative relationship between *real* freight rates, $\ln(F/P)$, and the supply of tonnage, which is one of essential pillars of the model. The coefficient on the linear time trend is small and insignificant.

The short-term fluctuations in freight rates can now be estimated within the framework of an error-correction model. This model comprises the other stationary variables listed above and an error correction term EC following from the cointegrating equation

$$EC_t = \ln F_t - \ln P_t + 0.5661 \cdot \ln K_t - 0.00015 \cdot TREND - 0.2298$$

The ordinary least squares estimates (standard errors in parentheses) are:

$$\begin{aligned}
\Delta \ln F_t &= \underset{(0.0628)}{0.1470} \cdot CYCLE_t + \underset{(0.0016)}{0.0047} \cdot CORN_t + \underset{(0.0169)}{0.0101} \cdot AUS_t + \underset{(0.0106)}{0.0249} \cdot ANTWAR_t \\
&\quad + \underset{(0.1089)}{0.2782} \cdot GOVSHIP_t - \underset{(0.0242)}{0.1231} \cdot EC_{t-1} + \underset{(0.1304)}{0.3287} \cdot \Delta \ln P_{t-1} + \underset{(0.0780)}{0.2004} \cdot \Delta \ln F_{t-1} \\
&\quad + seasonals + constant \\
R^2 &= 0.573, SEE = 0.0246, DW = 1.89
\end{aligned}$$

In general, the coefficients of the demand side variables all take on the expected positive sign. This conclusion applies to the variables reflecting the business cycle, grain imports as well as the two variables representing the anticipations of war and the size of the merchant fleet engaged by the British government during the war. The t-ratios are well above two in all cases except in the case of the AUS-variable, which seems to play a more marginal role than the other demand-side explanatory factors. The error correction term EC is highly significant, indicating that freight rates responded systematically to any shocks to the previous period's equilibrium rate.

In short, the estimation results show that nominal freight rates in the 1850s were proportional to the price level in the long run, that the supply of tonnage exerted a persistent negative effect on the freight rates and that short-term fluctuations can be successfully modelled when demand side variables are included as well.

One objection to the use of OLS estimation in this case is that any mutual interdependence between the cyclical variable and grain imports on the one hand and the freight rate on the other may introduce simultaneity bias.[69] The equation was reestimated by two-stage least squares, treating $CYCLE$ and $CORN$ as endogenous regressors. It turned out that coefficient estimates in general were little affected, except for somewhat lower coefficient estimates and higher standard errors in the case of the two endogenous regressors, which is a natural consequence of the use of lagged values as instruments.

[68] The chi-square statistic with one degree of freedom resulting from testing this restriction is 1.049, implying a probability level of 0.306.

[69] Note that the price level variable only enters with a one period lag; hence there are no simultaneity problems in this case.

5.4 Which factors were the most significant determinants of the freight rate fluctuations?

The Crimean War emerges as one of the key factors in explaining the fluctuations of inward freight rates of the 1850s, but so do a number of other demand and supply side factors as well. The relative importance of each of the explanatory variables can be inferred by first writing the estimated equation expressed in levels[70]:

$$\ln F_t = 0.8667 \cdot \ln F_{t-1} + 0.5290 \cdot \ln P_{t-1} - 0.3957 \cdot \ln P_{t-2} - .0755 \cdot \ln K_{t-1} + \alpha Z_t$$

where Z_t includes the variables $CORN$, $CYCLE$, AUS, $ANTWAR$ and $GOVSHIP$ as well as the deterministic components and residuals of the equation. This difference equation can then be solved and the impact of the individual variables disentangled.[71]

The outcome of these calculations are exhibited in Figure 8, where the impact effects are divided into six subperiods. The effects of $ANTWAR$ and $GOVSHIP$ have been combined into one variable, labelled WAR.

Periods 1 and 2: The pre-Crimean War period July 1852 - March 1854

The prewar period is split into two with a breaking point in June 1853, when the rumours of war started to have a significant effect on the freight market outlook. Nominal freight rates increased by more than 30 per cent in each of these two subperiods, or 62.7 per cent in all.[72] A little more than half (33.0 per cent) of this increase was accounted for by the rising price level. The remainder, 29.7 per cent, thus represents an increase in real freight rates.

In period 1, ending in June 1853, several demand-side factors account for between 2 and 3 per cent each of the 13.6 per cent increase in real freight rates: $CORN, CYCLE, AUS$, and $ANTWAR$. Because world tonnage grew less than trend there is also a positive effect from the supply side of 3.1 per cent.

In period 2, from June 1853 to March 1854 the contributions of grain imports and the business cycle are about the same magnitude, or slightly lower, compared with period 1. The effect of the Australian trade is now reversed, but no longer of any importance, which is consistent with the assessment of Tooke and Newmarch (1857, pp. 318-322) referred to above. The heavy investment in shipping capacity during 1853 now begins to depress the freight rates; the estimated effect in this

[70] In order to keep the solution of the dynamics tractable the equation was reestimated with the term $\Delta \ln F_{t-1}$ omitted. The coefficient estimates were not significantly affected although there are some small deviations from the reported equation.

[71] In general, the equation

$$\ln F_t = \beta \ln F_{t-1} + \gamma_1 \ln P_{t-1} + \gamma_2 \ln P_{t-2} + \gamma_3 \ln K_{t-1} + \alpha X_t$$

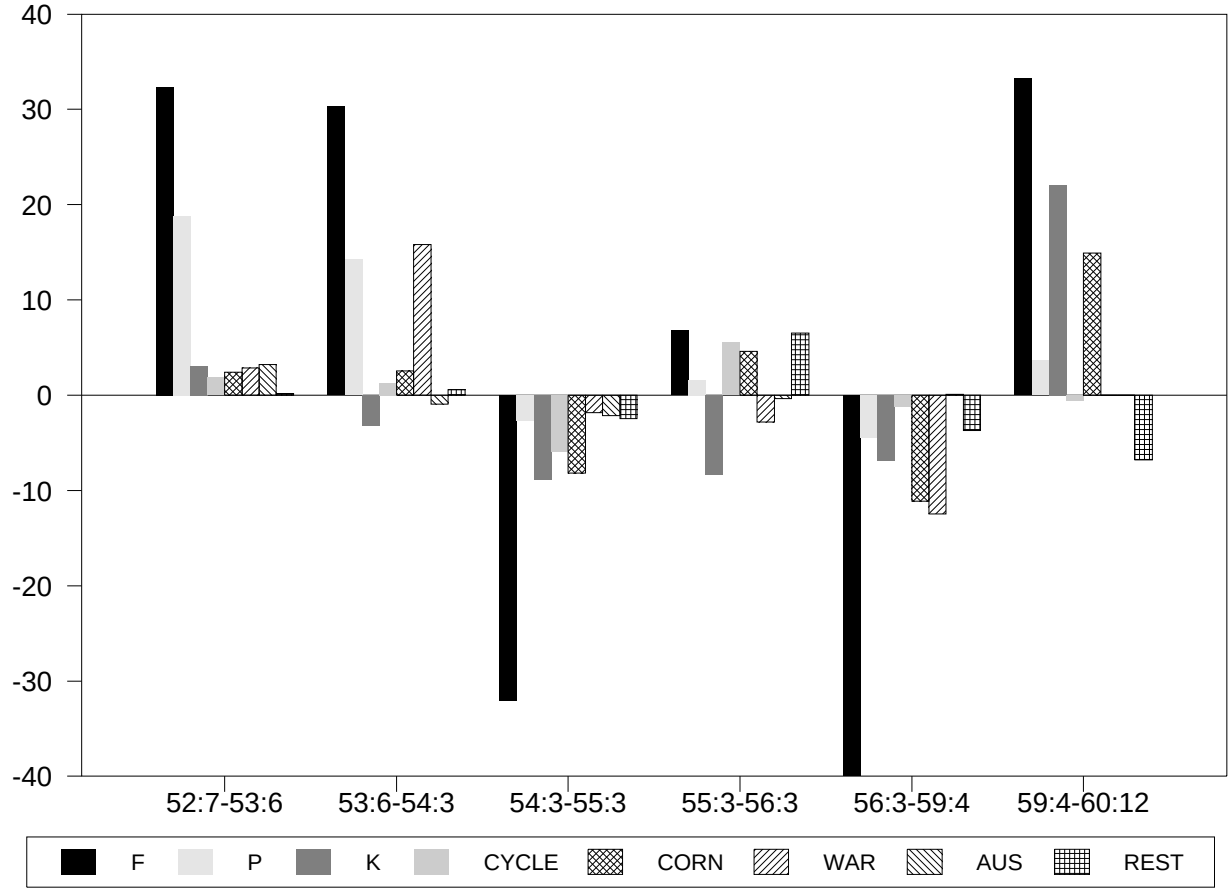
has the solution

$$\ln F_t = \gamma \sum_{i=0}^{\infty} \beta^i (\gamma_1 \ln P_{t-1-i} + \gamma_2 \ln P_{t-2-i} + \gamma_3 \ln K_{t-1-i} + \alpha X_{t-i})$$

Note that the full effect of any shock to an explanatory variable in period t is distributed over a long time period due to the error correction mechanism. The speed of adjustment is governed by one minus the coefficient estimate of the EC term; in this case $\beta = 0.8667$. This estimate implies a half-life statistic of 4.8 months, i.e. it takes slightly less than five months before fifty percent of the adjustment towards equilibrium has taken place.

[72] The log differences of the dependent variable, $\Delta \ln F$ between, say June 1853 and July 1852, correspond to continuously compounded growth rates over this period.

Figure 8. Nominal freight rate index and the contributions of the explanatory variables



subperiod is -3.2 per cent. The largest effect (13.5 per cent) emanates from the dummy variable which is being used to tentatively pick up the effect of the anticipations of war during the nine months preceding the outbreak of the Crimean War. In addition, the shipping contracts concluded by the British Government begin to make an impact (estimated at 2.3 per cent) on the demand for carrying capacity early in 1854.

Periods 3 and 4: The Crimean War, March 1854 - March 1856

In period 3, the first year of the Crimean War (from March 1854 to March 1855), inward freight rates fell by 32 per cent. Because commodity prices only fell by 2.6 per cent this implies a real decrease in freight rates of nearly 30 per cent. This observation may seem puzzling in view of the fact that government's demand for transport capacity was at its peak in 1854 and remained at a high level throughout 1855. According to our model three factors can account for the bulk of the fall in real freight rates: the increasing supply of tonnage (-8.9 per cent), the heavy fall in grain imports following the good harvest of 1854 (-8.2 per cent), as well as the deteriorating business cycle climate (-5.9 per cent). In addition, there was a further reversal of the Australian effect of -2.1 per cent. The total impact of the two Crimean War variables, $ANTWAR$ and $GOVSHIP$, is in fact now declining; the lagged response to the prewar scramble for shipping space is now fading away, and the estimated effect of the government's shipping contracts does not fully make up for this.

In the second year of the war, period 4, extending from March 1855 to March 1866, nominal freight rate movements were more moderate, increasing by 6.8 per cent. Real freight rates increased by 5.2 per cent. The large build-up of tonnage now depressed the market significantly (-8.3 per cent); on the other hand, the renewed surge in grain imports (4.6 per cent) and business cycle expansion (5.5 per cent) more than compensated for the negative supply effect.

Periods 5 and 6: The postwar period March 1856 - December 1860

Nominal freight rates were falling from October 1855, reaching a trough in April 1859. We therefore split this period into two subperiods: period 5 (March 1856 - April 1859) and period 6 (April 1859 - December 1860). There was a heavy fall of 35.5 per cent in real freight rates in period 5, arising from a 39.9 per cent decline in nominal freight rates minus 4.4 per cent accounted for by price level changes. The unwinding of the Crimean War engagements is a natural candidate with respect to explaining the large fall in freight rates. This is confirmed by the model, but, interestingly, this factor can only explain one third (-12.5 per cent) of the fall. The single most important other factor is the decline in grain imports (-11.1 per cent). A further increase in tonnage also contributes by - 6.9 per cent.

In the final period freight rates rose markedly again, 33.3 per cent nominally and 29.6 per cent in real terms. This movement can largely be explained the halt to shipbuilding in previous years, which now drove the tonnage capacity below trend, as well as the surge in grain imports.

6 Concluding remarks

What the role did the Crimean War play in shaping the strongly fluctuation freight rates of the 1850s? Our review of the contemporary view as reflected in newspapers and trade circulars is supported by the results from the econometric model as to the key explanatory factors: the anticipations of war contributed significantly to increasing the freight rates in the months preceding the outbreak of the war, the government's demand for shipping helped keeping the rates up during the war, and, finally, the unwinding of the war contracts contributed to the falling rates after the war. But it is important to add a number of qualifications with respect to the magnitude of the influence of the Crimean War.

First, it is essential to note that freight rates had been rising steeply for a year before concern over a possible interference from war activities began to be raised in the summer of 1853. This can be accounted for by the ordinary demand and supply factors that determine the freight rate markets: the business cycle, grain imports, the Australian episode and lags in the adjustment of the supply of tonnage.

According to our model the greatest impact of the Crimean War is in fact just at the time when the war broke out in March 1854. At that time nominal freight rates were estimated to having been raised by 16.6 per due to the particular influence of the war.[73] This figure should be viewed in conjunction with the fact that nominal freight rates increased by 62.7 per cent from the summer of 1852 up to the eve of the Crimean War declaration. Thus, the coming war roughly accounts for one quarter of the surge in freight rates in this period. It is also essential to note that the impact of the war on the level

[73]It is important to bear in mind once again that the estimates of the anticipations of war are founded on the use of a simple dummy variable, which in principle could pick up the effects of any factor shaping market behaviour in this period. The results are largely in line with the sentiments of the contemporary trade circulars, however.

of freight rates actually declined slightly during the war, falling to 12.5 per cent when the war ended in March 1856.

Although the price level is an integral part of the model explaining nominal freight rates in the long-run, much of the short-run fluctuations in nominal freight rates is mirrored in real freight rate movements. In general, harvest failures, the business cycle and the supply of tonnage are the key determinants of real freight rates of this period. The role of the Crimean War is important as well, in particular during certain subperiods, but perhaps less so than the intuition of most maritime historians would suggest.

References

Albion, R. G. (1938). *Square-Riggers on Schedule: The New York Sailing Packets to England, France and the Cotton Ports*. Princeton University Press, Princeton.

Bailey, M. J., R. F. Muth and H. O. Nourse (1963). A Regression Method for Real Estate Price Index Construction. *Journal of the American Statistical Association*, *58*, 933–942.

Beenstock, M. and A. Vergottis (1993). *Econometric Modelling of World Shipping*. Chapman & Hall, London.

Burns, A. F. and W. C. Mitchell (1946). *Measuring Business Cycles*. National Bureau of Economic Research, New York.

Clapham, J. H. (1932). *An Economic History of Modern Britain: Free Trade and Steel 1850-1886*. Cambridge University Press, Cambridge.

Davis, H. (1894). California Breadstuffs. *Journal of Political Economy*, *2*, 517–535 and 600–612.

Fairlie, S. (1965). The Nineteenth-Century Corn Law Reconsidered. *Economic History Review*, *18*, 562–575.

Fairlie, S. (1969). The Corn Laws and British Wheat Production, 1829-76. *Economic History Review*, *22*, 88–116.

Fischer, L. R. and H. W. Nordvik (1986). Maritime Transport and the Integration of the North Atlantic Economy, 1850-1914. In Fischer, W., R. M. McInnis and J. Schneider (eds.), *The Emergence of a World Economy 1500-1914*, 519–544. Franz Steiner, Wiesbaden.

Fletcher, I. and N. Ishchenko (2004). *The Crimean War: A Clash of Empires*. Spellmount, Staplehurst.

Glover, J. (1863). On the Statistics of Tonnage During the First Decade Under the Navigation Law of 1849. *Journal of the Statistical Society of London*, *26*, 1–18.

Graham, G. S. (1956). The Ascendancy of the Sailing Ship 1850-85. *Economic History Review*, *9*, 74–88.

Harley, C. K. (1980). Transportation, the World Wheat Trade, and the Kuznets Cycle, 1850-1913. *Explorations in Economic History*, *17*, 218–250.

Harley, C. K. (1988). Ocean Freight Rates and Productivity, 1740-1913: The Primacy of Mechanical Invention Reaffirmed. *Journal of Economic History*, *48*, 851–876.

Harley, C. K. (1989). Coal Exports and British Shipping, 1850-1913. *Explorations in Economic History*, *26*, 311–338.

Hughes, J. (1958). The First 1,945 British Steamships. *Journal of the American Statistical Association*, *53*, 360–381.

Hughes, J. R. T. (1960). *Fluctuations in Trade, Industry and Finance: A Study of British Economic Development 1850-1860*. Clarendon Press, Oxford.

Hultgren, T. (1953). *Transport and the State of Trade in Britain*. Occasional Paper no. 40. National Bureau of Economic Research.

Isserlis, L. (1938). Tramp Shipping Cargoes, and Freights. *Journal of the Royal Statistical Society*, *101*, 53–134.

Jones, E. L. (1964). *Seasons and Prices: The Role of the Weather in English Agricultural History*. George Allen & Unwin, London.

Kaukiainen, Y. (1991). *Sailing into Twilight: Finnish Shipping in an Age of Transport Revolution, 1860-1914*. Studia Historica 39. Societas Historica Finlandiae, Helsinki.

Kaukiainen, Y. (1995). Tons and Tonnages: Ship Measurement and Shipping Statistics, ca. 1870-1980. *International Journal of Maritime History*, *7*, 29–56.

Klovland, J. T. (1993). Zooming in on Sauerbeck: Monthly Wholesale Prices in Britain 1845-1890. *Explorations in Economic History*, *30*, 195–228.

Klovland, J. T. (1998). A Reassessment of the United Kingdom Business Cycle Chronology 1850-1914. In Dick, T. J. O. (ed.), *Business Cycles Since 1820: New International Perspectives From Historical Evidence*, 49–90. Edward Elgar, Cheltenham.

Klovland, J. T. (2006). A Repeat Sailings Index of Ocean Freight Rates for the 1850s. Discussion paper SAM 40 2006, Department of Economics, Norwegian School of Economics and Business Administration (www.nhh.no).

Lindsay, W. (1874). *History of Merchant Shipping and Ancient Commerce*. Reprinted by AMS Press, New York, 1965, London.

Mitchell, B. R. (1988). *British Historical Statistics*. Cambridge University Press, Cambridge.

Mohammed, S. I. S. and J. G. Williamson (2004). Freight rates and productivity gains in British tramp shipping 1869-1950. *Explorations in Economic History*, *41*, 172–203.

Moore, G. H. and V. Zarnowitz (1986). The Development and Role of the NBER's Business Cycle Chronologies. In Gordon, R. J. (ed.), *The American Business Cycle: Continuity and Change*, 735–779. University of Chicago Press, Chicago.

North, D. (1958). Ocean Freight Rates and Economic Development 1750-1913. *Journal of Economic History*, *18*, 537–555.

North, D. C. (1965). The Role of Transportation in the Economic Development of North America. In *Les grandes voies maritimes dans le monde XV-XIX sicles*. Paris.

Potter, J. (1955). The British Timber Duties, 1815-60. *Economica*, *22*, 122–136.

Royle, T. (2000). *Crimea: The Great Crimean War 1854-1856*. Abacus, London.

Tinbergen, J. (1934). Scheepsruimte en vrachten. *De Nederlandsche Conjunctuur*, 25–35.

Tooke, T. and W. Newmarch (1857). *A History of Prices, and of the State of the Circulation, 1792-1856*, vol. 5. Longman, Brown, Green, Longmans & Roberts, London. Reprinted by Thoemmes Press, 2002.

Vamplew, W. (1980). A Grain of Truth: The Nineteenth-Century Corn Averages. *The Agricultural History Review*, *28*, 1–17.

Worm-Müller, J. S. (1950). *Den norske sjøfarts historie, vol. II, part 2*. Cappelen, Oslo.

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