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Jonas Ljungberg

I. Introduction

Usually, it is a tacit assumption that prices in an open economy are given by the international market. Consequently, international integration means convergence of prices. Convergence may be very fast, as according to the monetary approach or purchasing power parity theory, or it may be a very gradual process.[1] However, integration is certainly part of a historical process that also entails innovation and changes in structures and institutions. In the present paper it is argued that this has a considerable impact even on the behaviour of prices. Thus, the levelling of prices between nations faces interruptions, due not only to institutional change but also due to technological and structural change.

Here the aim is to shed light on this process, through an analysis of the integration of some commodity markets, mainly in Britain, Germany, and Sweden, from the mid-19th century up to World War I. The data consist of price series for different commodities. Before I go headlong into this material, the approach must be presented. The secular behaviour of prices in one national economy, that is in Sweden, constitutes a point of departure for the present paper. How closely were the price movements in Sweden related to international prices,

* Paper presented at the II Congress of the European Association of Historical Economics in Venice, January 1996. The research has been carried out in the project *Sweden in International Market Integration*, financed by the Bank of Sweden Tercentenary Foundation, and in the project *Sweden During the Gold Standard*, financed by the Swedish Council for Research in the Humanities and Social Sciences. The paper is a report of research still under way, and therefore I have chosen not to revise or amend the version presented in Venice. Many thanks, however, to the colleagues whose endeavour at the congress gave an impetus for the further analysis of price behaviour in history.

1 Eloquent proponents of the first, very fast, view, are McCloskey & Zecher (1981, 1984). Convergence as a secular process is argued by Dupriez *et al.*(1966, 1970). For the contemporary period, this has been the subject of debate between adherents of purchasing power parity theory (PPP) and its critics, *e g*, Kravis & Lipsey (1978)

and was the same pattern manifest in other countries? A very broad overview of relative prices in Sweden is given in the second section of the paper.

The idea of working with prices instead of aggregates is touched upon in the third section. The analysis of prices evokes problems related to time series. This is the subject of the fourth and fifth sections, where I come up with some, perhaps unexpected, suggestions. Thereafter, in sections six to eight, markets for butter, iron and steel, and some products of engineering, are investigated. At nine it is time to conclude.

II. Long Swings in Swedish Relative Prices

A main finding of an investigation into the secular behaviour of prices is that relative prices change considerably. Furthermore, these changes often take place in distinct periods and could be inversely related to the development of the studied commodities or branches of industry. That is, falling relative prices have usually gone along with expanding production volume, and vice versa. In industrializing and industrial Sweden, this displays a pattern of trend periods or long swings, each of around twenty years of length. It has been thouroghly argued that this pattern is rooted in innovative activity in the Swedish industry.[2]

Figure 1 illustrates some of these changes in relative prices. Most clear are the trend periods in the relative prices of machinery, for which two periods of rapid change and transformation can be discerned: the two decades up to World War I, and the two decades following the Depression of the 1930s. Before the 1890s, products of engineering were scarcely standardized and less so production methods. Machinery is here represented by locomotives and shipbuilding, and compared to industry in general their prices were increasing. It should be remembered, however, that manufactures still constituted only a minor part of total commodity production and relative to the cost of living even ships, though not locomotives, saw falling prices. After World War I, important machinery products had become outmoded and prices increased while production stagnated, until a new period of transformation was initiated in the 1930s. While some machinery in the 1950s and 1960s saw a repetition of the 1920s, some products faced a strong foreign market pull.

2 L. Schön (1990, 1991, 1994), J. Ljungberg (1990, 1991); antecedents in O Krantz & C-A Nilsson (1975) and L. Schön (1982). More specifically, it is not innovations as such, but their complementaries, that are crucial. Dahmén's notion "development block" is central in this process. For the sake of simplicity, in this paper "innovation" denotes even this greater whole.

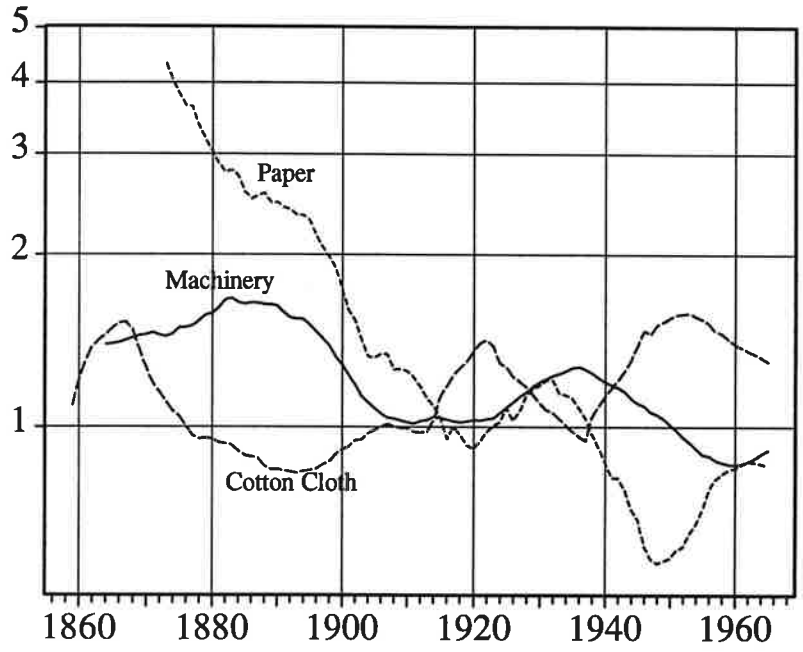

Figure 1. Relative Prices in Sweden, 1855-1869.

Note: Machinery and Cloth are ratio to deflator for industry, while Newsprint is ratio to mechanical pulp. Before 1888, Machinery is composed of ships and locomotives, and Newsprint is a price index for paper (before 1888). Nine years centered moving averages.

Sources: Schön (1988) and Ljungberg (1990)

Thus, both the stagnating and the expanding parts of this branch increased their relative prices.

As regards cotton cloth, the pattern is influenced, though not determined, by the American Civil War and the two World Wars. A rapid development in cotton weaving took place during the twenty years before 1890, and in the interwar period. In the 1950s and 1960s the falling relative prices were due to fierce foreign competition, and the branch actually retarded. The prices of paper, mostly newsprint, is not directly

comparable to the others in figure 1, as they are not related to industrial prices in general but to its own input, that is, mechanical pulp. Even in this relation we find traces of trend periods. In other words, the changes in relative prices did not fluctuate haphazardly, but they usually displayed a pattern of long swings.

Here, however, is no space for a further exploration of those Swedish relative prices. Instead, the focus is on the relation between commodity prices in Britain, Germany, and Sweden during an era of market integration. Does market integration mean that prices are levelled out quickly, or in the long run; and are they levelled out once and for all, or do price differences arise even in integrated markets? Consequently, are the trend periods in relative prices given by the international market, or does innovative activity influence the prices in a given country?

III. Aggregates or Commodity Prices?

If one compares the British Board of Trade wholesale price index with a similar, old fashioned WPI for Sweden, one may conclude that the British price level decreased by one-fifth relative to the Swedish one, during the last quarter of the 19th century. Sweden had entered the gold standard in 1873, so this continuous movement of price levels took place during a regime of fixed exchange rates.[3] This seems to be at odds with any theory that maintains that the convergence of prices is a quick process.

However, before one draws any conclusion from such a comparison, one should certainly know what is compared. Price indexes as well as GNP-deflators, which are sometimes employed in comparative analyses of prices, are not equally aggregated for two countries. That is, differentials may arise due to difference in composition. Therefore, a comparative analysis of prices based on aggregates should use similar commodities and the same weights for each country. Thus, one should go along in the same manner as in the construction of purchasing power parity indexes. That would supply an indicator, a standard, for the comparison of price structures, that is of aggregated relative prices in different countries.

That task will not be pursued in this paper. Instead, price series for similar, single commodities will be compared for the three countries. As some of these price series are results of the present, ongoing research on market integration, and have still not been published in full, it seems appropriate to include some comments on the reliability of the data. That

3 Ljungberg (1994)

will be done in connection with the analysis of the prices. A further note on the price data is found in the appendix.

IV. Cointegration a Measure of Integration?

How should price series be compared? A direct comparison of the levels presupposes knowledge about the relations between the quality of the considered commodities. Usually that knowledge is only very approximative. Fortunately, the levels are not crucial for a judgement of the convergence, or divergence, as the analysis could be based on relative prices.

It is now commonly argued that time series analysis should proceed from original data, taking both trend and fluctuations together. Cointegration tests seem to meet this requirement. When one series is regressed on another, they are said to be cointegrated if the lagged residual adds to the explanation of the first differences of the residual. In more liberal terms, it is a measure of the systematic character of the residual. When this is significant, the two series are said to be cointegrated of order zero if they are original or level data. If they are first differences they are said to be cointegrated of order one.

There are, however, some shortcomings of that type of analysis. Firstly, there is the problem of interpretation. The result gives only one coefficient for the whole period tested, and you are only told about the level of significance. A quantitatively comparable figure, such as elasticity or degree of explanation, is not supplied. One may hold that this shortcoming is shared with, for example, correlation analysis. Nevertheless, correlation is more transparent to common sense, as it can be seen through graphical inspection. The more compound measure of cointegration is scarcely visual, which can be illustrated by figure 2, while the displayed series (just logged) are also tested for cointegration. Even to the trained eye it is confusing that wheat freights should be cointegrated with the ship prices, while the other freight index is not. Ship prices will be treated further below.

Another example of failing transparency may be taken from cointegration tests on monthly prices in the market for sawn wood in London. "Swedish Good" is tested against deals of other origin, one for one. Table 1 summarizes the results.

Intuitively, it seems quite reasonable that series which are not cointegrated during a shorter period could be so in the longer term. It is harder to perceive, though, that the results during the subperiods stand in

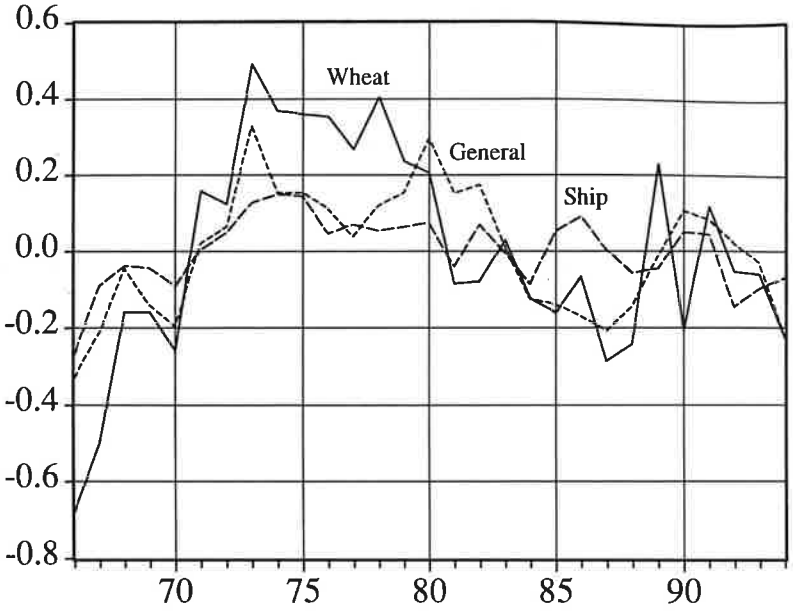

Figure 2. Swedish Ship Prices and US Freight Rates, deviations from trend 1866-1894

Note: Ship: Swedish ship prices. General: Index for US export freight rates. Wheat: Freight rates for wheat from New York to London.

Sources: Ljungberg MS, North 1958.

no relation whatsoever to the results for the whole period 1857-1914. The annual averages for Norwegian and Finnish deals are thus higher than for Canadian, although the latter is the only of these three that is cointegrated with the Swedish. Furthermore, the course of events cannot be interpreted from either of the results, as Canadian shows significant values for the first subperiod, and for the whole period. Norwegian and Finnish, on the other hand, seem cointegrated with Swedish during the last period but certainly not for the whole period. The only logical case, to a common sense interpretation, is the Russian one. T-statistics variates but are highest in the end period, average is almost significant, and the value for the full period clearly indicates cointegration.

Table 1. Cointegration tests on the London market for sawn wood, 1857-1914.

Dependent variable is (log for) "Swedish Good".
Independent variable at head of columns (logged). Figures given are Dickey-Fuller t-statistics. MacKinnon critical values at the 5 percent level are -3.37 for the subperiods and -3.35 for the full period.

Jan-Dec	Norway	Canada 1st	Finland	Russian
1857-70	-3.10	-3.38	-2.65	-2.89
1870-85	-2.79	-3.15	-2.45	-3.45
1885-1900	-1.80	-0.28	-1.51	-2.59
1900-14	-3.98	-2.54	-3.44	-4.37
Average	-2.89	-2.30	-2.49	-3.32
1857-1914	-0.75	-4.99	-1.23	-6.91

Source: *The Economist*, maximum prices. Before September 1885 only one Swedish quality is quoted, "Swedish Good" is extrapolated with that one.

The market for sawn wood was very important for the integration of the Scandinavian and the Baltic regions into the economy of Western Europe. In Sweden, the sawmill industry was a leading sector during industrialization up to 1890, and wood was a main export staple well into the 20th century. It should be observed that all these series are based on quotations in London, and, nevertheless, according to the tests that market does not seem so very integrated. Furthermore, integration seems to have been weakest not in the early period but in the 1880s and 1890s. This should be taken as a sign of the realism in my hypothesis that price differences may arise even in integrated markets.

The analysis of wood prices will not be pursued further in this paper, however. Presently I have only the London prices and Swedish prices, but no series for (sawn) wood in Germany. The commodity is more complicated than one might think at first sight, so an analysis would have to be rather extensive. It has been tentatively argued, that the seeming disintegration of the wood market in the late 19th century (which can be shown by other means than cointegration tests, as well) had to do

with a diversification that is not specified in the quotations.[4] Restricted to a European perspective, the analysis would presumably be rather unfinished. In the London market, prices came to diverge, but, grouped as European wood and as American wood, the movements were still correlated for each group. It has been argued that the prices (for American wood) in London actually were determined in another, larger, market, notably in New York.[5] If that was the case, it remains to be explained why all prices in the London timber market were not influenced. Diversification, or missing homogeneity of the price series, may be the answer. However, to be conclusive one must undertake an investigation in detail.

As regards cointegration tests, a second point of doubt should be added to the first one about the interpretation. The second point is about ambiguity. According to textbook terminology, two series, for example the price of Dutch butter in London and the price of Danish butter in Copenhagen, could be said to be cointegrated of order zero in the period 1857-1873, as the t-statistic (-5.24) is well above the critical value (-3.78 at 5 %). However, so far has one necessary presumption been forgotten, namely that Dutch butter is the dependent variable. If the dependency is reversed and the prices in Copenhagen taken as the dependent variable, these series were *not* cointegrated, as t-statistics (-2.62) is well below the critical value. To my mind, it seems unfortunate that the terminology is hiding this crucial characteristic. As cointegration tests are commonly presented and applied, it would be desirable that the test should be symmetric and produce the same result both ways.[6] Actually, cointegration means something more than an alternative to correlation, as it take account of the direction of dependency. Consequently, cointegration is more restrictive and could not plainly be substituted for correlation, as more refined and true.

As an ambiguity could also be seen the recommendation to proceed from cointegration test of order zero, to order one, that is, to check cointegration of the first differences if original data fail. In that way, I think, one is forced back to square one, as the advantage with the cointegration test was the analysis of the level and the variations in combination.

4 Ljungberg (1994)
5 McInnis (1993)
6 Applied on a subject related to the present paper, see, for example, T J Hatton (1992).

V. Trend and Historical Analysis

From a historical point of view, there is a lot of information hidden between the annual variations, that is first differences, and secular change, as traced from original data. I have tried to draw attention to the trend periods or long swings, in Swedish as well as in international price movements. It might be somewhat out of fashion, but nevertheless appropriate, to analyze such time series stepwise, as trends, and deviations from trend. It seems in place to recall Alexander Gerschenkron's apt comment upon the possible differential between a current-year-weighted index and a base-year-weighted index:

> "Those discrepancies in measurements are known as the index-number problem and are gall and wormwood to the statistician and theoretical economist. By contrast, their existence, magnitude, and change over time are a subject of very positive interest to the economic historian who regards them as an integral part of economic change."7

The decomposition of time series into trend, and deviations from trend, may be gall and wormwood from several points of view. Remember, for example, all those economic predictions that just prolonged the trend, may they rest in peace! However, if we already know when the trend did bend, then we can utilise that knowledge. In the analysis of historical processes, the decomposition into trend and deviations from trend is very useful. As will be shown below, this allows us to be more sensitive to, *inter alia*, features of market integration that are dismissed by cointegration tests.

The analysis of the price behaviour starts from the assumption of the existence of trend periods. The first period begins in the mid-19th century, and although only a few of the price series start already in 1850, the period ends in 1875. The turning point sometimes came a couple of years before, but I have let the periods overlap in order to somewhat neutralize the most extreme years. Thus, the second period ranges from 1866 to 1894. 1896 is often held as the turning point, but in several prices the break can be found in the late 1880s. To encompass some of this, the third period begins in 1890 and stops at the beginning of World War I.

When is a market integrated? Theory says there should be *one price*. Transport costs and transaction costs, especially if we under this heading even include costs for change of consumer preferences, will cause price differences. If these costs diminish, prices should converge. Differing trends may be due to such convergence, but divergence is also

7 Gerschenkron (1962) p. 204.

possible (the absolute level of prices is presumed to be unknown). Which is the case have to be judged from other facts, and from trends during the preceding and the following periods.

Furthermore, in real life things are not so straightforward. Transport cost, for example, may well be absorbed by distribution, making the market price of the commodity lower at the destination than at the place of origin. A case in point was butter, as will be seen below.

If convergence is a gradual process, that will also explain divergence in already, more or less, integrated markets, without the interference of tariffs or other institutional change. Namely, if innovations or technical change cause a rapid decrease in the price of a certain commodity in one country, then friction or transaction costs are connected with consumers's adaptation to the new model. How long this process of adaptation will last is then an empirical question.

What is meant by "differing trends"? It is certainly a question of mind. In this context it seems reasonable to consider a differential in the annual rate of change of at least 0.5 percentage points as such a difference. One may recall that over a period of 20 years, a "long swing", this will accumulate to a difference just over 10 percent.

If trends differ, the degree of integration could be seen in the correlation of deviations from trends. We could also look at the first differences, but deviations from trend will catch more of the conjunctural pattern, if there is any. In the following "variations" will, for the sake of style, be used synonymously with "deviations from trend." Of course, the analysis will even be supplemented by other means, not the least by graphical inspection, but also, as the case may be, by more refined methods as Granger tests. However, if the analysis should rest on Granger tests and cointegration tests only, then it seems as if market integration was very rare in history.

VI. Butter

Butter was a valuable commodity that had long been traded. In the latter part of the 19th century this trade increased manifold, and especially due to British imports. Britain had reduced her customs on butter stepwise until 1860, when they were completely abolished.[8]

While Denmark and Sweden exported large quantities of butter to Britain, Germany figured less in exports as well as in imports. The Danish and Swedish butter was, however, mostly sold in mid-England

8 Schlote (1938).

and in the north. Londoners preferred Dutch and French butter, and although Denmark was the major supplier to British imports,[9] The Economist began the quotations of Danish butter first in the mid-1890s. Fortunately, there is a price series based on quotations in Copenhagen, so it is possible to consider the role of Copenhagen in the butter market.

In the late 1850s the level of butter prices in London was 10 to 25 percent higher than in the other places of quotation. During the following decades, the prices for butter generally increased, but more outside Britain. In 1875, the price in Copenhagen and Hamburg[10] had caught up with the level in London. Then prices decreased down to the late 1880s, but more in London, and from this point onwards, butter seems to have been around 5 percent cheaper in London than abroad.

It is remarkable, provided qualities or conditions had not changed, that while in the 1860s butter had been cheaper in Malmöhus (the southernmost county in Sweden) than in Germany, Copenhagen, and London, after 1890 butter was most expensive in Malmöhus. In the third period, 1890-1914, the trends were largely equal in all the quoted places.

Notwithstanding the differences in trend up to 1890, variations were clearly correlated. This can be seen from Table 2, where an effort is made to review the network of relations. From what has already been said, it should be clear that the large quantities of the butter trade were not borne between these places of quotation, as most of the Danish (and Swedish) butter was landed in Newcastle. Therefore, the correlation figures accentuate the high degree of integration of the butter market.

Although London is given double representation for each period, its averages for the correlation coefficient are not top ranked. In other words, this city does not stand out as the pricing centre. Copenhagen and Hamburg were more closely related to price variations in the other places of quotation. It is striking that correlation becomes closer in the second period, but loosens in the third period when the trends had been equalized. One could query if this is due to the dismissing of Hamburg. If, however, as a substitute for Hamburg, Copenhagen is given double representation, or the London quotation for Danish butter is included, the averages would have increased only at the second digits.

According to the literature, the price setting was largely institutionalized, and the Copenhagen quotation determined prices in Britain until the late 1890s. At this point in time, the growing British

9 Fridlizius (1985).
10 For butter the Hamburg series is a wholesale quotation, *not* the *Börsenpreis* of the free port that is used for other commodities.

Table 2. Prices for Butter, 1857-1914: Trend, and Correlation in deviations from trend in different countries.

Columns ***"Trend"*** consider annual rate of change in percent.
Columns ***"Var"*** consider deviations from trend, average correlation coefficient against each of the others.

	1857-73		1866-94		1894-1914	
	Trend	*Var*	*Trend*	*Var*	*Trend*	*Var*
95% significance		*.456*		*.356*		*.423*
London, Carlow	1.21	.476				
London, Jersey*			-0.84	.633		
London, Dutch	1.03	.445	-1.00	.766	1.44	.470
London, Australian					1.03	.173
Berlin, 1st	1.18	.415	-0.24	.683	1.37	.403
Hamburg	1.59	.615	-0.68	.832		
Copenhagen*	1.82	.662	-0.18	.793	1.05	.536
Malmöhus	1.40	.600	0.27	.771	1.29	.319
Stockholm	0.93	.555	0.09	.745	1.34	.141

Note: The Jersey quotation ends in 1892, the Copenhagen quotation in 1913.

Sources, see the appendix.

imports of butter from Australia and New Zealand reduced the importance of Copenhagen.[11] The analysis of prices do not reject that opinion, as the average of correlation coefficients for Copenhagen was only surpassed, in the second period, by Hamburg. Moreover, the loosening of the connections in the third period is also in accord with this view.

If prices were set in Copenhagen, butter in this European region in the late 19th century could be characterized as a seller's market. It might be confusing, then, that butter was cheaper in Britain, an importing country. This reflected an increasing demand in the other countries too. Furthermore, even if the Copenhagen quotations determined the

11 Fridlizius (1985), Staffansson (1995).

wholesale price in the open market, the large quantities were bought under other conditions.[12]

An analysis of leads and lags in the variations between the different places might have verified that the price came to be set in Copenhagen, or Hamburg. However, such an analysis makes little sense as there exist only annual price series, except for London, where monthly data is at hand. In the time period under consideration, newspapers, and journals like The Economist, brought information across the sea in a few days, if not in a few hours as by the telegraph. The London monthly price data, that is based on weekly quotations in The Economist, may, nevertheless, shed some light on the problem.

The results of Granger tests, which show if lags in one series add significantly to the explanation of another series whose lags are also included in the regression, can be summarized as follows. In the 1860s no pattern can be discerned between local butter (Carlow and Waterford, respectively) and the butter from Jersey. Due to frequent gaps, Dutch butter had to be excluded before the 1870s. In the years 1875-1888, however, it seems as if Dutch butter systematically led the price movements when compared to the butter from Jersey. This may, though, be the result of a more pronounced seasonality in the Dutch series. The quotations of local butter had now expired in The Economist. In the 1890s, The Economist began to quote Danish and Australian butter. Due to gaps in the series, tests are pursued first for the years 1903-1908, and for 1909-1914. During the first of these periods, Danish butter led before both Dutch and Australian butter, even if there is some ambiguity depending on the number of lags as regards the Dutch butter. More lags favour Dutch butter. Australian butter nevertheless led Dutch. 1909-1914 Danish butter still led relative to Australian but not before Dutch butter. Dutch butter had taken the lead before both Danish and Australian butter, yet only at the second and later lag. Several months seem to be too a long gestation period in the London market, so it may be due to a more volatile seasonality in the Dutch butter prices.

Thus, neither do these results reject a leading role of the Danish butter in the London market, and it seems reasonable that Copenhagen kept a dominant position in the international butter market, still after the turn of the century 1900. Moreover, as it should be in a seller's market, Danish butter was the most expensive butter of those quoted. The

12 In Berlin in 1886, for example, the wholesale selling price is reported to have been 5 percent above the wholesale acquisition price. Wagemann (1935). The merchant firms that bought butter in Malmöhus and in Denmark for export, usually negotiated certain quantities from a dairy for a period. The contract price was determined by the Copenhagen quotation. Fridlizius (1985). There must, simply, have been a reasonable differential.

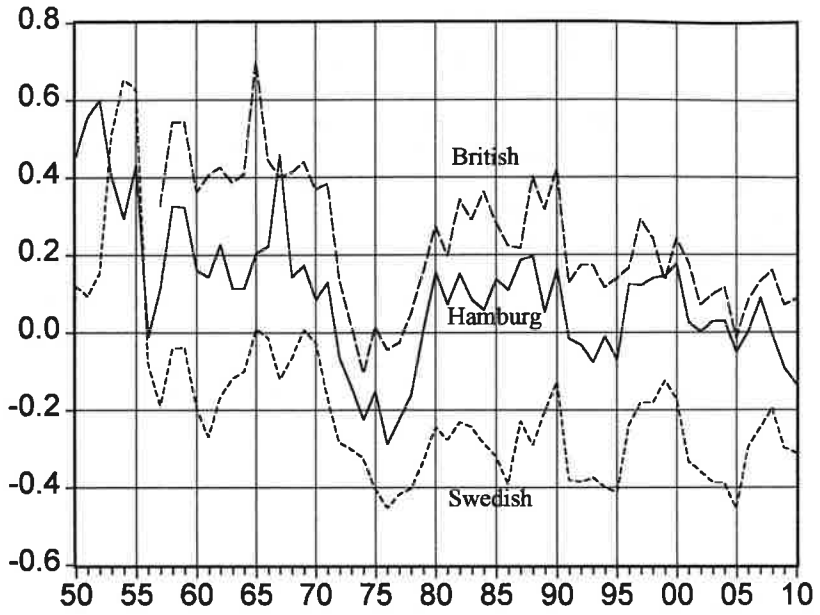

Figure 3. Differential to the Price of Pig Iron in Breslau, 1850-1910.

Note: Ratio between the differential, and each of the compared series. Adjusted for exchange rates at *pari*.

Sources: See the appendix.

1850-1870, only the connection between Sweden and Silesian Breslau falls out as insignificant (below 95 percent level of significance). The others display correlation well above 99 percent level of significance.

However, that is the case for Swedish pig iron against Breslau too, when the Swedish deviation from trend is lagged one year. Even against the other quotations the Swedish one is closer correlated when taken one year after. Thus, Swedish pig iron prices lagged one year behind, during the 1850s and 1860s. Unfortunately, only the British quotations by The Economist are of shorter than annual frequency, so a closer analysis of the time pattern is out of reach.

The problem can be approached from historical facts, though. The Swedish one year lag could not be explained by delayed information, as the merchant firms who organized the trade had close communications with the foreign metropoles. Rather, it seems to have been a surviving effect of the Swedish mercantilistic legislation. Until 1855 exports of pig iron were prohibited with the aim of enhancing the manufacturing and exports of bar iron, the traditional Swedish staple.[15] Thus the price of bar iron had determined the price of pig iron. That this was still the case a couple of decades after the deregulation of the trade, can be seen in the Granger causality found from Swedish bar iron to Swedish pig iron: at 99 percent level of significance with one lag, for the years 1850-65, thereafter gradually fading off, and changing direction. No such connection is found between Swedish pig iron and foreign quotations.

Aside from this special case, deviations from trend indicate fairly integrated iron markets in the third quarter of the century. While only pig iron and bar iron, and two Hamburg series, are represented in the material for the whole of the early period, the comparison is not very comprehensive. It should be noted, however, that the relation between levels did not stabilise. As can be seen from Table 3, pig iron in Breslau displayed a definite decrease over the period, whilst the other price series increased conspicuously.

An exhaustive analysis of the influence of customs on prices in the present data is still to be undertaken. However, as can be seen from figure 3, no distinct breaks can be found in the diminishing differential between the price of pig iron in Breslau, and prices at other sites. First in the late 1870s, there is a sharp increase that can be set in connection with the tariff reform in 1879. How much of this increase that was the result of customs, is hard to disentangle, though. During the boom of the early 1870s, prices in Breslau had not followed the other into the heights. This can be seen, in figure 3, as a drop in the mid-1870s, and the recovery after that drop in the differential seems "natural". Especially when compared to the price of Swedish pig iron, Breslau seems just to have returned to its long term trend. What stands out is this long term trend, a gradually decreasing relative price of pig iron in Breslau. When quotations begin in Ruhr, in 1879, these are close to those in Breslau. The general German development could thus be perceived as being the same as that of Breslau. As regards the level of prices, however, it should be remembered that the more specific comparibility of those displayed in figure 3 is not known. It is clear, though, that the Swedish charcoal pig

15 Montgomery (1947). On the organization of trade, see, *e g*, Attman (1958)

iron was of a higher quality and demanded for special purposes, especially by the works in Sheffield.[16]

The special purpose of the Swedish charcoal pig iron is, perhaps, the explanation for its relatively sluggish trend during the general decrease 1866-1894. However, another divergence in this period appears in the British market for bars. While the Sauerbeck and Economist quotations were at level with each other up to the boom of the 1870s, thereafter Sauerbeck sank much deeper. However, during these years there was a rapid transformation in iron and steel making, and we do not know about the homogeneity over time of the quoted products. Note, for example, the divergence between British rails and rails in Hamburg. Although both quotations consider an open market, trends diverge and the correlation between variations is the weakest in table 3, even if it is still around 98 percent level of significance. Actually, prices of rails in Hamburg were more volatile than those in Britain, and as an average for the second period some 25 percent more expensive. This differential increased to well above a third, as an average 1880-1894, whereafter prices converged somewhat. The greater volatility in Hamburg, may be due to changing quality as the quotation does not discriminate between iron and steel rails. However, the differential is not explained hereby, as steel rails were cheaper. The British steel rails quoted by The Economist were, for example, 17 percent cheaper than iron rails during the entire time they both were quoted (1884-1898).

Similarly, in the period 1866-1894, prices of sheets in Hamburg fell less than in Britain, albeit the correlation between the variations was very close. When trends diverged during this period, it was British iron and steel prices that fell relatively. Britain thus kept her competitive edge during this period of transformation in international iron and steelmaking. It makes no difference to this conclusion, if the cause was a general decrease in British relative prices, as indicated by the comparison of WPIs (see above), or a special effort in the industry. Neither Germany nor Sweden kept level with Britain up to around 1890.

Turning to the next period, 1890-1910, we find roles changed. Prices generally increased, but less so in Germany and Sweden. Only in the case of pig iron does it matter if interior German prices or the Hamburg *Börsenpreise* are selected for the comparison. Thus it seems not as if institutional factors, in the sense of regulation or tariffs, caused the change. The changing market notwithstanding, correlation between variations was generally still close.

16 Attman (1958)

Table 3. Prices for iron and steel, trends and variations.

Columns ***"Trend"*** consider annual rate of change in percent.
Columns ***"Var"*** consider deviations from trend, average correlation coefficient against the other series in the same commodity group.

	1850-75		1866-94		1890-1910	
	Trend	***Var***	***Trend***	***Var***	***Trend***	***Var***
95% significance		*.375*		*.356*		*.414*
Pig iron						
Scotch, Sauerbeck	1.47	.839	-1.88	.914	1.35	.734
Scotch, E (Economist)			-1.71	.913	1.76	.786
Swedish	1.50	.659	-0.82	.860	1.04	.393
Swedish, export					1.38	.726
German, Breslau	-0.79	.736	-1.82	.730	1.07	.765
German, Ruhr					1.20	.656
Germany, Hamburg	1.05	.844	-1.74	.880	1.47	.712
Bars, bar iron						
England & Wales, E			-1.38	.888	1.05	.690
British, Sauerbeck	1.11	.794	-2.14	.872	1.59	.742
Swedish	0.73	.663	-1.15	.821	0.61	.670
Hamburg	0.98	.792	-1.40	.879	0.13	.446
Rails						
British, Iron, E			-1.60	.404		
England, Steel, E					2.70	.512
Sweden, import					1.16	.394
Hamburg	0.44		-0.96	.404	1.26	.112
Sheets						
British, E			-1.34	.905	0.42	.482
Hamburg	1.45		-0.39	.905	-0.41	.482
Ship plates						
Scotch, iron, E					1.53	.855
Scotch, steel, E					0.69	.846
Swedish, steel					0.51	.763
Ship angles						
Scotch, iron, E					0.48	.796
Scotch, steel, E					0.58	.811
Swedish, steel					0.64	.658

Note: Due to the ending of the Hamburg price series in 1910, the last period is cut. Sources, see appendix. "England" means Staffordsshire for bars and Middlesbourough for rails. In Sweden pigs and bars are quoted i Bergslagen, the iron district in central Sweden, while ship steel is quoted in Malmö. In Germany prices are at works except for Hamburg, which are *Börsenpreise* in the free port.

Considering trends, a few exceptions could be found, though. British ship steel prices displayed a more moderate increase, at the same rate of change as Swedish ship steel. Even general purpose sheets in Britain displayed this more moderate increase, but, nevertheless, could not match the falling trend in Hamburg. The earlier very close correlation between variations were, furthermore, considerably reduced. This was due to a striking stability in the Hamburg quotation from the turn of the century. That seems puzzling, against the background of the relatively falling trend. According to the received view, the reduced variations would be due to imperfect competition. Yet, if prices were administered why should the trend of relative prices fall? Other cases in this period where cartellisation was involved, as in rails, do not display a reduction of volatility.[17]

The equilibrium in the international iron and steel market, that in the 1870s and 1880s was disturbed by the British, did not reign in the decades after 1890 either. Now it was innovations and production of scale in German steelmaking that moved the scene. The Swedish industry, still leaning heavily on its high quality, charcoal pig iron, managed to adjust to the change rather than act as its driving force.

VIII. Long Swings in Prices of Machinery?

The foregoing discussion on the behaviour of prices for butter and iron has substantiated the notion that the levelling of prices is not a rapid process. Moreover, it is not simply a gradual process, but innovations, technological change in production and marketing, including new products, cause interruptions. And once interrupted, the levelling has to start again. This explains the divergence of trends despite variations may be closely correlated.

In this section prices of the engineering industry will be explored somewhat. This branch of industry, especially, represents technological change, and an analysis of its prices would be a test for what has hitherto been said. However, the discussion will only be tentative, as some of the series are still in a preliminary state. Therefore, it is also necessary shortly to comment the reliability of the series.

17 About cartellisation, see, *e g*, Nilsson (1972). An alternative explanation is a debasement of the quotation. This is, however, contradicted by the not inconsiderable, and growing, quantities of sheets that was landed in Hamburg: 5,000 tons in 1894, and 27,000 tons in 1909. *Tabellarische Uebersichten*.

Table 4. Prices for selected machinery, locomotives, and ships

Columns ***"Trend"*** consider annual rate of change in percent.
Columns ***"Var"*** consider deviations from trend, average correlation coefficient against the other series in the same commodity group. For "Machinery," correlation coefficient is only against the same commodity in the other country.

	1860-75		1866-94		1890-1914	
	Trend	*Var*	*Trend*	*Var*	*Trend*	*Var*
95% significance		*.468*		*.356*		*.381*
Ships						
Clyde	-0.07	.403	-0.20	.393	0.33	.408
Sweden	0.95	.403	-1.19	.393	-0.84	.114
Hamburg					1.00	.424
Locomotives						
Britain*			-0.98	.021	0.21	-.481
Sweden	0.19	.777	-0.27	.021	-0.72	-.481
Germany	-0.07	.777				
Machinery						
Plough, one-furrow, Britain	0.99		0.35		0.35	.489
Plough, one-furrow, Sweden					0.20	.489
Portable steam engine, B.	-0.02		-0.05		0.30	.354
Portable steam engine, S.*					-0.77	.354
Light traction steam engine, B*			0.75		0.56	.763
Compound steam engine, B			0.00		0.44	.763
Electrical motors					1894-1914	
Direct current, British					-4.74	.347
Continuous current, Swedish					-3.80	.347

Note: * British locomotives from 1871; British light traction steam engine from 1868; Swedish portable steam engine ending 1912.

Sources, see appendix.

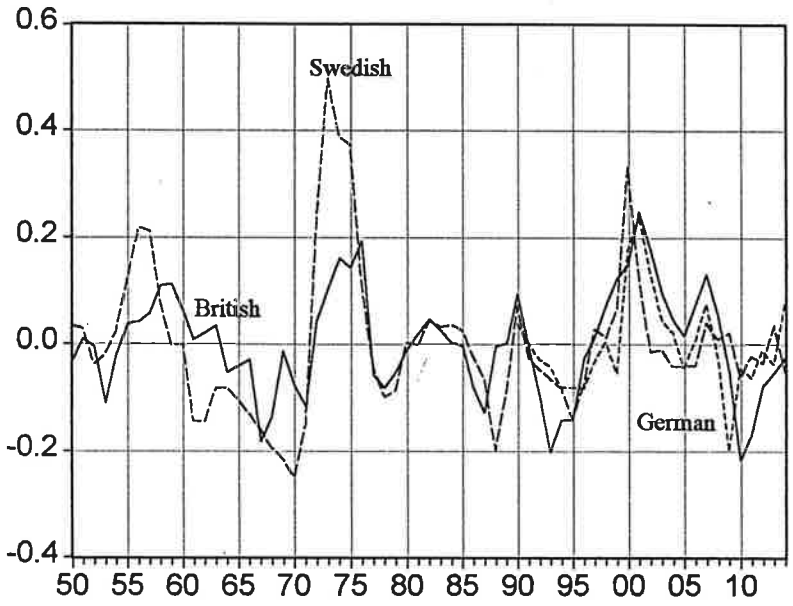

Figure 4. Variations in Prices for British and German Ships, and for Swedish Iron/Steel, 1850-1914.

Note: Deviations from trends linked in 1870 and 1890.

Sources: See the appendix.

In the first period, here 1860-1875, ship prices in Britain and in Sweden differed in trend as well as in the deviations from trend, which can be seen from

Table 4. That may be due to the infant character of Swedish shipbuilding at the time. Ships were small, yet of iron and they were steamships, mostly with screw propulsion. Quite a few of them were even exported, foremost to Russia, where they presumably trafficed inland and coast waters. Still, markets were divided.

In the second period, correlation between variations indicate that markets had begun to integrate. Trends, though, tell about the different state of shipbuilding in the two countries, with Sweden being in the

process of catching up with Britain, or at least narrowing the gap. What is remarkable with the figures is not that Swedish ship prices decreased, but the very slight decrease for British ships. This is at odds with the development of input prices, that is, iron prices. Compared to previous price indexes for British shipbuilding, the decrease is quite reduced.[18]

That this new index is not altogether spurious may be concluded from figure 4. It seems plausible that differences between intermediary prices and output prices that are due to technology, such as productivity change and development of products, are absorbed by the trend. Therefore figure 4 displays deviations from trends. Swedish bar iron (up to 1885) and ship steel (from 1885) is selected for comparison, I must confess, due to the smoother visual similarity with ship prices, than had the corresponding, more volatile, British prices. In Granger causality tests, though, values are as determining for British iron/steel as for Swedish iron/steel in "causing" British ship prices (level less than 0.01 for lags 1-3). This corroborates the present British ship price index. Even if the trend is the major problem, the variations should be at random if the splicing method, that is used to construct the series is flawed.

Why may British ship prices not have taken part of the general decrease in prices, not the least the prices in iron and steel? Another produce of heavy engineering, British locomotives fell by an annual rate of -0.98 percent 1871-1894. A reduction of the period for ships to the same years, cuts the differential somewhat. -0.53 percent for ships 1871-1894 make up, nevertheless, a significant difference. On the other hand, attention can be drawn to some British machinery which even increased in price (see Table 4). Maybe it is the decrease for locomotives that has to be explained. As can be seen from Table 4, even during the first period, when ship markets were divided, the variations in locomotive prices in Germany and in Sweden were well correlated, and differences in trend marginal. Unfortunately, the price index for British locomotives starts first in 1871, while the German index has (temporarily I hope) stopped in 1880. But one may conjecture, for historical reasons, that

18 According to Cairncross (1953) the annual rate of change 1870-1894 was a dramatical decrease, -4.5 percent. Feinstein (1976) halves the decrease, to -2.05 percent 1866-1894 [Feinstein (1988) -2.44]. My earlier computation, used in Schön & Ljungberg (1994), was halfway between Feinstein 1976 and the present estimate, -1.19 percent for the years 1866-1889. Due to space it is not possible to scrutinize these figures more closely. However, the main differences in methods are: Cairncross (1953) is based on average price per gross register ton, i e unit values. Feinstein (1976) is an estimate based on input factor prices. My method is shortly described in the appendix. My earlier estimate was based on a part of the data set only. I think Granger tests are useful to settle which of these indexes is most reasonable. For the earlier period, 1850-1875, the trend was stationary for prices of Denny steamers (-0.07 percent), according to Slaven (1980). On the same source, but differentiating due to ship type, the present estimate show a slight decrease (-0.41 percent).

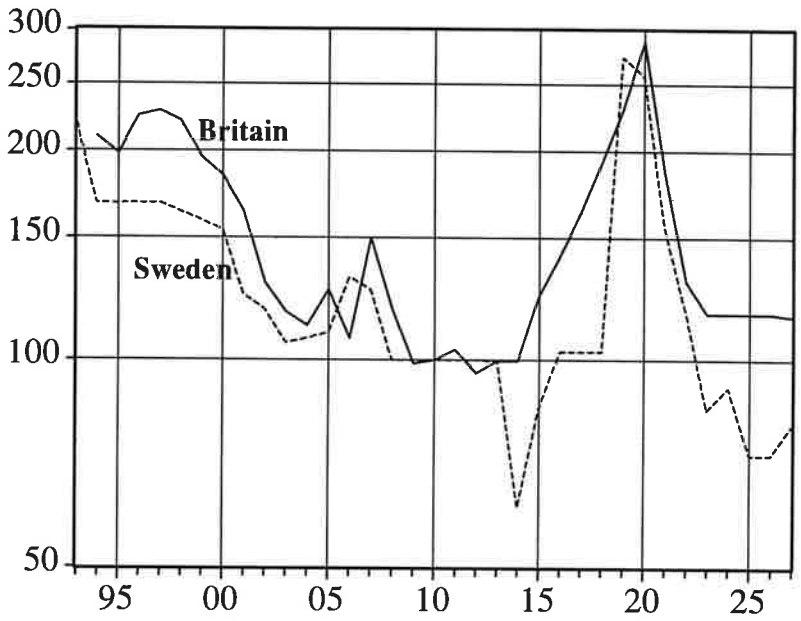

Figure 5. Price Indexes for Electrical Motors in Britain and in Sweden, 1893-1927. (1910/12=100)

Sources: See the appendix.

international competition was stiffer in locomotive manufacturing, thus exerting a pressure on British prices.

Before proceeding into the third period, the conspicious disintegration of the locomotive market in the period 1866-1894, has to be commented upon. Taking 1871 as start year, as for British locomotives, Swedish prices decreased slightly by an annual rate of -.27 percent. However, the difference to British and probably even to German locomotive prices was considerable. The cause is institutional. The Swedish prices consider renewals by Statens Järnvägar, the public railways.

Up to 1876, locomotives were delivered by well known British manufacturers, Swedish workshops, and even by German Borsig. After that year, when German prices were in a deep trough and British prices rapidly falling, the Swedish public railways only bought Swedish made locomotives. First around the turn of the century, when Swedish engineering was in a process of profound transformation and prices of machinery and related products dwindled, did Swedish locomotive prices adjust. This was in a time of international boom, resulting in inverse movement of locomotive prices in Britain and in Sweden. This can be seen in the negative correlation coefficient during the last period in table 4.

The profound transformation in Swedish engineering, that occurred simultaneously to the boom of the late 1890s, may also explain why Swedish ship prices during the third period were even more at odds with prices in Britain. However, there is also an incongruity in the data. While British and German ship prices, as well as Swedish prices up to 1888, consider delivery prices, after 1888 the Swedish series is based on contracts. It is hard to adjust for the bias as the time from order to delivery did variate. For the trend it is of no importance. For the correlation of variations, it may be.[19]

German ship prices increased somewhat more than British during this period, but, as is obvious from figure 4, variations were rather close, and the correlation coefficient between just Clyde and Hamburg is .718. Unfortunately, the only representative for German engineering (for the moment) is ships. As can be seen from table 4, there is a general divergence between trends, on the one hand for British products, and on the other for Swedish. The only exception is electrical motors, where the pattern is uniform for both countries. This is illustrated by figure 5.

Thus, a basic problem for the present research still remains. Was the downswing in prices of Swedish ships, locomotives and machinery during the decades before 1914, mostly a Swedish phenomenon. Or did the rapidly industrializing Germany display a similar picture? What stands out from table 4 is, with a few exceptions, the long term stability

19 An indication thereon, perhaps, is that the deviation from trend for Swedish ships Granger "causes" the corresponding series for British ships, at two lags (above 95 percent level of significance). In conformity with the foregoing footnote, the annual increase of 0.33 percent in the present price index for British ships should be compared to those previously in existence. Cairncross (1953)/Fairplay decreased at an annual rate of -0.10 percent 1890-1914. Pollard & Robertson (1979) give a rate of change that approaches the Swedish figure: -0.55 percent. And Feinstein (1976), at the other extreme, appreciates British ship prices somewhat more than I do: an annual growth rate of 0.64 percent [Feinstein (1988) 0.48; due to my carelessness the comparison with Feinstein's most elaborate estimate was not pursued in the congress version of this paper; still, the difference in method remains; with the addition of a factor for quality change Feinstein uses input factor prices for the construction of a ship price estimate; when publishing my price data in full, I will discuss this problem at length].

of British products. As regards engineering products, the pattern of innovations and production of scale leading to falling prices, well known from the British industrial revolution as regards cotton textiles, and repeated several times up to the contemporary electronics deflation, was not conspiciously pertinent in Victorian Britain.

IX. Conclusion

When Brinley Thomas wrote his seminal work on the Trans-Atlantic migration, the focus was on market integration.[20] Although the concept "market integration" does not figure in the book, in fact, this is the subject matter of his basic thesis. One of Thomas's argument is that the analysis of open economies, *i e* of an international economy, cannot proceed just as if it were a matter of a larger closed economy. Later on Thomas summed up:

> "As soon as we regard the individual nations as regions comprising an aggregate...there is no reason to expect each of the parts to pass through identical and simultaneous phases according to a theory of a closed system. Secular growth entails internal shifts within the aggregate via international factor movements; the expansion of the whole may well express itself through disharmonious rates of growth in the parts."[21]

This argument, I think, can as well be extended to the behaviour of prices. Such a proposition would certainly be false, however, if prices behaved according to the purchasing power parity theory of today. Then convergence should be a very quick process, and equilibrium would be the normal state of international commodity markets. Empirical evidence does not seem, still, to support the puchasing power parity theory of today. Bertil Ohlin was quite right when he pointed out:

> "...every explanation of pricing which attempts more than a statement of certain equilibria must consider time, and this is the chief cause of the difficulties a concrete theory of pricing encounter."[22]

My interpretation of price movements in the markets for butter, iron and steel, and machinery, is that prices certainly converged over periods of decades. Equilibrium, however, was never attained, due to the

20 Thomas (1954).
21 Thomas (1961) p. 43
22 Ohlin (1933) p. 51.

development of things. Aside from institutional change, and presumably more important, structural and technological change shifted the competitive positions between countries. This implied a challenge for the lagging countries, and their response required time.

Pure logic may dispute this description. Nonetheless, it seems to fit history, and real life is full of friction and constraints that are hard for pure theory to take account of.

A further point of the paper is long swings, due to structural and technological change, for which evidence is found in Swedish relative prices. According to the above line of reasoning, the same swings must not have been present in all parts of the international market at the same time.

It seems as if such swings did not have the same weight in the British economy. On the basis of the association between German and Swedish capital movements, it has been conjectured that some of the Swedish price swings were a response to German price movements.[23] So far, however, that cannot be confirmed.

23 Schön & Ljungberg (1994).

Appendix

Note on the price material

The price series are partly compiled from the literature, partly constructed from historical records. Most of that work was pursued in a research project on Sweden in international market integration during the 19th and 20th centuries, financed by The Bank of Sweden Tercentenary Foundation. Presently research on international price movements is performed in the project *Sweden During the Gold Standard*, where it is connected to developments in financial markets and monetary policy. This project is financed by Swedish Council for Research in the Humanities and Social Sciences, and by The Jan Wallander and Tom Hedelius Foundation for Social Sciences.

There are several fellow-beings who have lent me advice and assistance. Aknowledgements must, however, wait, but for some very concrete cases. First, I am grateful to Astrid Lieng, who has spent years with The Economist, Greenwood and Batley, and suchlike. Another few are mentioned below.

The price series used here, as well as some others, will be published in full. Below the sources of the price series in tables 2-4 are listed, and in some cases shortly commented.

Table 2: Butter

All the London series are based on weekly quotations, transformed to monthly and annual series respectively, in *The Economist*. The Dutch butter is very close to the annual Sauerbeck quotation (*Journal of the Royal Statistical Society*; cf Klovland [1993]).

The Berlin and Hamburg series are from A Jacobs & H Richter (1935). As remarked in the text, this Hamburg series is a wholesale quotation.

The Copenhagen series is from Pedersen & Petersen (1938).

The Malmöhus and Stockholm series are from Jörberg (1972). Just as "Malmöhus" considers the whole county, and not solely the city of Malmö, "Stockholm" stands for the county of Stockholm. They are market scales, *i e* official price lists used for the evaluation of tax contributions etc, and published for some twenty counties of Sweden. A penetrating analysis leads, nevertheless, Jörberg to the conclusion that the market scales are a close reflection of the market prices, even better than the quotations on which they are based, as the market scales are, in short, adjusted for seasonality.

Table 3: Iron and steel

The British series for iron and steel are, as denoted in the table, from the Sauerbeck quotation in *Journal of the Royal Statistical Society*, or recorded from *The Economist*.

Sources for the German series are: For Breslau, A Jacobs & H Richter (1935); for Ruhr, notably Dortmund, *Viertalsjahrs-Hefte zur Statistik des Deutschen Reichs*; for Hamburg, *Tabellarische Uebersichten*. The latter series consider *Börsenpreise* in the free port, *i e* except custom. The origin of the commodities must be investigated in each case, and cannot be regarded as foreign imports only. Quite a lot was reexported from Hamburg, and some German commodities came to Hamburg by sea. One might beleive that these *Börsenpreise* were unit values. However, the then head of the Swedish Central statistical bureau, Elis Sidenbladh, wrote a century ago a short study on these Hamburg *Börsenpreise*, and he commented the validity of the quotations:

> "Considering these price quotations it is stated that all commodities must, in a written report within eight days after the landing be recorded as to weight and value according to the ***Börsenpreis*** on the day of landing, and on the basis of these records are then the average price for the year computed...that therefore must be regarded as estimated with all conceivable accuracy." (Sidenblad [1892], my translation, JL)

The Swedish series for pig iron is an average for the market scales of the counties in the iron region (Bergslagen) up to 1884, Jörberg (1972); thereafter, and determinating the level even before 1885, it is based on transaction prices of Kockums shipyard in Malmö, Ljungberg (1990). The export series for pig iron is from Stockman (1922). For bar iron, average of market scales of the counties in Bergslagen is used, Jörberg (1972). For rails in Sweden, the source is Nilsson (1972). Finally, ship steel consider transaction prices of Kockums shipyard in Malmö, Ljungberg (1990).

Table 4: Selected machinery, locomotives, and ships

The British series, denoted "Clyde", is based on the register of vessels built at Denny's of Dumbarton [my gratitude to professor Slaven, who drew my attention to this marvellous source]. Year is taken at time of delivery, and price is final price (sometimes deviating from contract price). To account for technical change, indexes were constructed on basis of the price per gross register ton for several types and sizes, and then spliced. Usually, a price index adjusted for technical change will

deflate an index that does not. For ships, however, increasing sizes tend to squeeze the price per gross register ton, which is the common standard of ship price estimates. That is why the present index, as commented in footnote 18 and 19, inflates most other indexes. Denny built a lot of river steamers, mostly for India, and as I suspected that this market would display another behaviour of prices than other cargo/passenger steamers, two main series were constructed. However, as the result was almost identical they are combined into one index in this paper.

The Swedish series is, in principle, constructed along the same method as "Clyde." For the years up to 1888, it is based on ships built at Bergsund shipyard, close to Stockholm, and at Motala verkstad. As this source is second hand, lists recollected early in this century, with no explanations, it is not known if contract or final prices are quoted. Further, tonnage had to be estimated on the basis of ship dimensions, which probably has resulted in a random error. After 1888, the source is the records of Kockums shipyard in Malmö, and the series available in Ljungberg (1990). Prices are quoted from contracts and date of contract decides year of observation. During this period differences between contract and final price were presumably insignificant, but the delay between contract and delivery bias the comparison of variations with "Clyde" and "Hamburg", as commented in the text.

The German series, denoted "Hamburg", is based on records of the shipyard Blohm + Voss, and constructed along the same methods as the British and Swedish series.

Locomotive prices are based on records of renewals. In principle the same method has been used as for ships: price indexes have been constructed for different models, and then spliced.

For Britain the sources were records of the London Brighton and South Coast Railway, the London and South Western Railway [I am thankful to Mr. Anthony Heman who put his personal records of these two companies at my disposal], the North Eastern Railway, and the Caledonian Railway. As many of these locomotives were built at own works, I have a misbelief that the series reflect production cost more than prices, that should explain the mild volatility in the series. However, for certain (boom) years locomotives were even bought from commercial manufacturers, and the comparison do not support the misbelief. Still, I regard this series as preliminary.

For Sweden the source is official statistics, *BiSOS:La*. Locomotives are those acquired by Statens järnvägar, the public railways. Part of the series is available in Ljungberg (1990).

For Germany the source is *Statistik der in Betriebe befindlichen Eisenbahnen Deutschlands*, where all locomotives of the public railways, and of some private as well, in service in 1880 are listed. The specifications are rather detailed, and renewals extend back into the 1840s. A continuation of the series after 1880 is under way.

Machinery prices are based on price lists, and when models changed series have been spliced. List prices show trend, but reflect variations only partially.

British series are based on *Ransomes*, a leading manufacturer of agricultural and other machinery; Swedish series are available in Ljungberg (1990).

Prices of electrical motors are displayed well into the interwar period, mostly for the sake of comparison of the methods used in the construction of the series.

For Britain, the series is based on the sales books of the Leeds firm Greenwood and Batley [I am in debt to professor Floud for introducing me to this affluent source]. For the years 1894-1900 the splicing method has been used. For 1900-1921 a hedonic price index was constructed, something I before have denounced for historical data. In this case, however, an equation could be estimated for a certain type of electrical motors for each year. The number of observations, *i e* transactions, were on average 51, in two years of crisis, 1904 and 1921, decreasing to 18. Then, price series were simulated for several models on the basis of which the present index was computed. 1921-1927 a contemporary index computed by *British Electrical and Allied Manufacturers' Association* (in US Department of Commerce [1928]) has been used.

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