WERE HECKSCHLER AND OHLIN RIGHT?
PUTTING HISTORY BACK INTO THE
FACTOR-PRICE-EQUALIZATION
by
Kevin O’Rourke
University College Dublin

and
Jeffry G Williamson
Harvard University

WORKING PAPER NUMBER WP92/7

UNIVERSITY COLLEGE DUBLIN

Department of Economics

BELFIELD, DUBLIN 4, IRELAND
WERE HECKSCHER AND OHLIN RIGHT?
PUTTING HISTORY BACK INTO THE FACTOR-PRICE-EQUALIZATION THEOREM*

[Revised and extended version]

Kevin O’Rourke and Jeffrey G. Williamson

Abstract: Due primarily to transport improvements, commodity prices in Britain and America tended to equalize 1870-1913. This commodity price equalization was not simply manifested by the great New World grain invasion of Europe. Rather, it can be documented for intermediate primary products and manufactures as well. Heckscher and Ohlin, writing in 1919 and 1924, thought that these events should have contributed to factor price equalization. Based on Williamson's research reported elsewhere. Anglo-American real wages did converge over this period, and it was part of a general convergence between the Old and New World. This paper applies the venerable Heckscher-Ohlin trade model to the late 19th century Anglo-American experience and finds that they were right: at least half of the real wage convergence observed can be assigned to commodity price equalization. Furthermore, these events also had profound influences on relative land and capital scarcities. It appears that this late 19th century episode was the dramatic start of world commodity and factor market integration that is still ongoing today.

*Revised version of a paper presented to the Cliometrics Conference, May 15-17, 1992, and part of a larger collaborative project supported by the National Science Foundation, SES-9021951. We are grateful for the excellent research assistance of Stefan Oppers who collected the commodity price data, and to participants at the NBER/DAE conference (March 14, 1992), especially Ken Snowden, who offered some comments on an earlier version. In addition, we thank Jeremy Atack, Tom Cullen, Mary Cullen, Bob Gallman, Claudia Goldin, Lynne Kiesling and Peter Lindert.
THE FACTOR-PRICE-EQUALIZATION THEOREM AND HISTORY


The factor-price-equalization theorem has been a durable tool for trade theorists ever since Eli Heckscher and Bertil Ohlin made their seminal contributions shortly after World War I. The Heckscher-Ohlin paradigm has it that countries export commodities which use intensively the factors in which they are well endowed while they import commodities which use intensively the factors in which they are poorly endowed. Thus, commodity trade acts as if to equalize factor endowments among trading partners. Furthermore, under restrictive assumptions, it can be shown that a move from no trade to free trade can in fact equalize factor prices where wide differences existed before. Consider this example: Let falling transport costs and declining tariff barriers tend to equalize prices of traded commodities. Countries will now export more of the goods which exploit their favorable factor endowment. The demand for the abundant and cheap factor booms while that for the scarce and expensive factor falls. Thus, commodity price equalization tends to produce factor price equalization, although theory is ambiguous about how much.

Both Heckscher and Ohlin were Swedes, and thus they were very familiar with the small open economy. Indeed, when Heckscher was writing in 1919 and Ohlin in 1924, they were motivated by the commodity price equalization trends which they thought had taken place between Old World and New in the late 19th century (see the new translation edited by Flam and Flanders, 1991). Their economic metaphor was driven by primary foodstuffs: what we now call the New World invasion of grains, driven by the sharp decline in transport costs.
served to lower the relative price of grains in the Old World (like Sweden) and raise it in the New World (like America). Britain and the Scandinavian countries did not respond to the challenge with tariffs, although countries on the continent did (Kindleberger, 1951). What occurred in the late 19th century was exactly the kind of exogenous price shock which is supposed to set factor-price equalization in motion. Britain, Scandinavia and other Old World countries in the free trade zone had plenty of labor and little land, while America in the New World had the opposite. Thus, in 1870 the New World had high real wages and low land rents while the Old World had the opposite. According to the factor-price-equalization theorem, the invasion of grains should have raised real wages in the Old World free-trade zone while lowering them in the New World. *ceteris paribus*. Did it?

In spite of the durability of the famous factor-price-equalization theorem, nobody to our knowledge has explored its empirical significance during the epoch which motivated Heckscher and Ohlin in the first place -- the late 19th century. This odd state of affairs is all the more surprising given the attention which economic historians have devoted to the grain invasion, the decline in transport costs, and the convergence of prices internationally in the forty years or so following 1870.

There is another stream of literature which is relevant to the issues raised in this paper. For some time now, economists and historians have both been intrigued by comparative growth performance over the past century or so, manifested, in Moses Abramovitz's (1986) words, by catching up, forging ahead and falling behind. This recent literature has its antecedent with Alexander Gerschenkron's (1952) latecomer hypothesis, but it was reawakened with the appearance of *Productivity and American Leadership* by William Baumol and his
collaborators (1989), by the even more recent appearance of Gavin Wright's 
(1990) work on US industrialization around the turn of the century, and by the 
emergence of what has come to be called the "new growth theory".

A recent paper by one of the present authors (Williamson, 1992) 
constructed a purchasing-power-parity adjusted annual real wage data base for 
15 countries over the very long run. The 1870-1913 evidence is summarized in 
Figure 1 by a coefficient of variation, C(15), and it documents considerable 
convergence. Furthermore, the late 19th century real wage convergence is 
similar in magnitude to the better-known convergence during the great 
"Keynesian boom" after World War II. Perhaps most interesting, however, is the 
finding that most of the late 19th century real wage convergence was 
attributable to an erosion in the real wage gap between the Old World and New 
(Dno in Figure 1), and not to any significant convergence within the Old World 
(Do) or within the New (Dn). Around 1870, real wages in the labor scarce New 
World (Argentina, Australia, Canada and the USA) were much higher than in the 
labor abundant Old World (Ireland, Great Britain; Denmark, Norway, Sweden; 
Germany; Belgium, Netherlands, France; Italy and Spain). about 136 percent 
higher. But by 1895, real wages in the New World were "only" 100 percent 
higher, and in 1913 they were "only" about 87 percent higher. In short, the 
real wage gap between Old World and New fell by 36 percentage points over 
those twenty-five years, and by 49 percent over those forty-three years. The 
Old World caught up a bit with the New. While it was much less dramatic, what 
was true of Old and New World was also true of the two countries which best 
represented each: in 1870, real wages in the USA were 67 percent higher than 
in Britain while in 1895 they were "only" 44 percent higher, and in 1913 
"only" 54 percent higher. That is, the Anglo-American real wage gap fell by 23

3
percentage points over those twenty-five years, and by 13 percentage points over those forty-three years. Britain caught up a bit with the United States, a surprising finding given all that has been said about Britain losing her leadership to America during this quarter century and especially during the two decades which followed. Furthermore, the wage-(farm land) rental ratio doubled in Britain while it halved in America.

This paper links the factor-price equalization literature with the convergence literature. It asks: How much of the Anglo-American real wage convergence between 1870 and 1895 or 1913 can be explained by the convergence in commodity prices? Of course, America underwent superior industrial growth during this period (Wright, 1990), a force which should have tended to raise real wages in America relative to Britain. Knowing this, we can ask: By how much did commodity price equalization serve to mute the impact of the relatively superior American industrial performance on Anglo-American real wage gaps? Does the factor-price equalization theorem play a quantitatively significant role during the period of New World grain invasion, a period which motivated Heckscher and Ohlin in the first place?

The paper falls into two parts. The first documents the extent of commodity price equalization during the period, and for aggregate Anglo-American importables and exportables, not just grains. The second estimates the impact which these price shocks had on the British and the US economies, real wages in particular. To this end, computable general equilibrium (CGE) models for the two economies are constructed. These models are then used to answer questions like: If Anglo-American commodity price differentials in 1870 had been like they were in 1895 or 1913, by how much would the Anglo-American wage gap have diminished? Since the aim of the paper is to assess whether
commodity market integration would have led to some considerable real wage convergence even in the absence of factor flows, we shall assume initially that labor and capital were not mobile internationally. These assumptions about factor mobility can, of course, be progressively relaxed in just the way that Ohlin wanted to but couldn’t in his formal analysis (Flam and Flanders, 1991. p. 22).

The British and the US models will be kept simple. They will explicitly take into account linkages such as the role of New World food as a key wage good in both economies, the role of New World cotton as a key input to manufacturing in both economies, and the role of Old World manufactured exports as they competed with domestic manufactures in US markets. In the tradition of Heckscher and Ohlin, we begin by taking the endowments of capital, labor and land as given. Later in the paper, we explore the impact of international capital flows by taking the returns on capital as determined exogenously (so that these two trading partners can import or export all the capital they wish). In a future paper we intend to explore the impact of labor migration on the real wage gap between Old and New World. Clearly, therefore, the present paper should be viewed as only the first stage in what we hope will become a much longer project.

COMMODITY PRICE CONVERGENCE 1870-1913

The Evolution of Anglo-American Transport Costs and Tariffs

Economic historians have long been aware of the revolutionary decline in transport costs underlying overseas trade in the late 19th century. Douglass North (1958, p. 537) called the decline "radical" both for railroads and ocean
shipping. Since the UK imported foodstuffs and raw materials, and since these bulk commodities "were fundamental beneficiaries of the cheapening transport costs" (p. 544), he thought it was clear that it contributed in Britain to "lower priced foodstuffs and therefore rising real wages, and to the lowering in the cost of industrial raw materials" (p. 545) and therefore, we take it, rising rates of industrialization. Although North doesn't say so, symmetry suggests that real wages must have been lowered in the US while industrialization must have been suppressed.

The kind of evidence that North used in his seminal 1958 article is reproduced in Table 1. When deflated by a US general price index, North's freight rate index along American export routes in Table 1 drops by more than 41% between 1870 and 1910. His wheat-specific American East Coast freight factor (percent share of freight costs in CIF value) fell by even more between 1870 and 1913, about 53%. The older Isserlis index (which includes many other non-Atlantic trade routes) displays a less spectacular decline up to 1913, about 25%. Similar evidence is offered in Figure 2 based on Knick Harley's (1988) British overseas coal freight rates. All in all, Table 1 and Figure 2 would appear to support North's choice of the word "radical" in describing the decline in transport costs linking US and British commodity markets, even though the table ignores the even more pronounced decline in transport costs into the interior of each nation due to the railroads. Writing in 1924, Edwin Nourse thought these forces threw British farming "which had been in orderly retreat for over fifty years ... into a rout" (Nourse, 1924, p. 19).

There were other forces at work, however, which should have influenced the evolution of Anglo-American price differentials after 1870 -- the slow erosion in the height of American Civil War tariffs. The ratio of duties to
dutiable imports fell from 47% in 1870 to 42% in 1910; and as a ratio to total imports, it fell from about 45% to 21% (US Department of Commerce, 1975, p. 888). Since the US was a net importer of manufactures during most of this period, and since the Civil War tariffs were high on those importables, the erosion in US tariffs after 1870 should have served to aid commodity price equalization on manufactured goods, not just on primary products.

Grain Market Integration

In assessing the "radical" decline in overseas freight rates, the cost-reductions along the rails between Chicago and New York, or the erosion in Civil War tariffs, what mattered, of course, was its impact on the price convergence of tradables. By how much, for example, did these forces raise the price of foodstuffs in the US (like wheat, flour, meat and animal fats) and lower them in Britain? Almost without exception, the literature has explored the question by looking at the grain market. This is certainly true of Charles Kindleberger's (1951) important contribution to the debate over the Old World defensive policy response to the grain invasion, and it is also true of Knick Harley's writings on late 19th century transport, trade and settlement in the New World (Harley, 1980, 1986). Thus, we start there.

Figure 3 documents the behavior of wheat prices quoted in three markets: Liverpool, New York, and Chicago. As Appendix 1 reports, these are dollar prices per bushel for American #2 winter wheat (Harley, 1980, pp. 246-7, with interpolation for early years in Chicago). Liverpool prices exceeded Chicago prices by 60.2% in the three years centered on 1870, they exceeded Chicago prices by 25.9% in the three years centered on 1895, and by 14.2% in the three years centered on 1912. While the rest of this paper will try to isolate the
full general equilibrium effects of this massive price shock, the effect on Anglo-American real wage differentials through the cost of living was likely to have been large by itself. Since the share of wheat in the workers' budgets was about 16% (bread and flour: Williamson, 1985, p. 221, 1877-91 budgets), then Anglo-American real wage differentials would have declined about 7 percentage points between 1870 and 1912 due to wheat price convergence alone (.16x[.602-.142]=.0736). The share of meat and animal fats (beef, mutton, bacon, butter) in workers' budgets was about 30%, and if the Anglo-American price differentials for meat and animal fats declined by only half as much as wheat, then the figure would be augmented by about another 7 percentage points (.30x[.602-.372]=.069), for a total of 14 percentage points. Of course, the impact of manufactured tradable prices, presumably rising in Britain relative to America, would have had the opposite influence, but such items like clothing were a smaller share in workers' budgets (12%). In addition, we do not yet know what happened to trends in Anglo-American price differentials for non-tradable services (28% of the budget), or for other foodstuffs like sugar, tea and coffee. Therefore, the foodstuff price calculations are only a crude and incomplete first pass, and they totally ignore the employment effects central to the factor price equalization theorem, but they certainly suggest that Anglo-American commodity price equalization holds promise in accounting for a significant share of the real wage convergence which took place between 1870 and World War I.

Commodity Market Integration More Generally

Figures 3 and 4 plot the classic experience with Anglo-American price convergence for wheat. Figure 3 offers wheat price time series for Liverpool
(the main British port of entry for American grain), Chicago and New York. Figure 4 plots the percentage price differentials for Chicago and New York, both relative to Liverpool. Thus, in 1870 wheat prices were more than 60 percent higher in Liverpool than in Chicago, while they were almost 20 percent higher than in New York. The price differentials diminished up to World War I, although the decline was more dramatic over the first two decades. Wheat (and flour) was a large share of US exports in 1880, 27.4%, and it was also a large share of British imports in the same year, 15.3%, so unless other US exportables and British importables had very different price behavior these trends in Figure 4 are likely to appear more generally.

Was the experience in Anglo-American wheat markets repeated for other foodstuffs? The second biggest foodstuff tradable consisted of meat and animal fats (e.g., beef, pork, bacon, mutton, and butter): its share in US exports in 1880 was 18.3%, and in UK imports 9.3%. Figure 5 plots Anglo-American price differentials for this foodstuff. The series fluctuates widely, but figures implied by the estimated trend line suggests the following: meat price differentials between London and Cincinnati were higher than for wheat in 1870, about 93%; convergence up to 1895 was modest; but convergence over the full 43 years was, if anything, even more pronounced than that for wheat, price differentials declining from about 93% in 1870 to about 18% in 1913. Thus, there is certainly evidence of meat price convergence over the four decades as a whole.

What might come as a surprise even to the specialist is the impressive size of the price convergence for manufactures. We have been able to secure adequate information over the period as a whole only for cotton textiles and iron products. While textiles and iron and steel products accounted for a
large share of both US imports and UK exports of manufactures, we would be happier if we had more comprehensive price information on Anglo-American trade in manufactures. The two items we can document are plotted in Figures 6 and 7. They exhibit striking convergence between 1870 and World War I, approximating those already seen for wheat and meat. Using the predictions from the trend regressions, the cotton textile price differential between Boston and Manchester falls from about 14% in 1870 to about 1% in 1913, while the average iron products’ price differential between Philadelphia and London falls from 80% to 20% over the 43 years.

There is, however, an important and atypical case -- raw cotton. This key intermediate good claimed an important share of Anglo-American trade, 25.7% of 1880 US exports and 10.4% of 1880 UK imports. As Figure 8 suggests, Anglo-American cotton price differentials eroded only very modestly over the late 19th century, from about 13% in 1870 to about 10% in 1913 (based on the regression predictions). This is one important intermediate for which Anglo-American price differentials did not drop sharply during the late 19th century.

We have been able to document Anglo-American price differentials for an additional seven tradables displayed in Appendix 5: price convergence was strong for the intermediates including coal, copper, hides, wool and tin; it was mixed for coffee; and modest price divergence was true of sugar. In this version of the paper, however, we take those plotted in Figures 4-8 to be the representative (and large) components of Anglo-American trade.

The next step is to use the 1880 trade weights (Appendix 2) to develop Anglo-American percentage price differentials for six aggregates: US exportable and UK importable foodstuffs (wheat and meat), US exportable and UK
importable intermediates (cotton), and US importable and UK exportable manufactures (cotton textiles and iron products). These are used in the factor price equalization analysis which follows. They imply: the price differential on US exportable foodstuffs fell from 51.9 to 10.6%; the price differential on US importable manufactures fell from 56.6 to 8.9%; the price differential on UK importable foodstuffs fell from 56.8 to 11.4%; the price differential on UK exportable manufactures fell from 31.3 to 2.6%; and the price differential on tradable intermediates fell from 13.3 to 9.7% in both countries.

The terms of trade between manufactures and foodstuffs must have changed dramatically in both countries. If Britain absorbed all the price shock, her terms of trade would have almost doubled. If America absorbed all the price shock, her terms of trade would have more than halved. These were very big price shocks indeed.

ESTIMATING THE HECKSCHER-OHLIN MODEL AROUND 1870

Some departures from the standard textbook case will of course be necessary, but the models will be kept as close to the spirit of Heckscher and Ohlin as possible. The non-traded sector in both economies will need to be modelled; further, the fact that land (a factor of production central to the thinking of Heckscher and Ohlin) is specific to agriculture introduces an element of Ricardo and Viner into the analysis.

There are three sectors in the British model: manufacturing and mining (M), agriculture (A) and services (S). There are three factors of production: land (R), capital (K) and labor (L). Labor comes in two varieties, agricultural and non-agricultural (L_A and L_{na} respectively), of which more
later. In addition, an imported intermediate (I) is used in manufacturing. Production in the three sectors is described by the following (CES) production functions:

\[ M = M(L, K, IM) \]  \hspace{1cm} (1)
\[ A = A(L, K, R_a) \]  \hspace{1cm} (2)
\[ S = S(L_s, K_s, A) \]  \hspace{1cm} (3)

Migration between country and town is modelled by endowing the economy with "raw" labor \( L_a \) which is transformed into agricultural and non-agricultural labor via a constant elasticity transformation function:

\[ (L, L_a) = L(L) \]  \hspace{1cm} (4)

The elasticity of transformation indicates the extent to which domestic labor migration is sensitive to changes in wages in the two sectors.\(^1\)

Britain imports intermediates and food, and exports manufactures. The trade deficit is taken as exogenous. Services are non-traded. We assume Britain to be a "small" country, in the sense that she cannot influence traded goods prices, and the commodity price equalization shocks observed in the previous section are exogenous to the modelled economy. However, those shocks are apportioned between the British and American economies by a procedure (Appendix 4) which recognizes the market power of both the Old World and the New in foreign markets (an innocuous simplification which makes the modelling

\(^1\) This specification is standard in applied work; see Harley (1990), or O'Rourke (1991). It allows for the reality of endogenous wage gaps.
considerably easier). We shall have more to say about this below. There is a single British consumer, endowed with all factors of production and enough foreign exchange to finance the trade deficit. She consumes food, manufactures and services, and maximizes a CES utility function.

The American model is similar to the British but some essential amendments have been added. Most importantly, there is an additional fourth sector in the U.S. which produces intermediates such as cotton and tobacco (I). Production in this sector obeys CES assumptions:

\[ I = I(L_I, K_I, R_I) \]  

(5)

In addition, the data permit a more detailed specification of American manufacturing:

\[ M = M(L_M, K_M, A_M, I, T) \]  

(1')

where T represents imported tropical goods such as rubber and mahogany, not produced in the U.S. (These goods are also consumed.) Furthermore, domestic and imported manufactures are distinguished, and substitute less than perfectly with each other in consumption.\(^2\) The U.S. exports food, intermediates and domestic manufactures, and imports foreign manufactures and tropical goods.

The commodity price equalization shocks are imposed exogenously on the American economy, in the same way as for Britain, with the exception of cotton

\(^2\) The rationale and procedure for this are identical to those given in Harley (1990). In the trade and development literature, this known as the Armington specification.
(where the U.S. was the world's major producer by far). In all other cases, the commodity price equalization shocks are apportioned between the two countries according to the following logic. Transport cost declines affected trade between Europe and the rest of the world (ROW). Production and consumption in Europe and ROW for each good must therefore be calculated, and for a year as close to 1870 as possible. Given elasticities of supply and demand, the effects of a transport cost decline in exporting and importing regions can be calculated from the expression

$$X_e(p_e) + X_i(p_i(l+t)) = C_e(p_e) + C_i(p_i(l+t))$$

(6)

where $X_e$ and $X_i$ are production, $C_e$ and $C_i$ are consumption (in the exporting and importing region respectively). $t$ is the transport cost wedge assumed to have driven the commodity price equalization observed between 1870 and 1913.

The impact of transport cost declines on commodity price differentials is apportioned between regions in this way in all cases but one: there are strong general equilibrium forces that characterized the cotton market which simply cannot be ignored. Wheat transport costs declined a lot, leading to a large expansion of U.S. wheat production in response to rising farm-gate prices. In contrast, cotton transport costs declined only a little. Under "small" country assumptions, the wheat sector expands but the cotton sector contracts. But "small" country assumptions certainly do not hold for cotton. That is, U.S. cotton was "king" in a way that neither America nor Britain were so dominant in food or manufactures. Thus, the world price of cotton must rise by enough to maintain U.S. production at levels consistent with world cotton textile production. For these reasons, U.S. market power in cotton must be explicitly
modelled, even if it is not required for the other tradables. Briefly, we proceed in the following way: a "tariff" is imposed on U.S. cotton exports representing those transport costs; once abroad, U.S. cotton must face a constant elasticity demand function, forcing a new equilibrium.\(^3\)

The American model is estimated for 1869, chiefly using Census data and the work of Robert Gallman. The British model is estimated for 1871, largely based on Census data and the work of Deane and Cole. Full details on the models' empirical implementation are given in Appendix 3.

**ESTIMATING ANGLO-AMERICAN FACTOR-PRICE-EQUALIZATION EFFECTS**

The results of the counterfactual analysis are summarized in Table 2. The table offers estimates of the impact of commodity price equalization on Anglo-American factor prices for both the earlier 1870-1895 period as well as the full 1870-1913 period. Furthermore, the table offers estimates under various assumptions: that all of the price shock was absorbed by the U.S. alone; that all of the price shock was absorbed by Great Britain alone; and (the more relevant case) that the incidence of the price shock was shared by the two. What follows will focus on the more relevant "apportioned" case: here, the estimated impact on Anglo-American factor price equalization is very big in all cases.

First consider the Anglo-American urban wage gap. As we indicated in the introduction, the Anglo-American (urban unskilled) real wage gap declined in

\(^3\) The "tariff" revenue accrues to the American consumer, on the assumption that transport revenues accrued to American shipping interests. It would be a simple matter to let them accrue to foreign shipping interests; in any case, the amounts involved are too small to affect the results.
fact by 23 percentage points up to 1895. Table 2 suggests that about half of
that convergence can be assigned to commodity price equalization forces, 10.4
percentage points, under the more relevant assumption of shared incidence. For
the full period 1870-1913, commodity price equalization served to reduce the
Anglo-American real wage gap by 21.1 percentage points, a figure which exceeds
the actual measured convergence over the four decades as a whole suggesting
that the effects of the superior American industrial performance was dominant
after 1895. The counterfactual impact on the two economies, however, was very
different since, relative to the U.S., the contracting agricultural sector in
Britain was far less labor intensive compared with the rest of the economy.
Britain, it seems, conformed with the Heckscher-Ohlin factor intensity
assumptions far better than did America. Nevertheless, commodity price
equalization was playing a significant role in contributing to real wage
convergence up to 1895, and in muting the divergence effects of superior
American industrialization thereafter.

Second, note the big impact on real land rents. These price shocks served
to raise land rents in America over the full period by 13.4 percentage points,
helping explain the rise in farm land values of which so much has been made by
American economic historians. Meanwhile, on the other side of the Atlantic,
the same price shocks served to cause British real land rents to decline by an
enormous 54.2 percentage points over the four decades as a whole -- a great
agricultural depression of which so much has been made by British economic
historians. Thus, due to commodity price equalization trends alone, the gap in
real land rents between Old World and New collapsed by 67.6 percentage points.

Third, Anglo-American wage-rental ratios converged at an even greater
rate, the gap between them falling by 88.7 percentage points. It appears that
commodity price equalization accounts for about half of the observed change in Anglo-American relative wage-rental ratios.

Finally, commodity price equalization served to erode relative capital scarcity in America. Compared with the rest of the economy, agriculture was less capital intensive in both America and Britain. Thus, the price shocks served to lower the return to capital in America and raise it in Britain. On net, commodity price equalization served to erode the rate of return gap (which favored "capital scarce" America) by 29.7 percentage points. These results suggest that if world capital markets were perfectly integrated, commodity price equalization must have served by itself to accelerate accumulation in Britain relative to America thus reinforcing real wage convergence. Table 3 suggests that these forces were relatively modest: an assumption of perfectly elastic world capital flows in response to the price shocks implies that induced real wage convergence up to 1913 would have been 26.3 percent (Table 2) rather than 21.1 percent (Table 3). Our results are robust to assumptions about world capital markets.

A RESEARCH AGENDA

These are only tentative findings but the impact of Anglo-American commodity price equalization on factor price equalization is much too large to expect that ongoing improvements to the data base are likely to change them. We expect that the same is true of proposed modifications in the models -- including efforts to explore what happens when international labor migration allowed to respond to the price shocks. We shall see whether our optimism is warranted.
In any case, what about the rest of the New World? Were the same forces at work in Australia and Argentina? And what about the rest of the Old World? Were the factor price influences more modest on the Continent where tariffs were thrown up in the face of the New World grain invasion? And what about the interwar interruption in real wage convergence? Do these results for the late 19th century suggest that much of the cessation in long run real wage convergence can be explained by the disintegration of world commodity markets? Finally, can a good portion of the convergence in the post World War II period also be explained by commodity price equalization?

These are exciting questions, but for the moment we have enough evidence from the late 19th century Anglo-American economies to suggest that Heckscher and Ohlin were absolutely right when they were cultivating the factor price equalization theorem just after World War I.
TEXT REFERENCES


<table>
<thead>
<tr>
<th>Year</th>
<th>Isserlis: Many Routes</th>
<th>North: American Export Routes</th>
<th>North: American East Coast Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1869</td>
<td>95.1</td>
<td>102.7</td>
<td>112.3</td>
</tr>
<tr>
<td>1870</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>1871</td>
<td>95.1</td>
<td>128.4</td>
<td>119.8</td>
</tr>
<tr>
<td>1872</td>
<td>88.3</td>
<td>131.2</td>
<td>109.9</td>
</tr>
<tr>
<td>1873</td>
<td>98.5</td>
<td>166.9</td>
<td>146.9</td>
</tr>
<tr>
<td>1874</td>
<td>98.8</td>
<td>146.3</td>
<td>153.1</td>
</tr>
<tr>
<td>1875</td>
<td>96.1</td>
<td>141.2</td>
<td>142.0</td>
</tr>
<tr>
<td>1876</td>
<td>98.1</td>
<td>128.4</td>
<td>101.2</td>
</tr>
<tr>
<td>1877</td>
<td>97.3</td>
<td>150.5</td>
<td>135.8</td>
</tr>
<tr>
<td>1878</td>
<td>95.1</td>
<td>157.7</td>
<td>116.0</td>
</tr>
<tr>
<td>1879</td>
<td>92.0</td>
<td>171.8</td>
<td>106.2</td>
</tr>
<tr>
<td>1880</td>
<td>95.1</td>
<td>145.2</td>
<td>74.1</td>
</tr>
<tr>
<td>1881</td>
<td>89.6</td>
<td>143.2</td>
<td>71.6</td>
</tr>
<tr>
<td>1882</td>
<td>85.0</td>
<td>124.7</td>
<td>82.7</td>
</tr>
<tr>
<td>1883</td>
<td>78.1</td>
<td>110.3</td>
<td>79.0</td>
</tr>
<tr>
<td>1884</td>
<td>82.1</td>
<td>106.5</td>
<td>79.0</td>
</tr>
<tr>
<td>1885</td>
<td>80.2</td>
<td>100.8</td>
<td>87.7</td>
</tr>
<tr>
<td>1886</td>
<td>89.6</td>
<td>95.1</td>
<td>64.2</td>
</tr>
<tr>
<td>1887</td>
<td>101.8</td>
<td>98.9</td>
<td>65.4</td>
</tr>
<tr>
<td>1888</td>
<td>97.8</td>
<td>110.3</td>
<td>107.4</td>
</tr>
<tr>
<td>1889</td>
<td>83.4</td>
<td>121.7</td>
<td>61.7</td>
</tr>
<tr>
<td>1890</td>
<td>82.1</td>
<td>116.0</td>
<td>70.4</td>
</tr>
<tr>
<td>1891</td>
<td>75.8</td>
<td>106.5</td>
<td>69.1</td>
</tr>
<tr>
<td>1892</td>
<td>82.7</td>
<td>98.9</td>
<td>75.3</td>
</tr>
<tr>
<td>1893</td>
<td>86.2</td>
<td>83.0</td>
<td>70.4</td>
</tr>
<tr>
<td>1894</td>
<td>84.6</td>
<td>94.5</td>
<td>91.4</td>
</tr>
<tr>
<td>1895</td>
<td>85.9</td>
<td>108.9</td>
<td>90.1</td>
</tr>
<tr>
<td>1896</td>
<td>84.6</td>
<td>113.0</td>
<td>81.5</td>
</tr>
<tr>
<td>1897</td>
<td>99.5</td>
<td>127.4</td>
<td>80.2</td>
</tr>
<tr>
<td>1898</td>
<td>89.6</td>
<td>104.8</td>
<td>76.5</td>
</tr>
<tr>
<td>1899</td>
<td>93.9</td>
<td>129.4</td>
<td>101.2</td>
</tr>
<tr>
<td>1900</td>
<td>76.4</td>
<td>78.1</td>
<td>37.0</td>
</tr>
<tr>
<td>1901</td>
<td>66.6</td>
<td>63.2</td>
<td>44.4</td>
</tr>
<tr>
<td>1902</td>
<td>66.6</td>
<td>60.9</td>
<td>45.7</td>
</tr>
<tr>
<td>1903</td>
<td>65.7</td>
<td>59.0</td>
<td>30.9</td>
</tr>
<tr>
<td>1904</td>
<td>66.5</td>
<td>68.5</td>
<td>45.7</td>
</tr>
<tr>
<td>1905</td>
<td>62.6</td>
<td>76.1</td>
<td>43.2</td>
</tr>
<tr>
<td>1906</td>
<td>62.7</td>
<td>71.5</td>
<td>44.4</td>
</tr>
<tr>
<td>1907</td>
<td>57.9</td>
<td>60.9</td>
<td>38.3</td>
</tr>
<tr>
<td>1908</td>
<td>57.6</td>
<td>60.9</td>
<td>37.0</td>
</tr>
<tr>
<td>1909</td>
<td>59.5</td>
<td>58.7</td>
<td>39.5</td>
</tr>
<tr>
<td>1910</td>
<td>67.3</td>
<td>-</td>
<td>50.6</td>
</tr>
<tr>
<td>1911</td>
<td>85.3</td>
<td>-</td>
<td>85.2</td>
</tr>
<tr>
<td>1912</td>
<td>74.4</td>
<td>-</td>
<td>46.9</td>
</tr>
</tbody>
</table>

Table 2

The Estimated Impact of Anglo-American Commodity Price Equalization on Factor Prices, Without International Capital Flows (Deflated by Cost of Living Index): 1870-1913 (in percent)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Price shock assumed to be absorbed by:</th>
<th>Price shock apportioned between:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>United States alone</td>
<td>Great Britain alone</td>
</tr>
<tr>
<td>Early Period: 1870-1895</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban wage</td>
<td>0.1</td>
<td>23.4</td>
</tr>
<tr>
<td>Land rent</td>
<td>9.3</td>
<td>-45.1</td>
</tr>
<tr>
<td>Return to capital</td>
<td>-6.3</td>
<td>22.1</td>
</tr>
<tr>
<td>Wage rental ratio</td>
<td>-9.2</td>
<td>68.5</td>
</tr>
<tr>
<td>Full Period: 1870-1913</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban wage</td>
<td>0.6</td>
<td>53.3</td>
</tr>
<tr>
<td>Land rent</td>
<td>29.1</td>
<td>-80.8</td>
</tr>
<tr>
<td>Return to capital</td>
<td>-18.5</td>
<td>50.9</td>
</tr>
<tr>
<td>Wage rental ratio</td>
<td>-28.5</td>
<td>134.1</td>
</tr>
</tbody>
</table>
**FIGURE 1**

International Real Wage Dispersion, 1870-1913


**FIGURE 2**

Freight Rate Indices, 1741-1911
(deflated by U.K. GNP deflator, Rareo Scale)

FIGURE 3
WHEAT PRICES

FIGURE 4
WHEAT PRICE DIFFERENTIALS
British price - U.S. price, in percent of U.S. price

New York, regression line
New York, actual price gap
Chicago, regression line
Chicago, actual price gap
FIGURE 5
MEAT PRICE DIFFERENTIALS
British price - U.S. price, in percent of U.S. price

FIGURE 6
COTTON CLOTHS PRICE DIFFERENTIALS
U.S. price - British price, in percent of British price
FIGURE 7
IRON PRICE DIFFERENTIALS
U.S. price - British price, in percent of British price

FIGURE 8
COTTON PRICE DIFFERENTIALS
British price - U.S. price, in percent of U.S. price
FIGURE 9

U.S. IMPORTABLE MANUFACTURES, 1880 weights
U.S. price - British price, in percent of British price

FIGURE 10

U.S. EXPORTABLE FOODSTUFFS, 1880 weights
British price - U.S. price, in percent of U.S. price
FIGURE 11
U.S. EXPORTABLE INTERMEDIATES (cotton only)
British price - U.S. price, in percent of U.S. price

FIGURE 12
U.K. EXPORTABLE MANUFACTURES, 1880 weights
U.S. price - British price, in percent of British price
FIGURE 13
U.K. IMPORTABLE FOODSTUFFS, 1880 weights
British price - U.S. price, in percent of U.S. price

FIGURE 14
U.K. IMPORTABLE INTERMEDIATES (cotton only)
British price - U.S. price, in percent of U.S. price
APPENDIX I: ANGLO-AMERICAN PRICE DATA FOR TRADABLES

Three major sources have been used to document U.S. and British prices from 1870 to 1913: United States Congress, 52nd Congress, 2nd Session, Senate (1892-93), Wholesale Prices, Wages, and Transportation. Report by Mr. Aldrich, from the Committee on Finance. Washington: Government Printing Office. This report is also known as the "Aldrich Report"; U.S. Department of Labor, Bureau of Labor Statistics (1923), Wholesale Prices 1890-1922. Washington: Government Printing Office; and A. Sauerbeck (1892-1913), "Prices of Commodities", Journal of the Royal Statistical Society. This is a once-yearly summary of prices of 56 commodities in England, compiled by Sauerbeck. Before 1892, these prices are also quoted in the Aldrich Report. Other sources used are given below.

Average annual prices are used throughout. The prices in Sauerbeck and Wholesale Prices 1890-1922 are reported as yearly averages, although it is not clear exactly how the price quotes are constructed. In the Aldrich Report, if yearly quotes are available they are used directly. However, a number of price series reported in Aldrich give four quotes for each year, usually for January, April, July and October. In such cases, an average of the four quotes was used.

All prices in Aldrich before the return to gold in 1879 are given in greenback (paper) dollars, not in gold dollars. To ensure comparability with British prices, the Aldrich prices for 1870 to 1878 have been converted to gold dollar prices, using the dollar price of gold from table 2 in: Kindahl, J. K. (1961), "Economic Factors in Specie Resumption: the United States, 1865-79," Journal of Political Economy, pp. 30-48.

For the Sauerbeck prices, the Aldrich Report gives both the original price quotes and a price converted to U.S. gold dollars per unit. The implied conversion factors from the Aldrich Report are used to make the English Sauerbeck prices taken from the Journal of the Royal Statistical Society compatible with U.S. prices.

Special care has been taken to ensure the comparability of each pair of U.S. and English commodities for which prices are quoted. The following is a detailed description of the prices used for each commodity, with reference to the source from which they were taken.

Wheat: The series for American # 2 Winter wheat is used. Prices are quoted in gold dollars per bushel. They are obtained from the appendix table in: C.N. Harley (1980), "Transportation, the World Wheat Trade, and the Kuznets Cycle, 1850-1913," Explorations in Economic History 17, pp. 218-50. The following series are used: Chicago prices; Liverpool prices, where Harley constructs prices for American # 2 Winter from # 1 using the Chicago spread; and New York prices, where the price quotes are for # 2 Red Winter. Note that no greenback dollar adjustment is necessary for this series, since Harley reports gold dollar prices.

Iron bars: Prices are quoted in gold dollars per 2240 pounds. For the U.S. we use Philadelphia prices: for 1870-1889, these are obtained from the Aldrich Report, part 2, pp. 182-3, table XI: bar iron, best refined, rolled. For 1890-1913, we use prices from Wholesale Prices 1890-1922, p. 134: bar iron, from mill, best refined (1890-1904); and bar iron, from mill, common (1905-1913). For England, we use London prices, Sauerbeck series #24, iron
bars, common. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 234. They are continued once a year in the Journal of the Royal Statistical Society after 1891.

**Pig iron:** Prices are quoted in gold dollars per 2240 pounds. For the U.S., we use Philadelphia prices. For 1870-1889, these are obtained from the Aldrich Report, part 2, p. 196. They are listed as: pig iron, No.1, anthracite, foundry. For 1890-1913 we use quotes from Wholesale Prices 1890-1922, p. 130: pig iron, foundry, No.1. For England, we use London prices, Sauerbeck series #23: iron, Scotch pig. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 234. They are continued once a year in the Journal of the Royal Statistical Society after 1891.

**Cotton:** Prices are quoted in gold cents per pound. For the U.S., we use New York prices. Note that New Orleans prices yield the same trend in Anglo-American price differentials. For 1870-1889, the New York prices are obtained from the Aldrich Report, part 2, p. 11: upland, middling. We take averages of 4 quotes for each year. For 1890-1913, we use yearly observations from Wholesale Prices 1890-1922, p. 48: middling, upland. For England, we use Liverpool prices, Sauerbeck series #31: middling, upland. For 1870-1891 the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 235. For 1892-1913 they were obtained from the Journal of the Royal Statistical Society.

**Print cloths:** Prices are quoted in gold dollars per yard. For the U.S., we use Boston prices. For 1870-1893, these are obtained from the Aldrich Report, part 2, pp. 150-1: print cloths, 28-inch, 64 by 64, metacomet. For England, we use Manchester prices. For 1870-1893, we use prices from The Economist, as quoted in the Aldrich Report, part 1, pp. 221-2: cotton cloths, printers', 26 inch, 66 reed, 20 yards. They are converted to price per yard. Because of a lack of comparable price series for print cloths after 1893, we assume the price differential for 1894-1913 constant at the 1893 level.

**Coal:** Prices are quoted in gold dollars per 2240 pounds. For the U.S., we use New York tidewater prices. For 1870-1889 these are obtained from the Aldrich Report, part 2, p. 177: anthracite, stov. For 1890-1913, we use prices from Wholesale Prices 1890-1922, p. 122: anthracite, stov. For England, we use London prices at Wallsend Hetton, Sauerbeck series #25A. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 235. For 1891-1913, they were obtained from the Journal of the Royal Statistical Society.

**Sugar:** Prices are quoted in gold dollars per pound. For the U.S., we use New York prices. For 1870-1889, these are obtained from the Aldrich Report, part 2, pp. 112-3: fair refined. We take an average of 4 observations per year. For 1890-1913, we use yearly observations from Wholesale Prices 1890-1922, p. 90: 90° centrifugal. For England, we use London prices, Sauerbeck series #16: British West Indian, refined. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 232. For 1892-1913 we use quotes from the Journal of the Royal Statistical Society.

**Coffee:** Prices are quoted in gold dollars per pound. For the U.S., we use New York prices. For 1870-1889, these were obtained from the Aldrich Report, part 2, pp. 75-6: Rio, fair. We take an average of 4 observations over each year. For 1890-1913 we use yearly quotes from Wholesale Prices 1890-1922, p. 78: Rio No. 7. For England, we use London prices,
Sauerbeck series #18B: Rio, good. For 1870-1891 the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 233. For 1892-1913 we take them from the Journal of the Royal Statistical Society.

Copper: Prices are quoted in gold dollars per pound. For the U.S., we use Philadelphia prices. For 1870-1889 these are quoted in the Aldrich Report, part 2, p. 185: ingot. We take averages of 4 observations for each year. For 1890-1913 we use the yearly quotes in Wholesale Prices 1890-1922, p. 142: ingot. For England, we use London prices, Sauerbeck series #22: Chile, bars. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 234. For 1892-1913, we take them from the Journal of the Royal Statistical Society.

Hides: Prices are quoted in gold dollars per pound. For the U.S., we use Boston prices. For 1870-1891, we use data from the Aldrich Report, part 2, p. 141: dry, Buenos Aires. A compatible series for the later years could not be found, but the 1892-1913 data were constructed using a second series of prices obtained from Wholesale Prices 1890-1922, p. 56: green, salted, packers’. The second series was linked to the first using the average price differential between the two over 1890-1891. For England, we use London prices, Sauerbeck series #35A: dry, River Plate. For 1870-1891 the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 238. For 1892-1913 we take them from the Journal of the Royal Statistical Society.

Wool: Prices are quoted in gold dollars per pound. For the U.S., we use Boston prices. For 1870-1889, these can be found in the Aldrich Report, part 2, p. 171: Ohio, medium fleece, scoured. For 1890-1913, we use prices obtained from Wholesale Prices 1890-1922, p. 62: Ohio, scoured fleece, medium (1/4 and 3/8 grades), based on the price of washed wool. For England, we use London prices, Sauerbeck series #32A: merino, Port Philip, average fleece. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 237. For 1892-1913 we take them from the Journal of the Royal Statistical Society.

Meat: Prices are quoted in gold dollars per pound. For the U.S., we use Cincinnati prices. For 1870-1889, we use quotes from the Aldrich Report, part 2, p. 87: bacon, clear. For 1890-1913 we use price quotes from Wholesale Prices 1890-1922, p. 68: pork, cured, short clear sides. For England, we use London prices, Sauerbeck series #14: bacon, Waterford. For 1870-1891, the Sauerbeck prices are quoted in the Aldrich Report, part 1, p. 232. For 1892-1913, we take them from the Journal of the Royal Statistical Society.

Tin: Prices are quoted in gold dollars per pound. For the U.S., we use New York prices. For 1870-1891, these were obtained from the Aldrich Report, part 2, p. 215: Banca pig. We take an average of 4 observations over the year. For 1892-1913 we use price quotes from Wholesale Prices, p. 142: pig. For England, we use London prices, Sauerbeck series #23: Straits. For 1870-1891, the Sauerbeck prices were obtained from the Aldrich Report, part 1, p. 235. For 1892-1913, we take them from the Journal of the Royal Statistical Society.
APPENDIX 2: ANGLO-AMERICAN TRADE SHARES AND AGGREGATE PRICE DIFFERENTIALS.

To construct aggregate Anglo-American price differentials, we used U.S. and British trade shares obtained from two sources.

U.S. trade shares were constructed from: U.S. Department of Commerce, Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1970, (Washington: Government Printing Office, 1976). U.S. import shares were obtained by relating import values of individual commodities, series U 296-316, to total imports, series U 193. U.S. export shares were obtained by relating export values of individual commodities, series U 275-294, to total exports of U.S. merchandise, series 191. These numbers are reported at ten-year intervals in Appendix Table 2.

British trade shares were constructed from: B. R. Mitchell, British Historical Statistics, (New York: Cambridge University Press, 1988). British import shares were obtained by relating import values of individual commodities from pp. 474-480, to total imports from pp. 453-454. British export shares were obtained by relating export values of individual commodities from pp. 481-485, to total domestic exports from pp. 453-454. These numbers are reported at ten-year intervals in Appendix Table 2.

We constructed a number of aggregate price differentials, for different U.S. and British tradable commodity groups. For each of these groups, we constructed two separate aggregates, one using 1880 trade weights and the other using 1910 trade weights.

For U.S. exportable foodstuffs, we used an average of wheat price differentials and meat price differentials, measured as the British price minus the U.S. price, over the U.S. price. Averages were obtained using U.S. wheat & flour export weights and U.S. meat & animal fats export weights from Appendix Table 2, where the weights used were made to sum to one. For U.S. exportable intermediates, we used the price differential for cotton only, measured as the British price minus the U.S. price, over the U.S. price. For U.S. importable manufactures, we used cotton cloths price differentials and iron price differentials, measured as the U.S. price minus the British price, over the British price. Averages were obtained using U.S. cotton textiles import weights and U.S. iron & steel import weights from Appendix Table 2, where the weights used were made to sum to one.

For British importable foodstuffs, we used wheat price differentials and meat price differentials, measured as the British price minus the U.S. price, over the U.S. price. Averages were obtained using British wheat & flour import weights and British meat & animal fats import weights from Appendix Table 2, where the weights used were made to sum to one. For British importable intermediates, we used cotton price differentials only, measured as the British price minus the U.S. price, over the U.S. price. For British exportable manufactures, we used cotton cloths price differentials and iron price differentials, measured as the U.S. price minus the British price, over the British price. Averages were obtained using British cotton textiles export shares and British iron & steel products export shares from Appendix Table 2, where the weights used were made to sum to one.
**APPENDIX TABLE 2: ANGLO—AMERICAN TRADE SHARES 1870—1910**

<table>
<thead>
<tr>
<th>U.S. IMPORT SHARES, percent of total</th>
<th>Sugar</th>
<th>Hides &amp; skins*</th>
<th>Coffee</th>
<th>Raw silk</th>
<th>Cotton manuf.</th>
<th>Rubber iron &amp; steel</th>
<th>Wool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>13.1</td>
<td>4.2</td>
<td>5.5</td>
<td>0.7</td>
<td>5.3</td>
<td>0.7</td>
<td>9.2</td>
</tr>
<tr>
<td>1880</td>
<td>12.0</td>
<td>4.2</td>
<td>9.0</td>
<td>1.6</td>
<td>4.5</td>
<td>1.5</td>
<td>10.6</td>
</tr>
<tr>
<td>1890</td>
<td>12.2</td>
<td>2.8</td>
<td>9.9</td>
<td>2.9</td>
<td>3.8</td>
<td>1.9</td>
<td>5.3</td>
</tr>
<tr>
<td>1900</td>
<td>11.8</td>
<td>6.6</td>
<td>6.1</td>
<td>5.3</td>
<td>4.9</td>
<td>3.6</td>
<td>2.4</td>
</tr>
<tr>
<td>1910</td>
<td>8.6</td>
<td>7.2</td>
<td>4.4</td>
<td>4.2</td>
<td>4.4</td>
<td>6.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tin*</th>
<th>Fruits &amp; nuts*</th>
<th>Wool manuf.</th>
<th>Forest products*</th>
<th>Copper*</th>
<th>Furs*</th>
<th>Tea</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>7.0</td>
<td>1.5</td>
<td>0.1</td>
<td>1.2</td>
<td>3.2</td>
<td>53.0</td>
<td>38.3</td>
</tr>
<tr>
<td>1880</td>
<td>2.8</td>
<td>1.5</td>
<td>0.1</td>
<td>1.2</td>
<td>3.0</td>
<td>44.2</td>
<td>38.3</td>
</tr>
<tr>
<td>1890</td>
<td>2.7</td>
<td>1.6</td>
<td>0.1</td>
<td>1.0</td>
<td>1.5</td>
<td>44.1</td>
<td>44.1</td>
</tr>
<tr>
<td>1900</td>
<td>2.2</td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.3</td>
<td>47.3</td>
<td>47.3</td>
</tr>
<tr>
<td>1910</td>
<td>2.0</td>
<td>1.5</td>
<td>2.6</td>
<td>1.7</td>
<td>0.9</td>
<td>47.3</td>
<td>47.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>60.2</td>
<td>16.0</td>
<td>5.6</td>
<td>3.1</td>
<td>42.6</td>
<td>4.5</td>
<td>0.1</td>
<td>3.4</td>
</tr>
<tr>
<td>1880</td>
<td>25.7</td>
<td>27.4</td>
<td>13.8</td>
<td>6.3</td>
<td>23.2</td>
<td>4.5</td>
<td>0.1</td>
<td>3.4</td>
</tr>
<tr>
<td>1890</td>
<td>29.7</td>
<td>12.1</td>
<td>9.2</td>
<td>6.4</td>
<td>5.5</td>
<td>5.8</td>
<td>0.9</td>
<td>3.2</td>
</tr>
<tr>
<td>1900</td>
<td>17.7</td>
<td>10.3</td>
<td>9.3</td>
<td>6.3</td>
<td>5.3</td>
<td>5.4</td>
<td>4.3</td>
<td>3.4</td>
</tr>
<tr>
<td>1910</td>
<td>25.3</td>
<td>5.6</td>
<td>3.6</td>
<td>6.3</td>
<td>2.8</td>
<td>4.2</td>
<td>5.2</td>
<td>4.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Iron &amp; steel products</th>
<th>Tobacco</th>
<th>Cotton manuf.</th>
<th>Coal*</th>
<th>Fruits &amp; Naval stores</th>
<th>Cars</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>5.6</td>
<td>1.1</td>
<td>0.0</td>
<td>0.3</td>
<td>4.8</td>
<td>13.8</td>
</tr>
<tr>
<td>1980</td>
<td>0.1</td>
<td>1.2</td>
<td>0.0</td>
<td>0.6</td>
<td>23.7</td>
<td>13.8</td>
</tr>
<tr>
<td>1990</td>
<td>5.4</td>
<td>1.2</td>
<td>0.0</td>
<td>0.6</td>
<td>23.7</td>
<td>13.8</td>
</tr>
<tr>
<td>1910</td>
<td>3.5</td>
<td>1.9</td>
<td>0.0</td>
<td>0.6</td>
<td>23.7</td>
<td>13.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BRITISH IMPORT SHARES, percent of total</th>
<th>Grains &amp; Meal, animals</th>
<th>Cotton</th>
<th>Timber</th>
<th>Wool</th>
<th>Butter &amp; margarine</th>
<th>Sugar</th>
<th>Oils &amp; gums</th>
<th>Non-ferr. Silk goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1570</td>
<td>11.3</td>
<td>2.6</td>
<td>17.8</td>
<td>4.4</td>
<td>5.3</td>
<td>2.2</td>
<td>5.6</td>
<td>6.1</td>
</tr>
<tr>
<td>1880</td>
<td>15.3</td>
<td>6.5</td>
<td>10.4</td>
<td>4.2</td>
<td>6.6</td>
<td>2.9</td>
<td>5.8</td>
<td>4.1</td>
</tr>
<tr>
<td>1890</td>
<td>12.7</td>
<td>7.7</td>
<td>12.2</td>
<td>4.2</td>
<td>6.6</td>
<td>3.3</td>
<td>4.3</td>
<td>3.4</td>
</tr>
<tr>
<td>1900</td>
<td>11.3</td>
<td>8.9</td>
<td>7.8</td>
<td>5.3</td>
<td>4.3</td>
<td>3.6</td>
<td>3.7</td>
<td>3.4</td>
</tr>
<tr>
<td>1910</td>
<td>10.7</td>
<td>7.2</td>
<td>10.6</td>
<td>3.9</td>
<td>5.2</td>
<td>4.0</td>
<td>3.6</td>
<td>4.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tea</th>
<th>Hides &amp; skins*</th>
<th>Iron &amp; steel</th>
<th>Rubber</th>
<th>Petroleum</th>
<th>Wine</th>
<th>Tobacco</th>
<th>Dyes</th>
<th>Coffee</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>3.3</td>
<td>2.0</td>
<td>0.6</td>
<td>0.6</td>
<td>0.2</td>
<td>1.6</td>
<td>0.8</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>1880</td>
<td>2.8</td>
<td>1.8</td>
<td>1.0</td>
<td>0.0</td>
<td>0.3</td>
<td>1.6</td>
<td>0.7</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>1890</td>
<td>2.4</td>
<td>1.4</td>
<td>1.1</td>
<td>0.8</td>
<td>0.6</td>
<td>1.4</td>
<td>0.8</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>1900</td>
<td>2.0</td>
<td>1.6</td>
<td>1.4</td>
<td>1.3</td>
<td>1.1</td>
<td>1.0</td>
<td>0.9</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>1910</td>
<td>1.7</td>
<td>1.9</td>
<td>1.3</td>
<td>0.8</td>
<td>0.6</td>
<td>0.7</td>
<td>0.7</td>
<td>0.6</td>
<td>0.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BRITISH EXPORT SHARES, percent of total</th>
<th>Cotton manuf.</th>
<th>Coal</th>
<th>Iron &amp; steel</th>
<th>Wool</th>
<th>Machinery</th>
<th>Chemicals</th>
<th>Non-ferr. metals</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>35.8</td>
<td>2.8</td>
<td>11.8</td>
<td>13.4</td>
<td>2.7</td>
<td>2.6</td>
<td>2.4</td>
<td>28.7</td>
</tr>
<tr>
<td>1880</td>
<td>33.9</td>
<td>3.8</td>
<td>12.2</td>
<td>9.2</td>
<td>4.2</td>
<td>3.9</td>
<td>2.2</td>
<td>30.7</td>
</tr>
<tr>
<td>1890</td>
<td>28.2</td>
<td>7.2</td>
<td>11.8</td>
<td>9.3</td>
<td>6.2</td>
<td>4.6</td>
<td>2.7</td>
<td>29.9</td>
</tr>
<tr>
<td>1900</td>
<td>24.0</td>
<td>13.3</td>
<td>10.9</td>
<td>6.9</td>
<td>6.7</td>
<td>4.5</td>
<td>2.1</td>
<td>31.7</td>
</tr>
<tr>
<td>1910</td>
<td>24.6</td>
<td>8.8</td>
<td>10.2</td>
<td>7.3</td>
<td>6.8</td>
<td>4.3</td>
<td>2.2</td>
<td>35.8</td>
</tr>
</tbody>
</table>

**NOTE:** * The 1860 figure gives the 1882 value.
APPENDIX 3: MODELLING THE ANGLO-AMERICAN ECONOMIES

Some departures from the standard textbook case will, of course, be necessary, but the models which follow will be kept as close to the spirit of Heckscher and Ohlin as possible. The non-traded sector in both economies need to be modelled. Furthermore, the fact that land (a factor of production central to the thinking of Heckscher and Ohlin) is specific to agriculture will introduce an element of Ricardo and Viner into the analysis.

The Britain c1871 Model

There are three sectors in the British model: manufacturing and mining (M), agriculture (A) and services (S). There are in addition four factors of production in the model: labor (L), capital (K), land (R) and imported intermediate goods such as cotton (I). Production in the four sectors is described by the following (CES) production functions:

\[ M = M(L_m, K_m, I_m) \]  \hspace{1cm} (1)
\[ A = A(L_a, K_a, R_a) \]  \hspace{1cm} (2)
\[ S = S(L_s, K_s, M_s) \]  \hspace{1cm} (3)

Capital is taken to be mobile across sectors; land is specific to agriculture; labor is imperfectly mobile between agriculture and the rest of the economy. Migration between town and country is
modelled by means of a pseudo-production function, which transforms raw labor into agricultural and non-agricultural labor:

\[(L_A, L_N) = L(L_t)\]  (4)

where \(L_N\) is non-agricultural labor and \(L_t\) is the total labor force. The function \(L(\cdot)\) has a positive elasticity of transformation which determines how sensitive the allocation of labor is to changes in the rural-urban wage gap. The advantage of this specification is that the wage gap is endogenous.\(^1\)

Britain exports manufactured goods and imports food and intermediates. It is simplest to model Britain as a price taker in world markets, although this assumption could easily be revised. We assume Britain to be a "small" country in the sense that traded goods prices are given to it exogenously. However, the "exogenous" price shocks are determined outside the model by a procedure (Appendix 2) which recognizes the market power of both the Old World and the New in foreign markets (an innocuous simplification which makes the modelling considerably easier).

In 1871 Britain ran a trade deficit; the level of the nominal trade deficit is taken as exogenous. The representative consumer is endowed with land, labor, capital and the foreign exchange required to run the exogenous trade deficit; she

---

\(^1\)This specification is standard in the literature. See Harley (1990) or O'Rourke (1991).
maximises utility, and consumes manufactures, food and services.

The British Data

The British model is parametrized for 1871. The output data are from Deane and Cole (1962, Table 37, p. 166). Output in agriculture, forestry and fishing was 130.4 (all figures in this appendix are in millions of pounds); manufacturing, mining and building output was 348.9; and output in the domestic and personal, housing, government, professional and other service sectors was 397.8.

The Deane and Cole figures are value added. To get gross output, intermediate inputs have to be added to the Deane and Cole figures. Manufacturing uses imported intermediates, taken here to be: timber, cotton, wool, silk, oils, flax, hemp, jute, hides, dyestuffs, rubber, paper materials and petroleum. Imports of these products amounted to 146.2 in 1871 [Mitchell and Deane (1962), pp. 298-99]. Re-exports of 29.6 (p. 304) have to be subtracted from this figure, giving net imports of intermediates of (116.6). Adding this to manufacturing value added yields gross output (465.5).

Services used some inputs from the manufacturing and mining, in particular transportation, which purchased coal. Based on Deane and Cole [Table 55, p. 219], we take this figure to have been 1.4. When added to value added in services, gross output is 399.2.

The 1907 Census of Production showed labor getting 68% of
value added in industry, and capital getting 32% [Bowley (1919), Table VI, p. 45]. Applying these shares to the 1871 data gives labor and capital income in manufacturing (237.3 and 111.6, respectively). Bellerby (1956, Table 1, p. 56) estimates net rents in agriculture at 35.8 in 1870-3. Mitchell and Deane give the 1871 male labor force in agriculture and fishing as 1,634,000 and 47,000, respectively (p. 60). Williamson (1982, Appendix Table 4, p. 48) gives an annual agricultural wage in 1871 of 41.05 pounds, yielding agricultural labor income of 69. The residual, 25.6, is taken to be capital income. Finally, we estimate that labor’s share in services gross output was 0.4882 (Williamson, 1985, Appendix Table D.3, p. 241). Its share of value added was 0.4932. Applying this share to the 1871 data gives labor and capital income in services (196.2 and 201.6, respectively).

Having derived outputs and inputs in all sectors, it only remains to estimate trade flows. Unfortunately, the trade data given in the official statistics are for the United Kingdom, while the output and input data are for Britain alone. Imports of intermediates have already been dealt with. Food imports are calculated from Mitchell and Deane (pp. 298-99). Imports of grain and flour, coffee, sugar, wine, tea, meat and animals, butter and margarine amounted to 102.3 in 1871; re-exports of these products amounted to 7.8 (p. 307), yielding net food imports of 94.5.

Exports of manufactured goods amounted to 177.9 in 1871 (p. 38).
Imports amounted to 7.7 (pp. 298-99), and re-exports to 1.8 (p. 307). Net exports of manufactures thus amounted to 172. In addition coal exports amounted to 2.5 [Deane and Cole, Table 55, p. 219]. Net exports of M-goods thus amounted to 174.5. There was a trade deficit of 36.6 (= 116.6 + 94.5 - 174.5).

Production figures, intermediate input figures and net trade flows yield consumption levels of the four goods. All service output (399.2) was consumed. Consumption of manufactured goods was 289.6 (= 465.5 - 174.5 - 1.4); and consumption of food was 224.9 (= 130.4 + 94.5). Thus, total consumption amounted to 913.7. Factor income amounted to 877.1. The excess of consumption over income equalled 36.6, which was the level of the trade deficit.

Finally, the wage gap between farm and city can be easily estimated. The wage bill in agriculture was 69; the non-rural wage bill was 433.6. Feinstein (1972, Table 60, T131) gives agricultural employment in 1871 (in thousands) as 3120 (= 3060 + 60); and non-agricultural non-defense employment as 10680 (= 14050 -250 - 3120). The implied wage gap is

\[
\frac{w_c}{w_a} = \frac{69}{433.6} \times \frac{10680}{3120} = 0.54.
\]

which is close to that reported by Bellerby (1956), Williamson (1985), Boyer and Hatton (1991) and others.

---

\[2\] Iron and steel, hardwares and cutlery, machinery, non-ferrous metals and manufactures, cotton goods, wool goods, linen goods, silk goods, hats, leather goods and chemicals.
Elasticities

Elasticities of substitution in production are assumed to be: manufacturing, 0.5; agriculture, 1.0; services, 0.5 (all assumed by Williamson, 1985, as well). The elasticity of transformation in the migration function is taken to be 10. The elasticity of substitution in consumer demand is taken to be 1.0.

The U.S. c1869 Model

The American model is similar to the British, but some essential amendments have been added. Most importantly, there is an additional fourth sector in the U.S. which produces intermediates such as cotton and tobacco. Thus, the four sectors are: mining and manufacturing excluding food processing (M); agricultural raw materials (cotton, tobacco, hemp, flax, flaxseed, cotton seed) (I); agriculture, other than I, including food processing, fishing and forestry (A); and services (S). There are three primary factors of production: labor (L), capital (K) and land (R). In addition, tropical products (T) are imported, and are either used as an input into manufacturing (silk, india rubber and guttapercha) or consumed directly (tea and coffee).

Production in the four sectors obeys CES assumptions:

\[ M = M(L_m, K_m, I_m, T_m, A_m) \]  
\[ I = I(L_I, K_I, R_I) \]
\[ A = A(L_a, K_a, R_a) \]  \hspace{1cm} (3)
\[ S = S(L_s, K_s, M_s) \]  \hspace{1cm} (4)

Services are non-traded. The other three goods in the model are traded. U.S. manufactured output is however a less than perfect substitute for foreign manufactured goods in consumption.³

The model is parametrized for 1869 (1870 when necessary), with the data largely taken from the census. In what follows, all figures are expressed in millions of dollars. Some calculations presented below appear to be off by 0.1 due to rounding.

**American Foreign Trade Data**

We start with trade flows, since these data will be used in calculating some of the intermediate flows in the model. Calculating trade flows for 1869 or 1870 is complicated by the fact that during this period the dollar was off the gold standard and the value of the currency fluctuated in terms of gold. All import data were collected in terms of gold. However, export data were collected in terms of gold in the case of exports leaving from Pacific ports, and in currency for all other exports. The result is export data expressed in mixed currency terms (partly gold, partly currency). Happily, in a series of reports written in 1909 and 1910, the U.S. Department of Agriculture converted

³The rationale and procedure for this are identical to those given in Harley (1990). In the trade and development literature, it is known as the Armington specification.
most of these figures into gold terms. In what follows, we will first derive trade figures in gold terms, and then convert these to currency terms, thus making the trade data compatible with the input and output figures elsewhere in the model.

Total imports (gold terms, millions $) in 1869 were 417.5, of which 185.3 were farm products [USDA (1910a), Table 1, p. 6]. The agricultural imports included goods not produced in the U.S., I-sector goods (tobacco), and goods which were produced in the U.S. commodity detail is provided in a USDA report on agricultural imports [1910a, Table 4]. Tropical imports were 65.7.¹ Tobacco worth 2.0 was imported, leaving a residual of other agricultural imports equal to 117.6.

A 1909 USDA report on trade in forest products states that imports in 1869 (in gold) amounted to 14.3. Of this figure, 6.2 was accounted for by tropical goods;² the balance (8.1) was accounted for by imports of forest products also produced in the U.S.

In terms of the model, U.S. imports should be classified into 4 categories: agricultural and food imports (including forestry), agricultural raw materials, manufactures and mining products, and tropical goods. We have covered all the

¹Cochineal, silk, argols, cocoa, coffee and substitutes, vegetable fibers (including Peruvian and Egyptian cotton, which the USDA states were not competing with U.S. agricultural goods), fruit, indigo, vegetable oils (chiefly olive oil), opium, spices and tea.

²Cork, dyewoods, gums (including India rubber), ivory, palm leaf, tanning materials (chiefly hemlock and sumac) and cabinet woods.
agricultural and forestry imports; what about other tropical and manufacturing/mining imports? U.S. imports at the time were classified into the following categories: food and live animals, crude raw materials for domestic industries, semi-manufactures, manufactures, and luxury items. Imports in the latter three categories are taken to be manufacturing imports, and the first category has already been covered. What of crude raw materials? The following 10 items accounted for 90% of this category: unmanufactured fibers, silk, india rubber, hides and skins, wool, cotton, wood, chemicals, furs and skins, and tin [US Department of Treasury, 1903, p. 3279]. The first seven items in this list are agricultural or forestry imports and have been covered. Chemicals are a manufacturing import. This leaves furs, taken to be a tropical import (2.2 in 1870), and tin, taken as a mining import (2.0 in 1870). The 1870 figures for these two items are taken to apply for 1869 also (they are not given for 1869).

Summarizing, in 1869 imports were as follows: agricultural (including forestry): 125.7 (= 117.6 + 8.1); tropical goods: 74.2 (= 65.7 + 6.2 + 2.2); tobacco: 2.0; mining and manufactures: 215.6 (= 417.5 - 125.7 - 74.2 - 2); total: 417.5.

As stated earlier, export data were collected in mixed currency terms. The USDA calculated total, farm and forestry exports in gold terms, using (they say) a conversion rate for mixed currency of $0.727. This conversion rate is not the same as that calculated by Mitchell for currency ($0.752: Mitchell

---

USDA (1909), Table 1, p. 6; USDA (1910b), Table 1, p. 9.
(1908), Table 1, p. 4]. Furthermore, the USDA figures imply total
domestic exports (in gold) in 1869 of 275.2. In currency terms,
total domestic exports amounted to 371.0 [U.S. Treasury (1903),
p. 3249]. This implies a conversion rate of $0.742. In dealing
with the agricultural and forestry data, it will be assumed that
the USDA knew what it was doing; their gold based trade data will
be used; and the resultant trade flows will be converted into
currency terms using the $0.742 rate.

The USDA data imply total exports (in gold, including re-
exports) of 286.1, total farm exports of 212.4, and forestry
exports of 12.2. In mixed currency terms, exports of I-goods
amounted to 183.2. In gold terms, using the $0.742 rate, this
amounts to 135.9.\footnote{\textcopyright{} The $0.727 rate implies 133.2. The difference is clearly not quantitatively significant.} This leaves, in terms of the model,
agricultural exports in gold terms of 88.8 \((= 212.4 + 12.2 -
135.9)\). Mining exports in currency terms amounted to 5.9 [U.S.
Treasury (1903), p. 3249]; in gold this amounted to 4.4.
Manufacturing exports are calculated as a residual, equal to 57
\((= 286.1 - 88.8 - 135.9 - 4.4)\).

Net export flows (1869 gold terms) therefore amounted to:
agriculture: \(-36.9 \,(= 88.8 - 125.7)\); agricultural intermediates:
\(+133.9 \,(= 135.9 - 2)\); tropical goods: \(-74.2\); mining and
manufactured goods: \(-154.2 \,(= 57 + 4.4 - 215.6)\).

The figure for agriculture deserves comment, since it fits
poorly with the wheat invasion story we want to tell. The two
USDA reports referred to give commodity detail on agricultural exports (in mixed currency terms) and imports (in gold terms). Converting both sets of data into gold, we see that the U.S. was a net exporter of the following agricultural products (other than cotton and tobacco): grain, dairy products, hops, oilcake, vegetables, non-tropical forestry products, and packing house products other than hides and skins. The U.S. was a big net importer of live animals, wool, alcohol, rice, seeds, sugar, and hides and skins. The last two items were by far the biggest, especially sugar. Sugar imports totalled 72.4 in gold terms in 1869, accounting for 57.6% of total agricultural imports. Sugar was produced in the U.S. in 1869, but only in tiny quantities: the cane sugar crop was worth $5 m. that year, compared with a total value added in agriculture of $2535 m. [Gallman (1960), Table A-2, pp. 46-7]. It seems sensible to reclassify sugar imports as a tropical import; in terms of the model, the U.S. is then a net agricultural exporter, to the tune of 35.5 in gold terms in 1869. In currency terms, net trade flows were as follows: agricultural products: +47.8; mining and manufactured goods, -207.9 (exports = 82.7, imports = 290.6); tropical goods: -197.6; agricultural intermediates, +180.5. The trade deficit was therefore equal to 177.2.

American Agricultural Data

The data on value added in agriculture are taken from Gallman (1960). Total value added in agriculture in 1869 was
of this, 285 was accounted for by agricultural raw materials (cotton, tobacco, flaxseed, hemp and flax), and 2250 by the A-sector in our model.

According to Gallman (1982, Table 4.8, p. 196), the capital stock in agriculture in 1869 was 2.51 times value added in the sector in that year, or 6362.85 (=2.51*2535). This capital stock includes the value of improvements to farm land. While such improvements clearly constitute capital, they are equally clearly a factor of production specific to agriculture, and as such are analytically closer to land than capital (which in this model is mobile between sectors). These improvements should therefore be subtracted from the agricultural capital stock and treated as 'land', a factor of production specific to agriculture.

To calculate the value of land improvements, use is made of data given in Lindert (1988). First, Historical Statistics gives acres of land in farms by state (series K17-81, p. 460). Lindert gives the percentages of improved land (i) by state (Appendix Table D1), from which we get acres of improved (I) and unimproved land (U) by state. He also gives, by state, the price per acre of improved land (p_i), and the average price of land (p) (improved and unimproved). Within each state, p, p_i and the price of 'raw' land p, must be related to each other according to the relationship

\[ p = i p_i + (1 - i) p_u \]
which enables us to calculate \( p_x \) for each state.\

The value of land improvements is calculated as the sum over states of the term \( (p_x - p)I \), and equals 2538.2. This yields a residual agricultural capital stock of 3824.65. The total value of land (including land improvements) is calculated as the sum over states of the term \( p(I + U) \); it equals 5359.2.

Atack and Bateman (1992, Table 3, p. 8) state that net returns to agricultural capital in the U.S. were 11.8% in 1860-69, and 10.6% in 1870-79. An average return of 11.2% is thus assumed for 1869, for both agricultural capital and land. This implies a return to agricultural capital of 428.4, and a return to land of 600.2. The residual of 1506.4 is taken to be the wage bill in agriculture.

The next step is to disaggregate factor payments between the two sectors. In 1879 the return to capital and land combined on an acre of cotton was $5.87 [Ransom and Sutch (1977), p. 100]. In 1879 14,480,000 acres of cotton [Historical Statistics, series K-533, p. 518] yielded a cotton output of 269 [Gallman, Table A-2, p. 46]. Thus the share of labor in cotton was 0.684 (= 1 - (5.87*14.48/269)). Assuming that the same labor share applied in 1869, labor got 194.9 (= 0.684*285) in I. Labor therefore got 1311.5 (= 1506.4 - 194.9) in A.

The value of improved land in 1869 can be calculated from the Lindert data as 4140; this yielded income of 463.7. In 1869

* The weighted average of improved land prices is $21.91; that of raw land prices is $5.57; and that of average prices is $13.14.
there were 188.9 million acres of improved land in farms [U.S. Census]; in 1870 there were 9.662 million acres of land in cotton and tobacco [Historical Statistics, series K-553, K-424]. Rounding this up to 10 million acres, to take account of other crops, yields a land input in I of 24.5 (= 463.7*10/188.9) and an input in A of 575.7 (= 600.2 - 24.5).

Capital inputs in the two sectors are calculated as residuals. Capital income in agricultural intermediates equalled 65.6 (= 285 - 24.5 - 194.9); capital income in other agriculture equalled 362.8 (= 2250 - 1311.5 - 362.8).

To these figures for A we have to add figures for the fishing and food processing industries. In 1869, output in the fishing industry was 11.1, with wages of 3.4 and materials of 1.6 [U.S. Census]. Value added in fishing was therefore 9.5; subtracting the labor income gives a residual capital income of 6.1.

Finally, we have to add food processing onto the A-sector. The U.S. Census contains information on all industries, including value of output and materials, the wage bill, and the capital stock. Data for the food processing industries were extracted from the Census industry tables.* In 1869 their output came to 870.3; they used 672.6 in materials, and their wage bill was

* The following were regarded as food processing industries: baking powder, bread, butchering, cheese, cider, chocolate, confectionery, cordials, fish, flour, food preparations, canned and prepared fruits and vegetables, grease and tallow, liquors, malt, cured and packed meat, minerals and soda water; mustard, animal, fish, vegetable and castor oils; small beer, sugar, and vinegar.
44.3. Value added in the industries thus amounted to 197.7; capital income in the industries amounted to 153.4 (= 197.7 - 44.3).

Adding the figures for fishing and food processing onto the previous figures, we get totals for the A-sector of:
output: 2457.2; labor input: 1359.2; capital input: 522.3; land input: 575.7.

American Mining and Manufacturing Data

The Census of Mining reports mining output as 152.6 in 1869, a materials input of 14.3 (taken to be manufactured goods), and a wage bill of 74.5. The residual, 63.8, is taken to be the return to capital in the industry. Net mining exports amounted to 3.2 (see above); mining inputs into manufacturing were thus 149.4 (= 152.6 - 3.2).

The Census of Manufactures reports manufacturing output in 1869 as 4232.3; the wage bill is 775.6, and the materials bill is 2488.4. Subtracting the food processing sector figures, we get output in manufacturing of 3362.0; a materials bill of 1815.8; and a wage bill of 731.3. Capital income in manufacturing is taken as a residual, equal to 814.9 (= 3362 - 1815.8 - 731.3).

It remains to calculate inputs of the various other goods in the model into manufacturing. The mining input was 149.4, as stated above. Tropical imports in 1869 were 197.6, of which 171.2 were goods such as tea, sugar and coffee which were consumed; the balance (26.4) were goods such as india rubber and silk which
were used as an input into manufacturing. Output in the I-sector amounted to 285, and net exports of I-goods came to 180.5. The balance (104.5) was taken to be an input to manufacturing.

Finally, there were inputs of agricultural goods into the manufacturing sector, chiefly wool, wood and hides and skins. Forest products output was 97.4. Net exports were 4.2 in gold, 5.6 in currency. Inputs into manufacturing were taken to be 91.8 (= 97.4 - 5.6). Wool output amounted to 36; and 7.6 worth of wool was imported net in 1869 in currency terms. Wool inputs to industry were thus taken to be 43.6 (= 36 + 7.6).

In 1869, the tanned leather industry used materials worth 63.1, of which 52.3 (82.9%) were hides and skins (Census of Manufactures). The curried leather industry used materials worth 43.6, of which 6.8 were hides and skins (33.8 was accounted for by leather). If these two industries accounted for the bulk of the use of hides and skins, then total use of these materials amounted to 59.1. Agricultural inputs into manufacturing thus totalled 194.5.

Summarizing, of a total materials input of 1815.8, mining inputs were 149.4; tropical products were 26.4; I-sector goods were 104.5; and agricultural products were 194.5. Residual inputs, taken to be from manufacturing, thus amounted to 1341.

Finally the figures for mining and manufacturing have to be aggregated. Inputs from mining and manufacturing into the two sectors are netted out; the final figures are: output = 2009.9 (= 152.6 - 14.3 + 3362 - 1341 - 149.4); labor input = 805.8 (= 74.5 +
capital input = 878.7 (= 63.8 + 814.9); tropical goods input = 26.4; agricultural input = 194.5; inputs of agricultural raw materials = 104.5.

**American Service Sector Data**

Value added in services was 2925.9 [Gallman and Weiss (1969), p. 306]. Services as defined by Gallman and Weiss, however, includes figures for the smithing trades taken from the Census of Manufactures and included in the M-sector in this model. Value added in the blacksmith, coppersmith, gunsmith and locksmith industries was given in the Census as 30.7; value added in the S-sector in this model is therefore 2895.2.

Gallman and Weiss give total materials consumption in services as 115.1. From this materials consumption in the smithing industries (=14.4) has to be subtracted, giving total materials consumption of 100.7. Inputs ate taken to be from the M-sector; they have to be added on to services value added to give gross output, equal to 2995.9.

Another problem arises in trying to determine labor and capital shares in the two sectors. The approach used here is to take Gallman's capital/value added ratios for the various service sectors [Gallman (1982), Table 4.8, p. 196] and apply these to the value added figures from Gallman and Weiss to get capital stocks in the two sectors. Then a rate of return is assumed, giving capital income in the two sectors. Labor income is derived as a residual.
The capital/value added ratio in transportation and utilities was given by Gallman as 4.27; value added in the sector was 491.3; the capital stock in the sector was therefore 2098. Capital/value added ratios in government and education (value added = 158.3) were 1.27; in farm and non-farm residences (value added = 711) 6.28; and in commerce and other private business, 0.45 (the latter ratio was assumed to apply to all service sectors other than government, education and housing; namely, trade, finance, professional and personal services, and hand trades other than those smithing trades included in M; their joint value added was 1534.6). This yields a capital stock in services of 7455. Attack and Bateman (1992, Table 4, p. 9) give rates of return in a variety of service industries; an average rate of return of 10% seems a reasonable one to pick. This implies a capital income of 745.5 in services, and a labor income of 2149.7 (= 2895.2 – 745.5).

**American Consumption Flows Data**

These are easily calculated given the above data. For each good, take output, add net imports (subtract net exports), subtract inputs into other sectors, and the residual has to be consumption of the good (ignoring changes in inventories). The results are as follows: manufacturing, 2117.1 (consumption of U.S. manufactures = 1909.2; consumption of foreign manufactures = 207.9); agricultural products, 2214.9; services, 2995.9; tropical goods, 171.2.
Aggregate consumption equals 7499.1. Aggregate value added equals 7321.9. The difference, 177.2, equals the trade deficit, as expected.

American Wage Gaps

Finally, in some versions of the model, labor will earn different returns in agriculture than elsewhere in the economy. The wage bill in the two agricultural sectors amounted to 1506.4. The wage bill outside agriculture was 2955.5. Lebergott (1964, Table A1) gives total US employment (12,930,000) in 1870, and employment in the agricultural (6,790,000) and fishing (28,000) sectors. Employment in food-processing (161,000) can be calculated from the Census of Manufactures, and should be added to agricultural employment. Employment in the A and I sector in the model therefore amounted to 6,979,000; and non-agricultural employment was therefore 5,951,000. These figures imply that agricultural wages were only 43.5% of non-agricultural wages. They would be somewhat bigger if the comparison was restricted to the unskilled only (and it would be consistent with that of Hatton and Williamson (1991) on Michigan in the 1890s, about 50%).

American Elasticities

These are taken to be the same as in Harley (1990). Elasticities of substitution in production are: manufacturing, 0.45; agriculture, 1.0; intermediates, 1.0; services, 0.1. The
elasticity of transformation in the migration function is taken to be 10 (as in the British case). The "top level" elasticity of substitution in domestic consumption is taken to be 1.0. The elasticity of substitution between domestic and foreign manufactured goods is taken to be 5.

It should be said that the results do not appear to be sensitive to the precise elasticities chosen; rather, they hinge on relative factor proportions in the different sectors.
APPENDIX 4: APPORTIONING PRICE SHOCKS

Obviously, a decline in transport costs raises prices in the exporting region and lowers prices in the importing region. But did the convergence of Anglo-American prices due to the decline in transport costs in the late 19th century impact more on British or American prices? The answer clearly depends on the elasticities of supply and demand in the two regions.

Let $X_e$ and $X_i$ represent production of the good in question in the exporting and importing regions respectively; let $C_e$ and $C_i$ be consumption of the good in the two regions; let $p_e$ be the price of the good in the exporting region; and let $t$ be the transport cost wedge between prices in the two regions. Thus, the price in the importing region equals $p_e(1+t)$. If the two regions together comprise the whole world, or if there is no trade in this good between these two regions and the rest of the world, then it has to be the case that

$$X_e[p_e] + X_i[p_i(1+t)] = C_e[p_e] + C_i[p_i(1+t)] \quad (1)$$

Totally differentiating this expression, we obtain (after some simple manipulation):

$$\epsilon^x X_e dp_e/p_e + \epsilon^x X_i [dp_e(1+t)/p_e + dt] =$$
$$\epsilon^o C_e dp_e/p_e + \epsilon^o C_i [dp_e(1+t)/p_e + dt] \quad (2)$$

where $dt$ is the (negative) change in the transport cost wedge.
It is a simple matter to calculate the effects of a decline in transport costs on prices in the exporting and importing regions. Defining units such that the initial $p_x$ equals one, the percentage change in the export-region price is simply $dp_x$; the percentage change in the import-region price is $dp_x(1+t) + dt$. Therefore, we need only use (2) to calculate what $dp_x$ must be, given $dt$.

To do this we need the following data: quantities of the good produced and consumed in the importing and exporting regions; and the elasticities of demand and supply in the two regions.

What are the relevant regions? This is clearly a matter of judgement. If we take the view that the major goods flows were of food and raw materials into Europe, and exports of manufactures, from Europe, and that the major impact of transport cost decline during this period was to reduce transport costs between Europe and the rest of the world, then it makes sense to take Europe and the rest of the world (or perhaps Europe and the frontier economies) as the two regions; this certainly seems to make more sense than to only look at Britain and the U.S.

We take Europe and the rest of the world as the two relevant regions in equation (2) above. Thus, for food and raw materials the importing region is Europe, and the exporting region is the rest of the world; for manufactures, Europe is the exporting region and the rest of the world is the importing region. In what follows, we indicate the sources of the data used to infer the incidence of the price shock. These data (and hence the
apportioning of shocks) are, of course, rough, but they should serve to offer a plausible intermediate case to the upper and lower bounds reported in the text.

The transport cost wedges in 1870, 1895 and 1913 are given below; 'I', 'M' and 'F' stand for cotton, manufactures and food respectively. We calculate transport cost shocks for both 1870-1895 and 1870-1913. In all cases, initial wedges are 1870 wedges; thus, the figures below can be used to calculate the relevant 'dt'. Because the composition of U.S. exports was not identical to that of U.K. imports, and vice versa, the transport cost wedge for food and manufactures will look different from the U.K. and U.S. perspective. It makes sense to use the U.S. food exportable wedge when calculating the change in the U.S. food export price, and to use the U.K. food importable wedge when calculating the change in the U.K. food price; and similarly for manufactured goods.

<table>
<thead>
<tr>
<th>Year</th>
<th>US EX.I</th>
<th>US IM.M</th>
<th>US EX.F</th>
<th>UK IM.I</th>
<th>UK EX.M</th>
<th>UK IM.F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>0.133</td>
<td>0.566</td>
<td>0.519</td>
<td>0.133</td>
<td>0.313</td>
<td>0.568</td>
</tr>
<tr>
<td>1895</td>
<td>0.112</td>
<td>0.347</td>
<td>0.330</td>
<td>0.112</td>
<td>0.146</td>
<td>0.360</td>
</tr>
<tr>
<td>1913</td>
<td>0.097</td>
<td>0.089</td>
<td>0.106</td>
<td>0.097</td>
<td>0.026</td>
<td>0.114</td>
</tr>
</tbody>
</table>

**Food**

We take wheat to be the prototypical food, both because it bulked so large in world trade, and because the data are readily available. In millions of imperial quarters, production in the exporting regions was 145, and in the importing regions 123;
consumption in the exporting regions was 124.4, and in the importing regions 143.6 (Harley, 1980, Table 5, p. 228). The elasticity of demand was taken to be -0.3, and the elasticity of supply 1.0 (Harley, 1986, p. 604).

Over the period 1870-1895, the data above imply a change in the European price of -0.0857, and a change in the U.S. price of 0.0720. Over the period 1870-1913, the change in the European price is -0.1870, and the change in the U.S. price is 0.1578.

Manufactures

According to Bairoch, Europe accounted for 61.3% of world manufacturing output in 1880. Britain accounted for 22.9% of the world total (Bairoch, 1982, Table 10, p. 296). Output in British manufacturing, mining and building amounted to £395.9 m. in 1881, or $1926.7 m (Deane and Cole, 1962, Table 37, p. 166). This implies a world output of $8413.5 m., a European output of $5157.5 m., and a non-European output of $3256.0 m.

According to Yates (1959, Table A20, p. 228), European exports of manufactures amounted to $2155 m. over the period 1876-1880; European manufactured goods imports amounted to $1005 m. over the same period. These figures include intra-European trade; however, when calculating net exports for Europe as a whole, these internal flows will cancel out; European net exports were thus $1150 m. over the period. This implies European consumption of manufactures of $4007.5 m., and non-European consumption of $4406 m.

We have not been able to find good estimates of supply and
demand elasticities for the manufacturing sector as a whole. The
best alternative seems to be to adopt the elasticities embodied
in the models used here. Since demand is assumed to be Cobb-
Douglas, the demand elasticity is -1.0. Starting from the
benchmark equilibrium of the British model, when the price of
manufactures is increased by 10%, the output of British
manufactures rises by 11.9%, implying a supply elasticity of
1.19. This implied supply elasticity is assumed to hold for both
countries in assigning incidence of the price shock.

The price shocks implied by the above data are:
UK, 1870-1895: +0.0658
UK, 1870-1913: +0.1131
US, 1870-1895: -0.0961
US, 1870-1913: -0.2094

**Cotton**

We treat the apportionment for cotton prices differently,
and the reader can find that discussion in the text.
Appendix Table 3.1

Estimated Factor Intensities: Share of Input Costs in Gross Output ($\theta_{12}$)

<table>
<thead>
<tr>
<th>Industry</th>
<th>$\theta_L$</th>
<th>$\theta_M$</th>
<th>$\theta_N$</th>
<th>$\theta_I$</th>
<th>$\theta_A$</th>
<th>$\theta_C$</th>
<th>$\theta_W$</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States c. 1869</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.401</td>
<td>0.437</td>
<td></td>
<td>0.052</td>
<td>0.097</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.553</td>
<td>0.213</td>
<td>0.234</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0.684</td>
<td>0.230</td>
<td>0.086</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>0.718</td>
<td>0.249</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.34</td>
</tr>
<tr>
<td>Great Britain c. 1871</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.510</td>
<td>0.240</td>
<td></td>
<td>0.250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.529</td>
<td>0.196</td>
<td>0.275</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>0.491</td>
<td>0.505</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
</tr>
</tbody>
</table>

Source: See text for notation and sources.
Appendix Table 3.2
Estimated National Accounts

<table>
<thead>
<tr>
<th>Industry</th>
<th>Gross Output</th>
<th>L</th>
<th>K</th>
<th>R</th>
<th>I</th>
<th>A</th>
<th>T</th>
<th>M</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States c. 1869</strong> ($m.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>2009.9</td>
<td>805.8</td>
<td>878.7</td>
<td>104.5</td>
<td>194.5</td>
<td>26.4</td>
<td></td>
<td>1684.5</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2457.2</td>
<td>1395.2</td>
<td>522.3</td>
<td>575.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2457.2</td>
</tr>
<tr>
<td>I</td>
<td>285.0</td>
<td>194.9</td>
<td>65.6</td>
<td>24.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>285.0</td>
</tr>
<tr>
<td>S</td>
<td>2995.9</td>
<td>2149.7</td>
<td>745.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.7</td>
<td>2895.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7748.0</td>
<td>4509.6</td>
<td>2212.1</td>
<td>600.2</td>
<td>104.5</td>
<td>194.5</td>
<td>26.4</td>
<td>100.7</td>
<td>7321.9</td>
</tr>
<tr>
<td><strong>Britain c. 1871</strong> (£m.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>465.5</td>
<td>237.3</td>
<td>111.6</td>
<td></td>
<td>116.6</td>
<td></td>
<td></td>
<td></td>
<td>348.9</td>
</tr>
<tr>
<td>A</td>
<td>130.4</td>
<td>69.0</td>
<td>25.6</td>
<td>35.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>130.4</td>
</tr>
<tr>
<td>S</td>
<td>399.2</td>
<td>196.2</td>
<td>201.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
<td>397.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>995.1</td>
<td>502.5</td>
<td>338.8</td>
<td>35.8</td>
<td>116.6</td>
<td></td>
<td></td>
<td>1.4</td>
<td>877.1</td>
</tr>
</tbody>
</table>

**Source:** See text for notation and sources.
APPENDIX REFERENCES


Wesley Mitchell (1908), Gold, Prices, and Wages Under the
Greenback Standard (Berkeley, Calif.: The University of California Press).


P. Lamartine Yates (1959), Forty Years of Foreign Trade (New York: Macmillan).