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THE HECKSCHER-OHLIN MODEL BETWEEN 1400 AND 2000: WHEN IT EXPLAINED FACTOR PRICE CONVERGENCE, WHEN IT DID NOT, AND WHY

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ABSTRACT

There are two contrasting views of pre-19th century trade and globalization. First, there are the world history scholars like Andre Gunder Frank who attach globalization "big bang" significance to the dates 1492 (Christopher Colombus stumbles on the Americas in search of spices) and 1498 (Vasco da Gama makes an end run around Africa and snatches monopoly rents away from the Arab and Venetian spice traders). Such scholars are on the side of Adam Smith who believed that these were the two most important events in recorded history. Second, there is the view that the world economy was fragmented and completely de-globalized before the 19th century. This paper offers a novel way to discriminate between these two competing views and we use it to show that there is no evidence that the Ages of Discovery and Commerce had the economic impact on the global economy that world historians assign to them, while there is plenty of evidence of a very big bang in the 19th century. The test involves a close look at the connections between factor prices, commodity prices and endowments world wide.

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I. Global Trade and Global History

This is a paper about intercontinental trade, since factor proportions differ far more between continents than within. Long distance intercontinental trade was also the economic event which motivated the theoretical work of Bertil Ohlin. In the words of Harry Flam and June Flanders (1991, p. 26) “the Heckscher-Ohlin model ... is concerned with the gains from trade and world benefits of trade when factor endowments are very different ...” Indeed, the first and most frequent example offered by Ohlin to illustrate his argument is land-abundant Australia trading with land-scarce Europe (Flam and Flanders 1991, pp. 90-92), while Eli Heckscher spoke of trade between land-abundant America and labor-abundant Europe to illustrate his (Flam and Flanders 1991, pp. 56-60).

The key insights of Heckscher and Ohlin were that factor endowment differences could be a basis for trade, and that trade could lead to factor price convergence between trading partners (or, Heckscher argued, factor price equalization). These Swedish economists, one a theorist and one a historian, were motivated by late 19th century intercontinental trade, when the regions of recent settlement (as the League of Nations would later call them) shipped ever-increasing quantities of food and raw materials to the capital- and labor-abundant European continent. We have argued in previous work that Heckscher and Ohlin were right insofar as the late 19th century was concerned since commodity price convergence did induce some factor price convergence (O’Rourke and Williamson 1994; O’Rourke, Taylor and Williamson 1996; O’Rourke and Williamson 1999, Chapter 4).[1] But was their model only relevant to that period of history which motivated its Swedish founders in the first place, or can it help us understand the evolution of factor prices in other periods as well?

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[1] We also found, but did not emphasize, that Knut Wicksell was wrong. Wicksell argued that trade would lead to a decline in the demand for Swedish labor and thus, we take it, in the real wage (Flam and Flanders 1991, p. 7). In fact, CGE models suggest that commodity price convergence vis à vis America would have led to a <u>rise</u> in Swedish real wages (O’Rourke and Williamson 1995).

In order for trade to influence factor prices, two things have to be true. First, trade-creating forces have to change domestic commodity prices. Second, the changes in domestic commodity prices have to induce a reshuffling of resources between sectors. This paper offers powerful evidence that these conditions were not always satisfied. Indeed, they only began to be satisfied less than two centuries ago. Like most economic paradigms, the Heckscher-Ohlin model can only help us understand some phases of world history, not all.

Long distance trade between continents developed as transport costs, monopoly, government intervention, and international conflicts declined. Initially, only goods with very high value to bulk ratios were shipped, like silk, exotic spices and precious metals. The range of goods traded extended over time, but it was not a gradual evolution, but rather a history punctuated by abruptly changing trade regimes. In fact, the six centuries from 1400 to the present trace out three very distinct eras of commodity exchange and specialization. Long distance trade in the pre-18th century period was strictly limited to what might be called non-competing goods: Europe imported spices, silk, sugar and gold, which were not found there at all, or were in very scarce supply; Asia imported silver, linens and woolens, which were not found there at all (with the important exception of Japanese silver before 1668). Ronald Findlay (1996, pp. 53-54) reports that Dutch exports of precious metals to Asia accounted for between a half and two-thirds of the value of Asian products imported into Europe by the Dutch East India Company (hereafter, VOC: Vereenigde Oostindische Compagnie, established 1602). Almost by definition, these non-competing goods were very expensive in importing markets, and thus could bear the very high cost of transportation from their (cheap) sources.

There are two contrasting views on this pre-18th century trade in the literature. First, there are the world history scholars like Andre Gunder Frank (1998) who attach globalization “big bang” significance to the dates 1492 (Christopher Colombus stumbles on the Americas in search of spices) and 1498 (Vasco da Gama makes an end run around Africa and snatches monopoly rents away from the Arab and Venetian spice traders). Such scholars are on the side of Adam Smith who believed that these were "the two most important events in recorded history" (Tracy 1990, p. 3), although Smith was writing those words before the industrial and transport revolutions of the 19th century. One well-known scholar of the early modern world, James Tracy, expressed his skepticism with the 1490s big bang theory this way: "What remains ... in doubt is the contemporary *impact* or *significance* of these new configurations of long-distance trade" (Tracy 1990, p. 2, emphasis added), and "it is far less clear what meaning the new connections had for those who lived in the sixteenth or even the seventeenth century" (Tracy 1990, p. 3). Second, there is the contrasting view of the economic historians who now "argue that long-distance trade has been overemphasized by students of the early modern period[, that] the international economy was poorly integrated before 1800, [and] that if there was a transport revolution ... it happened then in the nineteenth century" (Menard 1991, pp. 228 and 272).

This paper offers, we think for the first time, a way to discriminate between these two competing views and we will use it to conclude that there is precious little evidence that the age of discovery, and the age of commerce that followed, had the economic impact on the global economy that world historians seem to assign to it, while there is plenty of evidence of a very big bang in the 19th century. Although it is commodity price convergence that matters, historians rarely look for evidence of such convergence or its absence. They look instead at shipping technologies, port histories, the evolution of trading monopolies, the rise and fall of trade routes and so on. Such evidence may or may not correlate with commodity price convergence, but we see no evidence documenting significant pre-19th century global price convergence for the (competing) commodities that really mattered to the economic lives of the vast majority. Nor do we see any evidence of significant commodity price convergence even for those (non-competing) commodities that mattered little to the vast majority. And trade theory tells us that if a country's relative commodity prices are little affected by such external events, then its consumption, production and factor income distribution will also be little affected. This inference follows regardless of how colorful are the tales of explorers, discoverers, sea battles, plunder, pirates, flows of gold, flows of silver and the immense spice trade profits that fill our history books. However colorful, those are tales about rent-seeking, not about the integration of global commodity markets.

The second era starts in the early 19th century with the rise of trade in "basic" competing goods such as wheat and textiles, preceded by an 18th century transitional phase sprinkled with trade in furs, tobacco and cotton. The 19th century is the classic Heckscher-Ohlin era of spectacular transport cost declines, commodity price convergence, and a big income distribution impact on long distance trading partners. The third era contains the present, decades which have seen trade in both basic and highly differentiated manufactured commodities. The power of the Heckscher-Ohlin model is more difficult to identify in this period, characterized as it is by the rising dominance of skills and new technologies, than it is in the previous era of more stable technologies during which endowments of land, labor and capital mattered most. Since there are many economists present at this conference who know better than we how well the Heckscher-Ohlin model has performed in the second half of the 20th century, this paper will dwell instead on the experience between 1400 and 1940: we shall generously give them 60 years while keeping 540 years to ourselves.

World historians don't view these 540 years the way we do, perhaps because they rarely offer an explicit economic model that can be used to organize global history, and because they rarely offer any systematic evidence supporting their view that "there was a single global world economy with a worldwide division of labor and multilateral trade from 1500 onward" (Frank 1998, p. 52) and that, even before 1500, "trade networks reached almost all regions of Eurasia and sub-Saharan Africa and large volumes of commerce encouraged specialization of agricultural and industrial production" (Bentley 1999, p. 7). Heckscher-Ohlin theory offers an elegant model for organizing global history, and it shows what happens when we put some empirical content into world history rhetoric. The model suggests that there are three metrics that can be used to organize the history between 1400 and 1940. First, when were the price shocks emanating from global integration, long distance trade and commodity price convergence biggest? Second, when was the output mix of trading economies most responsive, and their income distribution most vulnerable, to these globalization-induced price shocks? And thus, third, when were the political implications of globalization – e.g., policy backlash – most likely to have been manifested?

Section II reviews the Heckscher-Ohlin model in order to motivate the empirical analysis which follows. We argue that Bertil Ohlin had a 3x2 model in mind, not the stripped down 2x2 version, and the added sector-specific factor turns out to be critical to many of our findings. Sections III and IV offer evidence which, we hope, establishes the superiority of our dating of global history over that of Andre Gunder Frank and other world historians. Section V offers the key test of our central proposition. Here we explore almost four centuries of English experience with relative factor prices, commodity prices and factor endowments. We expect to find the terms of trade between agriculture and industry (relative commodity prices) and the wage-rental ratio (relative factor prices) closely tied to the land-labor ratio (relative endowments) in the 16th, 17th and 18th centuries, while we expect to find far more independence between them after the French Wars and the dismantling of the Corn Laws. If we are right, then the date for big bang theories of global economic history should be the 1820s, not the 1490s. Section VI expands the evidence regarding the connection between trade and factor income distribution by exploring the impact of globalization on wage-rental ratios the world around in the seven decades between 1870 and 1940, as land-scarce continents traded competing commodities with land-abundant continents, events which motivated Eli Heckscher and Bertil Ohlin in the first place. Section VII offers some concluding remarks.

II. Heckscher-Ohlin-Samuelson Economics versus the Economics of Ohlin

In his introduction to the Flam and Flanders edition of Heckscher's and Ohlin's original contributions, Paul Samuelson graciously regretted that Ohlin had left to Samuelson's own generation the 'easy pickings' of such low-dimensional models as the 2x2 Heckscher-Ohlin-Samuelson model. As the title of Samuelson's (1971) article, 'Ohlin was right', suggests, had Ohlin chosen to formulate such a model it would more likely have been the specific factors rather than the 2x2 model which bears his name today. Although we are not historians of economic thought, it seems clear to us that Ohlin's insistence that trade would lead to factor price convergence across countries (but not equalization) can be explained by the features of the late 19th century economy which he was trying to describe: an economy in which trade could and did influence income distribution, but in which factor price differences continued to provide an incentive for intercontinental factor mobility, which in turn led to further factor price convergence.

The late 19th century Atlantic economy saw unprecedented levels of international migration and capital transfers: 60 million Europeans sailed to the New World in the century following 1820 (Hatton and Williamson 1998),[2] while as a percentage of GDP, international capital flows in the years before the Great War attained levels never matched before or since (Obstfeld and Taylor 1998). Moreover, the trade flows which characterized that era largely took the form of the New World exchanging agricultural products for European manufactured goods: land was a crucial factor of production then, in addition to labor and capital. Both of these stylized facts are more easily captured in a 3x2 model, than in a 2x2 model.[3] More than thirty years ago, Peter Temin wrote a paper on the antebellum American economy in which he assumed that manufactured goods were produced with labor and capital, while food was produced with labor and land (Temin 1966). This specific factors model was fully developed shortly thereafter by Ronald Jones (1971), who thanks Robert Fogel in a footnote for bringing Temin's article to his attention. We draw attention to the cliometric antecedents of this model, not just out of team spirit, but in order to highlight a

[2] Heckscher had to grapple with this fact while developing his argument that trade equalizes factor prices (Flam and Flanders 1991, pp. 58-59).

[3] Is it a coincidence that the 2x2 model was developed and popularized by American economists writing after 1945, by which time agriculture had shrunk in importance in developed countries, even in land-abundant ones like the United States?

theme of the present paper: the ‘correct’ trade model may vary with the period being studied.

Within the context of this model, what are the determinants of factor prices, and in particular of the wage-rental ratio? First, take the Heckscher-Ohlin open economy case, in which commodity prices are determined in world markets and thus are exogenous to the individual (small) economy. Endowments matter: increases in either the capital-labor or land-labor ratio will push up wages, lower land rents, and increase the wage-rental ratio. Commodity prices matter too: when the ratio of agricultural prices to manufactured goods prices rises, wage-rental ratios fall. The specific factors model is quite explicit about which factor price should do the most adjusting: the magnification effect identified in the 2x2 model will apply to sector-specific factors, but not to the mobile factor (Jones 1971, p. 9). Thus, returns to specific factors such as land rents should change proportionately by more than returns to mobile factors such as labor. Finally, technological progress may change the wage-rental ratio. Many economic historians have argued that technological change in the Old World was labor-using and land-saving during the late 19th century, whereas technological change in the New World was labor-saving and land-using (Habakkuk 1962; Hayami and Ruttan 1971; David 1975; O’Rourke, Taylor and Williamson 1996), implying that technological progress should have raised wage-rental ratios in Europe but lowered them in the New World.

Second, take the closed economy case, in which commodity prices are determined in local markets. An increase in the land-labor ratio will increase the relative supply of food and lower its relative price, while it will still increase the wage-rental ratio. As in the open economy, there should be a negative correlation between the wage-rental ratio and the relative price of food. But in the closed economy, the correlation is not causal: rather, both price ratios are determined by factor endowments. Is this the better description of historical reality until the 19th century, or was the open economy Heckscher-Ohlin model relevant from 1490s onwards?

III. The First Era: Non-Competing Goods and the Absence of Commodity Price Convergence

Long time series documenting early modern intercontinental commodity price convergence, or the presumed sharp fall in transport costs, are very scarce. This section summarizes what little we have, but none of it supports the view that global trade ties between continents -- as we and Ohlin have defined them -- rose dramatically during the three centuries after the 1490s and prior to the 1820s when the French Wars had ended.

Was There a Transport Revolution in the North Atlantic Before 1800?

The best summary we have seen dealing with the evolution of transport costs in the North Atlantic prior to the early 19th century is by Russell Menard (1991),[4] and he finds very little evidence favoring a transport revolution. Of course, our interest is, and Ohlin's interest was, commodity price convergence, and thus we care less about its sources. Menard's focus is on freight costs and the role of productivity advances in transportation in reducing them. Still, Menard's freight cost indices offer very mixed evidence with no unambiguous support either for a pre-18th century transport revolution or for commodity price convergence

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We start with the most negative evidence, the sugar trade of Barbados and Jamaica with London, and the rice trade of Charleston with England. Menard (1991, Table 6.6, p. 264) documents stability in the peacetime real freight charges on sugar between the 1650s and the 1760s, deflating the nominal charges by the Brown-Hopkins consumer price index. But if sugar prices in Barbados and Jamaica fell more than did the CPI in England, the rise in Menard's real freight rate index would be understated and its fall overstated. Apparently sugar prices did fall by more (Mechner 1999, Figure 2.2, p. 58a; McCusker and Menard 1991,

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[4] Much of Menard's evidence is taken from James Shepherd and Gary Walton (1972), but these scholars did not deflate their nominal indices as has Menard.

Figure 7.1, p. 158). In short, "the sugar trade offers little support for the notion of a European transport revolution" (Menard 1991, p. 267) in the North Atlantic prior to the 19th century. The rice trade also shows no fall in real freight rates between the 1690s and the 1760s, although it did undergo an impressive decline thereafter (Menard 1991, Table 6.8, pp. 268-9). Once again, if rice prices in Charleston fell by more than the CPI in England, then this late 18th century decline in freight rates is overstated, an offset that would have been greatly reinforced by rising insurance charges in the more hostile world of the French Wars.

Menard offers a freight rate index for the wine trade between Bordeaux and London, from the 1290s to the 1660s (Menard 1991, Table 6.1, pp. 241-2). His index rises up to the 1490s, rather than falls, and remains relatively high until the 1550s. No transport revolution here, but rather a transport regression. For the next century, however, the index drops sharply. Yet, that big drop is not caused by a fall in nominal freight charges, since they did not fall: nominal freight charges ranged from 20.3 to 40.2 between the 1530s and the 1550s, and from 24 to 37.5 between the 1620s and 1660s. It is the huge surge in the Brown-Hopkins consumer price index between the 1550-54 and 1616 that drives down Menard's real freight rate. Here again, why deflate by the CPI? Since our interest is solely in commodity price convergence, we should deflate by the price of wine. Did it rise less than the CPI, an index that excludes wines entirely and is dominated by grains (Brown and Hopkins 1981, pp. 32-59)? Unfortunately, Margery James (1971, pp. 37 and 60-63) does not report wine prices for the early modern period, so we cannot pursue this issue for that crucial half-century 1550-54 to 1616. However, we note that there was absolutely no fall in the real freight index on the wine trade connecting Malaga and London between the 1590s and the 1680s (Menard, 1991, Table 6.10, p. 273), a period when, as we have seen, the wine trade between Bordeaux and London recorded a big fall in real transport charges.[5]

The best case for a North Atlantic pre-19th century transport revolution can be found in the case of

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[5] There was a fall, however, in real freight rates on the Lisbon/Oporto wine run to London across the 18th century.

tobacco. Between 1618 and 1775, freight charges on tobacco shipments from the Chesapeake to London fell consistently, and by a lot. Adjusted by the Brown-Hopkins CPI, real freight rates fell by 1.6 percent per annum over the entire colonial period (Menard 1991, p. 255). Menard is unimpressed by this fall since it had nothing to do with transport revolutions: almost all of the gains were due to the introduction of standard containers and the more efficient use of cargo space. However, it's the only evidence suggesting significant pre-19th century commodity price convergence in the North Atlantic.

Was There a Transport Revolution Along Asian Trade Routes Before 1800?

In Schumpeter's grand vision, major innovations are followed by long periods of minor tinkering, so that costs fall, very fast at first, approaching asymptotically stable levels later. If Adam Smith was right, and 1492 and 1498 were the two most important dates in pre-industrial history (Smith was writing in 1776 prior to the industrial revolution), then we should see plenty of evidence of transport cost declines, commodity price convergence and trade booms along the Euro-Asian trade route in the three centuries that followed. As far as trade booms are concerned, Ralph Davis (1962, p. 17) points out that even by 1663 -- almost two centuries after the alleged big bang of the 1490s -- only a tiny 6 percent of the total tonnage of ships engaged in English external trade was involved in East Asia. Furthermore, there is not much evidence documenting what happened to transport costs along the Euro-Asian route. Nor is there even a scholarly tradition of seeking that evidence. One impressive exception, however, is a paper by Niels Steensgaard on Dutch and English freight costs on southeast Asian trade routes between 1601 and 1657 (Steensgaard 1965).

At the beginning of the 17th century, freight costs on the East India round-trip voyage from Europe was £30-32 per ton, whether carried in a Dutch or an English vessel (Steensgaard 1965, p. 148). By the 1650s, the freight costs on English chartered ships had fallen to £16-23 (Steensgaard 1965, Table 1, p. 152). Surely Steensgaard's evidence points to a big fall in transport costs? After all, it amounts to a 23-50 percent decline over the half century, for an average fall of about 1 percent per annum. It looks as though the 17th century underwent a transport revolution almost as spectacular as the 19th century (a 1.5 percent per annum decline). Looks, however, can be deceiving. The source of the decline "was undoubtedly the reduction in the time that ships were away [and] after 1640 it was appreciably shorter – not only for chartered ships but for the Company's own ships as well" (Steensgaard 1965, p. 154). Steensgaard is not talking about the duration of the voyage out and the voyage back, which remained unchanged, but rather the turnaround time in Southeast Asia. Prior to 1640, these ships were also required to perform protective duties in Asian waters -- to put down local revolts, build forts, show the flag, negotiate agreements and so on. After 1640, chartered ships did not perform these functions, but rather a permanent Asian fleet of smaller VOC ships did. The cost per ton per trip does not include the cost of the permanent fleet, borne by the East India Company as before, but not directly included as part of the charter cost per ton. When these costs are added back in, our guess is that most of the decline in transport costs over the half century would evaporate.[6]

Ralph Davis (1962, pp. 262-4) and Bal Krishna (1924, pp. 321-3) extend the freight cost evidence from the 1650s to the 1730s. They find that freight costs "were higher in the 1720s and 1730s than they had been in the 1660s and 1660s and they took another step upward in the 1760s, when they return to the levels prevailing in the early seventeenth century" (Menard 1991, p. 250).

There is no evidence of any transport revolution along Euro-Asian trade routes during the age of commerce.

Was There Commodity Price Convergence in Spices Before 1800?

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[6] We say "most" but do not assert "all." Presumably, the VOC saved on costs by switching to a permanent Asian fleet. In Steengaard's words, "The extra expense involved in setting up this permanent Asian trading fleet must have been slight compared with the saving achieved by employing the big return ships solely for the purpose for which they were intended" (Steengaard 1965, p. 156).

While we have very little evidence documenting the presence or absence of commodity price convergence for basic or competitive commodities prior to 1800, we do have that kind of evidence for three non-competitive commodities -- cloves, coffee and pepper, important evidence when we remember that spices and pepper combined were 68 percent of Dutch homeward cargoes in the mid-17th century (Reid 1993, pp. 288-9). Table 1 summarizes the evidence (Bulbeck, Reid, Tan and Wu 1998). The clove prices are expressed as the spread between Amsterdam and Maluku relative to Maluku (in the Southeast Asian archipelago, east of Borneo and Sulawesi, north of Timor); the pepper prices between Amsterdam and Southeast Asia (in and around Sumatra); and the coffee prices between Amsterdam and Java or Sumatra. There is plenty of evidence of price convergence for cloves from the 1590s to the 1640s, but it was short-lived, since the spread soared to a 350-year high in the 1660s, maintaining that high level during the VOC monopoly and up to the 1770s. The clove price spread fell steeply at the end of the French Wars, and by the 1820s was one-fourteenth of the 1730s level. This low spread was maintained across the 19th century. Between the 1620s and the 1730s, the pepper price spread showed no trend, after which, however, it soared to a 250-year high in the 1790s. By the 1820s, the pepper price spread of the early 17th century was recovered, and price convergence continued up to the 1880s, when the series ends. While there is some evidence of price convergence for coffee during the half century between the 1730s and the 1780s, everything gained was lost during the French Wars. At the war's end, price convergence resumed, so that the coffee price spread in the 1850s was one-sixth of what it had been in the 1750s, and in the 1930s it was one-thirteenth of what it had been in the 1730s.

[Table 1 about here]

The moral is this: there is no evidence of commodity price convergence for these three non-competing goods prior to the 19th century. Of course, the price spread on pepper, cloves and coffee was not driven solely, or even mainly, by the costs of shipping, but rather, and most importantly, by monopoly,[7] international conflict, and government tariff and non-tariff restrictions. But we are indifferent about the sources of commodity price convergence: anything that impedes price convergence suppresses globalization, and Table 1 offers no evidence of significant globalization before the 1820s. Is there any reason to expect the price spread on competing goods between Europe and Asia to have behaved differently? We think not.

IV. The Second Era: 19th Century Transport Revolutions and Commodity Price Convergence

The Amazing 19th Century World-Wide Decline in International Transport Costs[8]

In the century prior to the railway era, investment in river and harbor improvements accelerated. British navigable waterways quadrupled between 1750 and 1820 when canals offered a transport option 50-75 percent cheaper than roads (Girard 1966, p. 223). On the European Continent, French canal construction boomed, and the Congress of Vienna recognized freedom of navigation on the Rhine (Girard 1966, p. 224). In the United States, construction of the Erie canal between 1817 and 1825 reduced the cost of transport between Buffalo and New York by 85 percent, and cut the journey-time from 21 to 8 days. The rates between Baltimore and Cincinnati fell by 58 percent from 1821 to 1860, and rates fell by 92 percent

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[7] A reading of Douglas Irwin (1991, esp. p. 1297) suggests that pretty much all of the intercontinental trade at this time was by state-chartered monopolies. Like most monopolies, they raised prices paid by consumers (in Europe), lowered prices paid by suppliers (in Asia), restricted output and limited trade. These are hardly the ingredients that make globalization flourish!

[8] This and the next sub-section draw heavily on Chapter 3 of our recent book (O'Rourke and Williamson 1999, pp. 33-54).

between Louisville and New Orleans from 1816 to 1860. While it took 52 days to ship a load of freight from Cincinnati to New York City in 1817, it took only 6 days in 1852 (Slaughter 1995, p. 6). It has been estimated that total factor productivity in US internal transport probably rose at about 4.7 percent per annum in the four decades or so before the Civil War (Williamson and Lindert 1980), and Matthew Slaughter estimates that, as a result, regional price differentials on some basic commodities fell from as high as 100 percent to as low as 10 percent (Slaughter 1995, p. 13).

Steamships were the most important 19th century contribution to shipping technology. In the first half of the century, they were mainly used on important rivers, the Great Lakes, the Baltic, the Mediterranean and other inland seas. A regular trans-Atlantic steam service was inaugurated in 1838, but until 1860 steamers mainly carried high-value goods similar to those carried by airplanes today, like passengers, mail and gourmet food. A series of innovations in subsequent decades changed all that: the screw propeller, the compound engine, steel hulls, bigger size and shorter turn-around time in port all served to produce a spectacular fall in intercontinental transport costs. Far eastern trade was still dominated by sail, but the opening of the Suez Canal on November 17, 1869 helped change all that, halving the distance from London to Bombay and making it easier for steamships to refuel en route.

The other major 19th century development in transportation was, of course, the railroad. Table 2 indicates the phenomenal growth in railway mileage during the late 19th century, particularly in the United States, where railroads would play a major role in creating a truly national market. Indeed, the railroad was in many ways to the United States what the 1992 Single Market program was to the European Union, and with similar consequences for firm sizes (Chandler 1977) and business regulation (McCraw 1984). On the Indian subcontinent, and for the first time in recorded history, the railroad served to almost eliminate local famines by connecting regional grain markets.

[Table 2 about here]

Refrigeration was another technological innovation with major trade implications. Mechanical refrigeration was developed between 1834 and 1861, and by 1870 chilled beef was being transported from the United States to Europe. In 1876, the first refrigerated ship, the *Frigorifique*, sailed from Argentina to France carrying frozen beef. By the 1880s, South American meat, Australian meat, and New Zealand butter were all being exported in large quantities to Europe. Not only did railways and steamships mean that European farmers were faced with overseas competition in the grain market, but refrigeration also deprived them of the natural protection distance had always provided local meat and dairy producers. The consequences for European farmers of this overseas competition would be profound.

It is important to stress that this 19th century transport revolution was not limited to the Atlantic economy. Certainly the Black Sea and the eastern Mediterranean were part of it. Gelina Harlaftis and Vassilis Kardasis (1999) have shown that the declines in freight rates between 1870 and 1914 were just as dramatic on routes involving Black Sea and Egyptian ports as on those involving Atlantic ports, and perhaps even more so. Three of their figures are reproduced here. Figure 1 compares the Odessa-UK route with the New York-UK route for grains, and the decline in Odessa freight rates is steeper. Figure 2 compares the Alexandria-UK route with the US Gulf Port-UK route for cotton, and the decline in Alexandria freight rates is about as steep as the decline in US rates. Figure 3 collects evidence for more ports – Constantinople – and more goods – coal – and it confirms our assertion that the Black Sea and the eastern Mediterranean were sharing the transport revolution documented for the Atlantic economy.

[Figures 1-3 about here]

We have already noted the impact of the Suez Canal in connecting Europe and Asia, but there were equally dramatic changes taking place within Asia.[9] In an insightful book entitled The Tyranny of Distance (1966), Geoffrey Blainey showed how distance shaped Australian history. Distance had the same impact on the rest of Asia until late in the 19th century, isolating Asia from Europe where, after all, the industrial

[9] The Asian material that follows is taken from Williamson (1999a).

revolution was unfolding. Late in the 19th century, transport innovations started to change all that, although not completely. The appearance of the Suez Canal, cost-reducing innovations on sea-going transport, and railroads penetrating the interior did not completely liberate Asia from the tyranny of distance by 1914. But it was the change in the economic distance to the European core which mattered to the Asian periphery, even though the levels remained high well in to this century. The tramp charter rate for shipping rice from Rangoon to Europe, for example, fell from 73.8 to 18.1 percent of the Rangoon price between 1882 and 1914 (Shein 1964, p. 155 divided by Latham and Neal 1983, col. I, p. 276). The freight rates on sugar between Java and Amsterdam fell by 50-60 percent between 1870 and World War I (Yasuba 1978, Graph 2). China and Japan were also involved in this Asian transport revolution. The freight rate on coal (relative to its export price) between Nagasaki and Shanghai fell by 76 percent between 1880 and 1910, and Yasukichi Yasuba (1978, Tables 1 and 5) has estimated that total factor productivity on Japan's tramp freighter routes serving Asia advanced at 2.5 percent per annum in the thirty years between 1879 and 1909.

Perhaps the greatest 19th century "globalization shock" in Asia did not involve transport revolutions at all. Under the persuasion of Commodore Perry's American gun ships, Japan switched from virtual autarky to free trade in 1858. It is hard to imagine a more dramatic switch from closed to open trade policy, even by the standards of the recent Asian miracle. In the fifteen years following 1858, Japan's foreign trade rose from nil to 7 percent of national income (Huber 1971). The prices of (labor-intensive) exportables soared, rising towards world market levels; the prices of (land- and machine-intensive) importables slumped, falling towards world market levels. One researcher estimates that Japan's terms of trade rose by a factor of 3.5 between 1858 and the early 1870s (Huber 1971); another thinks the rise was even bigger, a factor of 4.9 between 1857 and 1875 (Yasuba 1996, p. 548). Whichever estimate one accepts, this combination of declining transport costs and the dramatic switch to free trade unleashed powerful globalization forces in Japan. Other Asian nations followed this liberal path, most forced to do so by colonial dominance or gunboat diplomacy. Thus, China signed a treaty in 1842, at the end of the Opium

Wars with Britain, opening her ports to trade and adopting a 5 percent *ad valorem* tariff limit. Siam avoided China's humiliation by going open and adopting a 3 percent tariff limit in 1855. Korea emerged from its autarkic "Hermit Kingdom" about the same time, undergoing market integration with Japan long before colonial status became formalized in 1910. India went the way of British free trade in 1846, and Indonesia mimicked Dutch liberalism. In short, by the 1860s commodity price convergence was driven entirely by sharply declining transport costs in Asia without much change in tariffs one way or the other. Asia's commitment to globalization, forced or not, started more than a century ago.

Figure 4 offers a summary of the impact of these productivity improvements on transport costs in the Atlantic economy. What is labeled the North index (North 1958) accelerates its fall after the 1830s, and what is labeled the British index (Harley 1988) is fairly stable up to mid-century before undergoing the same, big fall. The North freight rate index dropped by more than 41 percent, in real terms, between 1870 and 1910, while the British index fell by about 70 percent between 1840 and 1910. These two indices imply a steady decline in Atlantic economy transport costs of about 1.5 percent per annum, for a total of 45 percentage points up to 1913, a big number indeed. There is another way to get a comparative feel for the magnitude of this decline. The World Bank reports that tariffs on manufactures entering developed country markets fell from 40 percent in the late 1940s to 7 percent in the late 1970s, a 33 percentage point decline over thirty years (Wood 1994, p. 173). While impressive, this spectacular postwar reclamation of "free trade" from interwar autarky is still smaller than the 45 percentage point fall in pre-1914 trade barriers due to transport improvements.

[Figure 4 about here]

Figure 4 makes another point: the 19th century transport revolution was a spectacular regime switch, occurring some time between 1820 and 1850. If world historians are looking for a globalization big bang, they should switch their gaze from the 1490s to the 1820s.

19th Century World-Wide Commodity Price Convergence

What was the impact of these transport innovations on the cost of moving goods between markets? The decline in international transport costs after mid-century was enormous, and it ushered in a new era. When economists look at this period, they tend to focus on tariffs and trade volumes. This is a mistake. The volume of trade is an unsatisfactory index of commodity market integration: it is the cost of moving goods between markets that counts. The cost has two parts, that due to transport and that due to trade barriers (such as tariffs). The price spread between markets is driven by changes in these costs, and they need not move in the same direction. It turns out that tariffs in the Atlantic economy did not fall from the 1870s to World War I; the globalization which took place in the late 19th century cannot be assigned to more liberal trade policy. Instead, it was falling transport costs which provoked globalization. Indeed, rising tariffs were mainly a defensive response to the competitive winds of market integration as transport costs declined (O'Rourke 1997). As we have seen, the opposite was true of Asia, and, furthermore, there were no offsetting tariff hikes in the eastern Mediterranean either. But we have gotten ahead of the story. What about commodity price convergence?

Trend estimates based on Knick Harley's (1980) annual data show that Liverpool wheat prices exceeded Chicago prices by 57.6 percent in 1870, by 17.8 percent in 1895, and by 15.6 percent in 1912. Both the Liverpool-New York and New York-Chicago price gaps declined steeply (Figure 5), which is consistent with the evidence on freight rates offered earlier. Moreover, these estimates understate the size of the price convergence because they ignore the collapse in price gaps between Midwestern farm-gates and Chicago markets. This price convergence experience in Anglo-American wheat markets was repeated for other foodstuffs. The second biggest tradable foodstuff consisted of meat and animal fats such as beef, pork, mutton and butter. Figure 6 plots London-Cincinnati price differentials for bacon. While there was no convergence across the 1870s, there was convergence after 1879-1880. Indeed, the price convergence after 1895 was even more dramatic for meat than it was for wheat: price gaps were 92.5 percent in 1870, over

100 in 1880, 92.3 in 1895, and 17.9 in 1913. The delay in price convergence for meat, butter and cheese has an easy explanation: it required the advances in refrigeration made towards the end of the century.

[Figures 5 and 6 about here]

Anglo-American price data are also available for many other non-agricultural commodities (O'Rourke and Williamson 1994). The Boston-Manchester cotton textile price gap fell from 13.7 percent in 1870 to about zero in 1913; the Philadelphia-London iron bar price gap fell from 75 to 20.6 percent, while the pig iron price gap fell from 85.2 to 19.3 percent, and the copper price gap fell from 32.7 to almost zero; the Boston-London hides price gap fell from 27.7 to 8.7 percent, while the wool price gap fell from 59.1 to 27.9 percent. Commodity price convergence can also be documented for coal, tin and coffee. Furthermore, similar trends can be documented for price gaps between Buenos Aires, Montevideo, Rio de Janeiro and London (Williamson 1999b).

Commodity price convergence also involved the European continent. Denmark was a free-trader throughout this period, and one might, therefore, expect to see Danish price convergence on America equal to that of Britain. Figure 7 does indeed show that there was Danish-American wheat price convergence throughout the period. The Ukraine and the rest of the east European periphery was also part of this world-wide price convergence: wheat price gaps between Odessa and Liverpool of about 40 percent in 1870 had almost evaporated by 1906 (O'Rourke 1997).

[Figure 7 about here]

We have already seen that railroad mileage increased by more than six times between 1870 and 1910 (Table 2), and there was impressive commodity price convergence *within* India as a result (Hurd 1975, p. 266). Transport cost declines from interior to port and from port to Europe also ensured that Asian economies became more integrated into world markets. Price gaps between Britain and Asia were driven down by the completion of the Suez Canal, by the switch from sail to steam, and by other productivity advances on long distance sea lanes. The cotton price spread between Liverpool and Bombay fell from 57 percent in 1873 to 20 percent in 1913, and the jute price spread between London and Calcutta fell from 35 to 4 percent (Collins 1996, Table 4). The same events were taking place even farther east, involving Burma and the rest of Southeast Asia. Indeed, the rice price spread between London and Rangoon fell from 93 to 26 percent in the four decades prior to 1913 (Collins 1996, Table 4). These events had a profound impact on the creation of an Asian market for wheat and rice, and, even more, on the creation of a truly global market for grains (Latham and Neal 1983; Brandt 1985, 1993; Kang and Cha 1996). Finally, the impact of transport revolutions on commodity price convergence involving the eastern Mediterranean was just as powerful. The price spread on Egyptian cotton in Liverpool and Alexandria markets plunged off a high plateau after the 1860s. The average percent by which Liverpool exceeded Alexandria price quotes was: 1824-1832 42.1; 1837-1846 63.2; 1863-1867 40.8; 1882-1889 14.7 and 1890-1899 5.3 (calculated from Yacoub Artin Pacha in Issawi 1966, pp. 447-8).

V. Documenting the Regime Switch: What Determined English Wage-Rental Ratios and the Inter-Sectoral Terms of Trade 1565-1936?

If we are right in asserting that the first great globalization shock hit the world economy in the early 19th century rather than in the late 15th century, then it follows that while domestic prices should have been determined primarily by domestic supply and demand in Europe prior to the early 19th century, they should have been determined by global supply and demand afterwards. Moreover, the distributional implications of international trade, central to the economics of Bertil Ohlin, should only have begun to manifest themselves some time between Waterloo and the Great War. Here we test this intuition for one economy, Great Britain, which was at the heart of the 19th century global economy and which was thus fully exposed to the effects of growing international trade. Previous work has shown that international commodity price convergence can explain a large proportion of British distributional trends between 1870 and 1914 (O'Rourke and Williamson 1994; O'Rourke, Taylor and Williamson 1996), and that British grain markets were well integrated with those on the European Continent as early as the 1830s (Williamson 1990; O'Rourke 1994). Was this also true of earlier centuries, or does the Heckscher-Ohlin model only apply to British experience after Waterloo?

To answer these questions, we gathered data on British endowments, commodity prices, and factor prices from 1565 to 1936 (see Appendix for details). For these four centuries from the age of commerce to the great depression, we were able to construct: the ratio of agricultural land to the economy-wide labor supply (LANDLAB); the ratio of agricultural prices to industrial prices (PAPM); and the ratio of wage rates to farm land rents (WR1 and WR2, corresponding to two alternative rent series).[10] All variables are expressed in natural logarithms. To repeat, increases in land-labor ratios should in a closed economy lead to a decline in relative agricultural prices and to an increase in the wage-rental ratio: commodity prices and factor prices should both be determined by endowments (and demand). Moreover, if Malthus was right then a technology-induced rise in the real wage should induce an increase in the labor force, and a reduction in the land-labor ratio. Thus, we might also observe factor and commodity prices having an impact on endowments in a closed economy. As commodity prices become increasingly exogenous in an open economy (i.e. determined by world market conditions, rather than by domestic factor endowments), factor prices should be determined more and more by commodity prices and less and less by endowments (or even by commodity prices alone, in the historically unrealistic 2x2 case). Land-labor ratios might still depend on wages and prices through some sluggish Malthusian mechanism, or through more responsive international migration flows.

To see if these predictions hold, we split the data into two long eras: 1565-1828 and 1828-1936. The choice of 1828 as the break point has a straightforward explanation. That year saw a radical liberalization of British commercial policy, and Britain stuck to that liberal policy up to the 1846 Repeal

[10] We emphasize the results obtained with WR1 in the text. The results using WR2 were similar, and are reported in subsequent footnotes.

and beyond. Prior to 1828, grain imports were prohibited if domestic prices fell below a certain 'port-closing' level, 70 s. per quarter in the case of wheat (80 s. per quarter prior to 1822). Thus, during the early postwar years grain imports were effectively excluded much of the time. In 1828, the Duke of Wellington's government replaced these import restrictions with tariffs, which varied with the domestic price: this not only lowered British grain prices but increased the integration of British and Continental grain markets (Williamson 1990). Moreover, this adoption of the sliding scale tariff came at the end of a decade which had seen several other moves towards freer trade: a reform of the Navigation Acts in 1822; tariff reductions across the board; and the repeal of more than 1,100 tariff acts in 1825, the year in which the emigration of skilled workers was once again authorized (Bairoch 1989, pp. 9-10). Of course, prior to 1815, the French Wars effectively served to block commodity trade and factor mobility.

Figures 8A and 8B plot the raw data, and they show that the 1820s do indeed mark a watershed in British economic history. Prior to the 1820s, the relative price of agricultural commodities (PAPM) rose steadily, while the wage-rental ratio (WR) fell steadily. After the 1820s, the wage-rental ratio rose steadily, while from the 1840s onwards the relative price of agricultural goods stopped increasing and, eventually, started falling in response to cheap food imports from Russia and the New World. It is the striking reversal in distributional trends that is most suggestive: it looks like a regime switch in which wage-rental ratios were first determined primarily by domestic endowments (and thus declined as land-labor ratios fell) to one in which they were determined primarily by booming trade with more land-abundant economies (and thus rose, despite the fact that land-labor ratios at home kept falling). But can we show with econometrics that the closed economy model fits the facts prior to the 1820s, but that it is the open economy model associated with Bertil Ohlin's name that becomes relevant after the introduction of the Duke of Wellington's sliding scale?

[Figures 8A and 8B about here]

Table 3 reports correlation coefficients between our three variables in each of the two periods, and they are certainly consistent with our hypotheses. In the earlier period, the land-labor ratio was strongly and positively correlated with the wage-rental ratio (0.889), and strongly and negatively correlated with the relative price of agricultural goods (-0.956), precisely as closed economy theory suggests. In the later period, prices and endowments are uncorrelated, as they should be in an open economy; what is now a negative correlation between endowments and wage-rental ratios (-0.859) seems puzzling, a bit of unexpected over-kill in favor of our hypothesis, driven, we suppose, by omitted factors.[11]

[Table 3 about here]

We next proceeded to estimate VARs incorporating these three variables, as well as a time trend, for each of the two subperiods.[12] The Akaike and Schwartz Bayesian information criteria suggested that just one lag be included; however, since some of the annual data we use are interpolated from decadal estimates, we also ran VARs incorporating the previous 20 years of lagged data for the pre-1828 period (20 being preferred to10, 30, 40 etc. according to the Akaike and Schwartz criteria) and 10 years of lagged data for the later period (again, 10 being preferred to 20, 30, 40, etc. according to the Akaike and Schwartz criteria). Impulse response functions are reported in Figures 9A and 9B and in Figures 10A and 10B, for both lag lengths, along with plus/minus two standard-deviation bands. In the earlier period, increases in land-labor ratios induce rising wage-rental ratios and falling relative agricultural prices, regardless of the lag-length. Wage-rental ratio increases lead to increases in the relative price of agricultural goods if a single lag is used (but not in the 20-lag case), and to declines in land-labor ratios (consistent with Malthusian

[11] Econometric exercises outlined later suggest that this result is driven primarily by time trends in the data, and by the increasing impact of capital-labor ratios on income distribution. Table 3 reports results using WR1 wage-rental estimate. It's replacement by WR2, however, does not seem to matter to our results. In the earlier period, the correlation between WR2 and LANDLAB is 0.907, while in the later period it is -0.799. The correlation between PAPM and WR2 is -0.864 in the earlier period, and -0.361 in the later period. See the Appendix for a full description of the two wage-rental series.

[12] All econometric exercises described below were performed using Eviews 3.

theory) if a one-year lag is used (but not in the 20-lag case).[13] These results are consistent with the closed economy prediction that endowments were driving commodity and factor prices prior to the early 19th century. In the later period, none of these variables are significantly related to each other, in either the one-lag or 10-lag case, indicating that the earlier relationships had broken down.

[Figures 9A, 9B, 10A and 10B about here]

These VARs were then used to perform Granger-causality tests among the variables. Table 4 indicates whether the null hypothesis that variable x did not Granger-cause variable y is rejected at the 10% confidence level (rejections at the 5% level are indicated by an *, and rejections at the 1% level by an **). In each cell, results are given both for the one-lag case, and for the 20-lag or 10-lag case as appropriate, with the latter result being shown in parentheses. For example, Panel B indicates that WR1 Granger-caused PAPM after 1828 if a one-lag VAR is estimated (at a 5% significance level), but that it did not Granger-cause PAPM if a 10-lag VAR is used. A final row indicates whether the variable in question is endogenous, in the sense that it is jointly caused by one or both of the other two variables at a 10% significance level or higher. The most important hypothesis concerns the impact of endowments on prices, and it is confirmed by the data once again: endowments Granger-caused prices in the earlier period, but not in the later, regardless of the number of lags used. Whether prices were exogenous in the later period depended on the number of lags included in the VAR, however: as mentioned earlier, factor prices appear to Granger-cause goods prices if a one-lag VAR is used, but not if a 10-lag VAR is used. Factor prices may have been endogenous in the former period, but seem to have been exogenous in the latter (contrary to our expectations); the results relating to endowments are all sensitive to lag length assumptions.

[Table 4 about here]

All variables appeared to be integrated of order one. We next proceeded to see if there were

[13] Increases in PAPM seem to lead to a decline in LANDLAB, for reasons which are obscure.

cointegrating relationships linking them. We first estimated these relationships directly, using OLS methods. Table 5 reports the estimates which would obtain in a closed economy, in which both commodity and factor prices were driven by endowments. The results for the pre-1828 period indicate an elasticity of prices w.r.t. endowments of -0.882 [equation (1)], and an elasticity of wage-rental ratios w.r.t. endowments of 0.907 [equation (3)].[14] Unfortunately, when the residuals from these equations were inspected, the hypothesis that the series contained a unit root could not be rejected (albeit by a narrow margin).[15] In the case of prices, Figures 11A and IIB suggest that this failure may have been due to the impact of the Napoleonic Wars; when the relationship was re-estimated for the sub-period 1565-1800, the elasticity of prices w.r.t. endowments was -0.866 [Table 5, equation (2)], and the Engle-Granger procedure shows PAPM and LANDLAB to have been cointegrated. For the 1828-1936 period, simple OLS regressions show no relationship at all between prices and endowments, consistent with our predictions [equation (4)], while wage-rental ratios are now negatively related to endowments [equation (5)].[16] Clearly, the structure of the economy was very different after 1828 than before: while the closed economy model fit the facts very well prior to 1828, it fit them very badly thereafter.

[Figures 11A, 11B and Table 5 about here]

The wage-rental ratio should be a function of endowments, technology and prices in an open economy, with prices being exogenous. In the 16th, 17th and even 18th centuries, land and labor were the

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[14] Although the results are not included in Table 5, the qualitative impact of endowments on commodity and factor prices is the same if a time trend is included in the equation: with a time trend included, the elasticity of PAPM w.r.t. LANDLAB is precisely -1, while the elasticity of WR1 w.r.t. LANDLAB is 0.51. Both coefficients remain statistically significant at the 1% level. The elasticity of WR2 w.r.t. LANDLAB is 1.93 if no trend is included, and 0.21 with the trend included; again both coefficients are statistically significant at the 1% level.

[15] This test uses the critical values in Davidson and MacKinnon (1993, Table 7.2, p. 722). The same is true in the case of WR2.

[16] The same is true if WR2 is used.

most important factors of production, but by the 19th century capital was also having an important impact on economy-wide wages. Any post-1828 equation expressing wage-rental ratios as a function of land-labor ratios and commodity prices without in addition including capital-labor ratios and technology would be mis-specified, as Section II suggested.[17] Since capital-intensity and total factor productivity were both trending up during the 19th and 20th centuries, we estimated the following equation (as before, all variables are in logarithms):

$$WR = a_1 + a_2 LANDLAB + a_3 PAPM + a_4 trend \qquad (1)$$

where the trend term is a proxy for the combined impact of capital deepening and technological change. The results for both periods are given in Table 6. They show that the open economy model fits the post-1828 facts extremely well, but that it fits the pre-1828 facts extremely poorly (prices have the wrong sign in the regression). Table 6 also shows that there was a dramatic switch in the impact of capital-deepening and technical change on the wage-rental ratio after 1828. Moreover, when the residuals from the post-1828 regression were examined, the null hypothesis of a unit root in the series was rejected at the 1 percent confidence level, indicating that the estimated equation constituted a cointegrating relationship between the variables.[18]

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[17] O'Rourke, Taylor and Williamson (1996). Technology, as proxied by the Solow residual, was found in our 1996 paper to be positively related to the wage-rental ratio in Europe, suggesting that technological change was indeed labor-using, as economic historians had previously suggested.

[18] When WR2 is used, the coefficients are very similar to those in Table 6, equation (2); however, the residuals from this equation narrowly fail the Engle-Granger cointegration test. We also implemented the Johansen (1991, 1995) VAR-based cointegration test, and found it even more favorable to our closed-economy hypothesis for the pre-1828 period than the above Engle-Granger procedure. In implementing the test, we assumed that there were linear trends in the data (as Figures 8A and 8B suggest), but that the cointegrating relationships between variables contained no time trends (i.e. the relationships between endowments, commodity prices and factor prices did not contain time trends, as in Table 5). The Johansen L.R. test statistic suggested that there were two cointegrating relationships between the variables, regardless of whether 1 or 20 lags were used: the wage-rental ratio emerged as a positive function of the land-labor ratio, and the relative price of agricultural goods as a negative function of land-labor ratios. Unfortunately, the Johansen procedure did not produce as satisfactory an outcome for the post-1828 period. In this case we implemented the test assuming both time trends in the data, and a time trend in the

[Table 6 about here]

We conclude that there is strong evidence for our contention that the closed economy model fits the facts before 1828 but not afterwards, while the open economy model fits the facts after 1828 but not before. If the world historian is looking for a big globalization bang, she will find it in the 1820s, not in the 1490s.

VI. The Impact of Commodity Price Convergence on Factor Price Convergence: Wage-Rental Ratios World-Wide 1870-1940[19]

If there was truly a globalization big bang in the century prior to 1914, the Heckscher-Ohlin model tells us that we should see unambiguous evidence of factor price convergence. We should see it world-wide. And since agriculture was still such a large sector, and since farm land was still such an important asset, we should see it in the behavior of the wage-rental ratio. The previous section argued that these predictions hold up well in the British case. Can we extend the evidence to other parts of the world as well?

With the collaboration of Alan Taylor, the present authors have already shown how factor price convergence took place in the Atlantic economy over the four decades or so following 1870 (O'Rourke, Taylor and Williamson 1996). These factor price convergence trends are reproduced in Table 7, where new evidence for the interwar period and new evidence for Uruguay join revisions of the rest, yielding for the decades prior to about 1940 data for: five land-abundant overseas settlements – Argentina, Australia, Canada, Uruguay and the United States; four land-scarce European countries that pretty much stuck to free trade – Denmark (data only to 1913), Great Britain, Ireland (data only to 1913) and Sweden (data only to

cointegrating relationship (for the reasons discussed above). We expected to find one cointegrating relationship linking all three variables (as in equation 1) and this we did; we also expected to find a negative relationship between the wage-rental ratio and relative prices, consistent with Heckscher-Ohlin theory, and this we did. However, the relationship between WR1 and LANDLAB was also negative, which is inconsistent with our simple theory.

[19] This section draws heavily on two papers by one of the authors (Williamson 1999c, 1999d).

1930); and three land-scarce European countries that raised tariffs to help fend off the winds of competition – France, Germany (data only to 1913) and Spain (data only to 1910). The wage-rental ratio – rents denoting rents on farm land or farm land values, wages denoting unskilled daily or weekly wages – collapsed in the land-abundant New World, and it surged in the land-scarce Old World. Land-scarce European countries that were less committed to the globalization game -- raising tariffs to fend off foreign competition -- underwent a less dramatic increase in their wage-rental ratio, just as Ohlin would have predicted. While there is certainly no evidence of factor price equalization anywhere in the Atlantic economy during this century of globalization, Table 7 offers overwhelming evidence of factor price convergence, at least up to the eve of World War I and prior to interwar de-globalization.

[Table 7 about here]

What happened outside of the Atlantic economy, and what about the interwar years? As we have seen, the move to free trade in much of Asia and the eastern Mediterranean, plus the revolutionary decline in transport costs everywhere in the Third World, dramatically eroded commodity price gaps between the European core and the periphery in the century before 1914. It probably eroded them even more within the periphery, since there was far less globalization backlash there. Prices of exportables boomed in the exporting countries. Price trends reversed after World War I, but on either side of that great divide one would have thought that the relative rewards to land and labor should have been dramatically affected. Exactly how they were affected should have depended, of course, on whether the abundant factor was land -- as in the Southern Cone, Egypt, Southeast Asia and the Punjab, or labor -- as in Japan, Korea and Taiwan.

Consider again the canonical land-scarce and labor-abundant case, Japan. As we noted above, when Japan emerged from isolation after 1858, prices of its labor-intensive exportables soared, rising towards world market levels, while prices of its land- and machine-intensive importables slumped, falling towards world market levels. The Heckscher-Ohlin model predicts that the abundant factor, labor, should have flourished while the scarce (and sector-specific) factor, land, should have languished over the fifteen years or so following 1858. Did they? The available factor price evidence for Japan in mid-century is limited. Table 8 confirms that data on land rents or land values are not available until 1885, long after Japan's leap to openness had taken place. But we do have some crude pre-1885 evidence, and it seems to confirm the Heckscher and Ohlin hypothesis. Maddison (1995, p. 182) estimates that real GDP per capita increased by only 17 percent between 1820 and 1870. Assume that all of that increase took place between 1850 and 1870, an unlikely possibility which would work against our thesis. J. Richard Huber (1971) estimates that the real wage for unskilled workers in Osaka and Tokyo increased by 67 percent in this period. True, this huge increase is much bigger than the real wage growth that others have estimated more recently (Williamson 1999a). Nevertheless, consider the implication of Huber's estimates: the wage of unskilled labor, the abundant factor, increased by 43 percent relative to average incomes in Japan. And under plausible assumptions,[20] this implies that land rents fell by more than 50 percent in Japan. Thus, the wage-rental ratio rose by more than 3.3 times (from 1.0 to 1.67/0.50). To repeat, this is exactly what one would have predicted when a technologically quiescent economy is hit with a huge price shock which favors the exportable and disfavors the importable: in a land-scarce economy like pre-industrial Japan, the wage-rental ratio should have soared, with obvious distributional (and, one supposes, political) consequences.

[Table 8 about here]

For pre-industrial Japan, these are only informed guesses, but Table 8 reports the real thing for

[20] The arithmetic is trivial. Let national income (Y) equal the sum of wages (wL, the wage per worker times the total labor force) and land rents (rD, rent per hectare times total hectares), and ignore skills, capital and all else: Y = wL + rD. Then per worker income growth is (where an "*" refers to the percentage growth over the full fifteen years): $Y*-L* = w*\grave{e}_L + L*(\grave{e}_L-1) + r*\grave{e}_D$. Assume that labor and land's share exhausted national income, and that labor got 60 percent. Also assume that land hectarage was fixed, and that labor force growth (assumed equal to population growth) was 7.6 percent between 1850 and 1870 (Maddison 1995, p. 106). If some of the GDP per capita growth between 1820 and 1870 actually took place before 1850, then land rents fell by even more than our guess here. This calculation is taken from O'Rourke and Williamson (1999, Chapter 4).

subsequent decades. East Asian wage-rental ratio trends can be constructed for Japan starting in the late1880s, Korea starting in the late 1900s and Taiwan starting in the late 1900s. In contrast with the Punjab in the four decades after 1873 or Japan in the two or three decades after 1858, the early 20th century was not a period of technological quiescence for East Asian agriculture. Instead, the region was undergoing land-saving and labor-using innovation (Hayami and Ruttan 1971), forces which should have served by themselves to raise the wage-rental ratio. It was also a period of dramatic industrialization, at least in Japan, which served to pull labor off the farms (Brandt 1993), another force serving to raise the wage-rental ratio. The period after 1910-1914 was also one of unfavorable farm price shocks (Kang and Cha 1996), yet another force serving to raise the wage-rental ratio. In short, we might expect those wage-rental ratio trends initiated by globalization forces in mid-19th century East Asia, as illustrated by Huber's data for Japan, to have continued well into the 20th century. That is exactly what Table 8 reveals: East Asian wage-rental ratios surged up to the 1920s and 1930s. Indeed, land-scarce Europe experienced the same surge in wage-rental ratios during its export-led industrialization and the so-called grain invasion after the 1870s, at least where trade policy remained liberal (O'Rourke, Taylor and Williamson 1996). Furthermore, the magnitudes were not so different. Between 1910-14 and 1925-29, the wage-rental ratio rose by 88 percent in Japan, by 72 percent in Korea, and by 40 percent in Taiwan (Table 8). The average increase in the wage-rental ratio for Britain, Ireland, Denmark and Sweden was 27 percent between 1890-04 and 1910-14, and 50 percent between 1875-79 and 1890-94 (Table 7). It might also be relevant to add that politically powerful landed interests were able to secure some protection from these globalization forces in continental Europe with tariffs on wheat (O'Rourke 1997), so that the wage-rental rose only about a third as fast in the average of France, Germany and Spain compared with the open four of Britain, Ireland, Denmark and Sweden (Table 7). Japan achieved much the same with import restrictions on rice (Brandt 1993).

In contrast with East Asia and Europe, we take the Punjab to have been relatively land-abundant, an assumption that seems to be confirmed by the fact that agricultural exports from that Indian region to Europe boomed after the 1860s and early 1870s. Compared with land-scarce Japan, globalization should have had the opposite effect on the wage-rental ratio in the land-abundant Punjab: it should have fallen, and fall it did. Between 1870-74 and 1910-14, the wage-rental ratio in the Punjab fell by 59 percent. The Punjab's wage-rental ratio experience was not so different from that of the Southern Cone and other parts of the New World. Between 1870-74 and 1910-14, the wage-rental ratio fell by 69 percent in the combined pair of Australia and the United States (Table 7); and between 1880-84 and 1910-14 it fell by 85 percent in the combined pair of Argentina and Uruguay (Table 8). Egypt, riding a cotton boom, conformed to these Asian and Latin American trends: from the late 1870s to 1910-14, the Egyptian wage-rental ratio fell by 54 percent, and from the late 1880s it fell by 85 percent (Table 8).

However, perhaps the best examples of factor price convergence in land-abundant and labor-scarce economies can be found in rice-exporting Southeast Asia. Table 8 documents wage-rental ratio trends there for two countries, Burma and Siam. Pre-1914 globalization shocks served to lower the wage-rental ratio in both places, and the decline was huge. The Burmese ratio fell by 44 percent over the twenty years between 1890-94 and 1910-14, while the Siamese ratio fell by 92 percent over the same period, and by 98 percent between 1870-74 and 1910-14! These are even bigger wage-rental ratio declines than those recorded in the Southern Cone, Australia or North America.[21]

What happened after 1914 when so many countries in the Atlantic economy retreated behind tariff walls, underwent competitive devaluations, restricted migrations, and used other devices to try to move back towards their pre-1800 autarkic roots? Factor price convergence ceased, and in many cases

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[21] We can already hear Ron Findlay's voice rising from the conference audience with the question: what about factor supply response -- labor immigration from Madras and South China, and land settlement in Upper Burma and the Thai north? Elsewhere, Professor Findlay has dealt with endogenous factor supply theory (Findlay 1995), and one of us plans to deal with the comparative historical facts in another paper (Williamson 1999c). Be patient, Ron.

divergence set in, but that story will have to wait for another paper (Williamson 1999c).

The factor-price-convergence theorem seems to have been alive and well before 1940 the world round -- in the Atlantic economy, in Asia, in Latin America and in the Middle East.

VII. Concluding Remarks

Eli Heckscher and Bertil Ohlin developed a theory of international trade that was motivated by the late 19th century experience. While their theory does a very good job in accounting for that 19th century experience, that fact does not necessarily imply that Heckscher-Ohlin forces were also important in accounting for distributional trends in earlier periods. Commodity price convergence was not nearly strong enough to have had a big impact on domestic commodity prices, and, by extension, on factor prices. Furthermore, most intercontinental trade was in non-competing goods which by definition did not displace domestic production.

None of this should come as a surprise: why should any economic model be equally relevant for all periods and places? Two examples should suffice to illustrate the point. First, while a suitably augmented Solow model does a good job in accounting for late 20th century growth (Mankiw, Romer and Weil 1992; Barro 1997), it performs very poorly for the late 19th century: farm land was still an important factor of production, huge amounts of labor and capital flowed between countries, and land endowments themselves could change as frontiers expanded (Findlay 1993; Taylor 1996). Second, while openness and growth may be positively correlated today, they were not correlated during the interwar years, and they were negatively correlated a century ago (Vamvakidis 1997; O'Rourke 2000).

One key difference between today's developed economies and those of a century ago is that agriculture plays a much smaller role today. The specific factors model suggests that trade should have had a much greater impact on land rents than on wages, and the evidence bears that prediction out. European wages grew more rapidly than they did in the New World during the late 19th century, but on average the margin was slim (1.4 percent per annum, as opposed to 1.2 percent in the New World);[22] and, in any event, most of the international real wage convergence experienced then can be attributed to international migration, rather than to commodity market integration (Taylor and Williamson 1997). By contrast, while real land values rose by over 400 percent in Australia between 1870 and 1910, and by over 250 percent in the United States, they fell in European countries such as Britain, France and Sweden (in Britain by more than 50 percent). Commodity prices do a very good job explaining land price movements during this period (O'Rourke 1997), but they seem to have had a less systematic impact on real wages, just as theory suggests: the strong correlation between relative commodity prices and the wage-rental ratio was driven more by movements in the latter's denominator than by movements in its numerator.

Specific factors were more affected by trade, and they also had a greater incentive to lobby for protection. Unlike farm labor, land could not exit from agriculture, and so it exercised considerable voice. This was particularly true in Europe, where restrictions on agricultural produce were erected which remain in place to this day. Trade had a large impact on domestic politics in the 19th century, and the divisions to which it gave rise can largely be understood by Heckscher-Ohlin thinking, as Ronald Rogowski (1989) and others have shown so convincingly. Thus, free-trading slave and land owners in the ante-bellum cotton South opposed northern industrial capitalists in the United States, free-trading labor and capital opposed protectionist landowners in mid-century Britain, and protectionist coalitions of land and capital opposed labor in Germany after 1879. The fact that trade policy frequently gave rise to major political debates, and that those debates seemed to evolve along class lines, is in itself powerful evidence that the Heckscher-Ohlin model describes the 19th century well. Their model suggests that trade produces losers as well as winners, and by the end of the 19th century many of those losers were able to gain protection from

[22] O'Rourke and Williamson (1999, Table 2.2, p. 19).

accommodating legislators. This globalization backlash was sometimes quite significant.[23]

The politics of trade were very different before 1800 when conflicts were far more likely to erupt between nations than within nations. The evidence summarized here can help us understand why. If trade had no large distributional effects on domestic economies, then the various classes in society had no great incentive to lobby for protection or free trade. If trade was still largely characterized by monopoly rents, then the key political question for (mercantilist) statesmen was who would get those rents, their own monopolists, or those of other nations.[24]

We hope that this paper has demonstrated why Heckscher-Ohlin trade theory is not very helpful in understanding the mercantilist era, but very helpful in understanding the global era that followed. There was no global big bang in the 1490s, but there was a very big global bang in the 1820s.

[23] See, for example, O'Rourke (1997) on European grain tariffs and Williamson (1997) on New World manufacturing protection and immigration restrictions.

[24] This topic -- mercantilism -- was, of course, explored at length by Heckscher (1931). More recently, its monopolistic and rent-seeking attributes have been explored by Douglas Irwin (1991).

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Appendix

Data Sources for the Analysis of English Wage/Rental Ratios and the Inter-Sectoral Terms of Trade, 1565-1936

Nominal Wages 1280-1940 (1900=100)

1280-1850: male daily wages in agriculture; reported decadal, interpolated geometrically to get annual; from G. Clark, "Nominal and Real Male Agricultural Wages 1250-1850, and English Economic Growth," Agricultural History Center Working Paper 96, University of California, Davis (n.d.), Tables 6 and 7, pp. 38-9 and Appendix, pp. 47-8.
1850-1914: annual; **1850-1880** from A. L. Bowley, "The Statistics of Wages in the United Kingdom during the last Hundred Years (Part IV)," Journal of the Royal Statistical Society, LXII (September 1899), pp. 562-4, col. Ad/52 for England and Wales, col. Bd/52 for Scotland; UK a weighted average of the two series, where the weights are male population from B. R. Mitchell and P. Deane, Abstract of British Historical Statistics (Cambridge: Cambridge University Press, 1962), p. 6; **1881-1914** from Bowley, Wages and Income Since 1860 (Cambridge: 1937), Table II, p. 8 for the UK.
1914-1940: annual; from a revised data base for nominal wages underlying J. G. Williamson,"The Evolution of Global Labor Markets Since 1830: Background Evidence and Hypotheses," Explorations in Economic History, vol. 32, no. 2 (April 1995), pp. 141-96.

Nominal Farm Land Rents 1565-1936 (1900=100)

Index A:
1560-1830: reported decadal, interpolated geometrically to get annual; from G. Clark, "Land Hunger: Land as a Commodity and as a Status Good, England, 1300-1910," Agricultural History Center WP 86, University of California, Davis (February 1997), data underlying Figure 4, p. 26 (personal correspondence from Clark to Williamson).
1831-1870: annual; from J. Thompson, "An Inquiry into the Rent of Agricultural Land in England and Wales during the Nineteenth Century," Journal of the Royal Statistical Society, LXX (December 1907), Appendix, Table A, p. 612.
1871-1900: annual; an unweighted average of Thompson (1907) and H. A. Rhee, The Rent of Agricultural Land in England and Wales (London: Central Landowners Association, 1949), Appendix Table 2, pp. 44-5.
1900-1936: annual; Rhee (1949).

Index B:
Alternative index 1690-1914: annual; linked forwards and backwards to the rest of Index A above: M. E. Turner, J. V. Beckett, and B. Afton, Agricultural Rent in England 1690-1914 (Cambridge: Cambridge University Press, 1997), Appendix Table A2.2, pp. 314-8.

Inter-Sectoral Terms of Trade, Pa/Pm (1900=100): Pa 1316-1938

1316-1450: Exeter wheat; annual; from Mitchell and Deane (1962), pp. 484-6.
1450-1649: "average - all agricultural products," including grains, other arable crops, livestock and animal products; reported decadal, interpolated geometrically to get annual; from Joan Thirsk (ed.), The Agrarian History of England and Wales, Volume IV: 1500-1640 (Cambridge: Cambridge University Press, 1967), Table XIII, p. 862.

1640-1749: "average - all agricultural products," including grains, other field crops, livestock and animal products; reported decadal, interpolated geometrically to get annual; from Thirsk (ed.), The Agrarian History of England and Wales, Volume V: 1640-1750 (Cambridge: Cambridge University Press, 1985), Table XII, p. 856.
1749-1805: wheat; reported decadal, interpolated geometrically to get annual; from P. Deane and W. A. Cole, British Economic Growth 1688-1959, 2nd ed. (Cambridge: Cambridge University Press, 1962),Table 23, p. 91.
1805-1913: total agricultural products; annual; from Mitchell and Deane (1962), pp. 471-3.
1913-1938: total food; annual; from Mitchell and Deane (1962), p. 475.

Inter-Sectoral Terms of Trade, Pa/Pm (1900=100): Pm 1450-1938

1450-1649: "industrial products"; reported decadal, interpolated geometrically to get annual; from Thirsk (1967), Table XIII, p. 862.
1640-1749: "industrial products"; reported decadal, interpolated geometrically to get annual; from Thirsk (1985), Table XII, p. 856.
1740-1796: "other prices" (equals unweighted average of Schumpeter's producer goods); annual; from Deane and Cole (1962), Table 23, p. 91.
1796-1938: price indices of merchandise exports (equals Imlah and Board of Trade, linked on 1913); from Mitchell and Deane (1982), pp. 331-2.

Land/Labor Ratios (1900=100): Male Farm Labor Force 1541-1940

Post-1840:
1841-1951: males employed in agriculture, horticulture and forestry, Great Britain; reported for census dates, interpolated geometrically to get annual: from Mitchell and Deane (1962), pp. 60-1.
Pre-1841:
These early years are poorly documented, so we apply crude agricultural employment share benchmarks (SH) to population totals (P) to infer trends in the total agricultural labor force (SHxP=La), linked to the 1841 male farm labor force estimate (La) above.
Population 1541-1841: England; annual; from E. A. Wrigley and R. S. Schofield, The Population History of England 1541-1871 (Cambridge, Mass.: Harvard University Press, 1981), Table A3.3, pp. 531-4.
Total agricultural employment shares 1801-1841: census benchmarks; from Deane and Cole (1962), Table 30, p. 142.
Total agricultural employment shares 1688 and 1759: two benchmarks; from N. F. R. Crafts, British Economic Growth during the Industrial Revolution (Oxford: Clarendon Press, 1985), p. 14, 1688=55.6% and 1759=48%. We assumed the pre-1688 SH stayed at the 1688 level and filled in 1688-1759 and 1759-1801 by geometric interpolation.

Land/Labor Ratios (1900=100): Total Economy-Wide Labor Force 1541-1940

Post-1840:
1841-1951: "total occupied", males and females; reported for census dates, interpolated geometrically to get annual (including the missing years 1932-1936); from Mitchell and Deane (1962), pp. 60-1.
Pre-1841 period:
Labor force or population age distribution estimates do not exist for the period prior to the late 18th century. Thus, we simply link the population totals up to 1841 with the economy-wide labor force totals 1841 onwards (e.g., we assume the 1841 labor participation rate was constant between 1560 and 1840, and

at the 1841 rate).
Population 1541-1841: England; annual; from Wrigley and Schofield (1981), Table A3.3, pp. 531-4.

Land/Labor Ratios (1900=100): Land in Agriculture 1541-1940

Post-1866:
1867-1939: acreage in crops; Great Britain; annual: from Mitchell and Deane (1962), pp. 78-9 and we assume 1940=1939.
Pre-1867:
In his seminal paper on population in pre-industrial England, Ronald D. Lee ("Population in Preindustrial England: An Econometric Analysis," Quarterly Journal of Economics 87, 4, November 1973: 581-607) quotes Postan to justify his assumption of a constant farm land endowment: "By 1066 the occupation of England by the English had gone far enough to have brought into cultivation ... most of the area known to have been occupied in later centuries of English history." (M. M. Postan, "Medieval Agrarian Society in Its Prime," in H. J. Habakkuk and M. M. Postan (eds.), Cambridge Economic History of Europe, Volume I (2nd ed.) , Chapter VII, Part 7, pp. 567-8). We make the same assumption.

Table 1

Commodity Price Convergence? The Relative Price Spread for Three Non-Competing Goods, Amsterdam versus Southeast Asia 1580-1939

Decade	Cloves	Black Pepper	Coffee
1580-89	5.58		
1590-99	-		
1600-09	7.89		
1610-19	3.82		
1620-29	2.70	3.00	
1630-39	1.99	3.34	
1640-49	1.33	2.25	
1650-59	8.50	3.11	
1660-69	23.95	5.40	
1670-79	13.47	3.61	
1680-89	13.08	2.94	
1690-99	12.93	3.71	
1700-09	12.88	3.24	
1710-19	12.88	3.49	
1720-29	12.88	2.39	2.20
1730-39	12.88	3.79	4.24
1740-49	15.55	4.70	3.35
1750-59	21.33	4.20	3.52
1760-69	14.73	4.90	3.20
1770-79	14.73	4.36	2.90
1780-89	-	5.99	2.99
1790-99	-	9.31	9.47
1800-09	5.46	3.83	14.72
1810-19	7.89	5.03	4.98
1820-29	0.91	3.37	0.72
1830-39	0.18	2.74	0.73
1840-49	-0.22	2.07	1.21
1850-59	-0.09	2.25	0.65
1860-69	0.14	2.53	0.43
1870-79	0.44	2.14	0.26
1880-89	0.90	1.13	0.19
1890-99			0.09
1900-09			0.12
1910-19			0.36
1920-29			0.07
1930-39			0.35

Source: Bulbeck, Reid, Tan and Wu (1998), Tables 2.15, 3.6, 3.13 and 5.8, pp. 58-9, 84, 103 and 175. Calculated as Amsterdam minus Southeast Asia price, divided by Southeast Asia price. Clove prices quoted in Maluku; black pepper prices in Sumatra region; and coffee prices ("good ordinary Java") in Java or Sumatra.

Table 2

Railway Mileage, 1850-1910

Country	**1850**	**1870**	**1890**	**1910**
Austria-Hungary	954	5,949	16,489	26,834
Australia	—	953	9,524	17,429
Argentina	—	637	5,434	17,381
Canada	66	2,617	13,368	26,462
China	—	—	80	5,092
France	1,714	11,142	22,911	30,643
Germany	3,637	11,729	25,411	36,152
India	—	4,771	16,401	32,099
Italy	265	3,825	8,163	10,573
Japan	—	—	1,139	5,130
Mexico	—	215	6,037	15,350
Russia (in Europe)	310	7,098	18,059	34,990
United Kingdom	6,621	15,537	20,073	23,387
United States	9,021	52,922	116,703	249,902

Source: Hurd (1975, Appendix 2, p. 278).

Table 3. Correlation Coefficients, 1565-1936

Panel A. 1565-1828			
	PAPM	WR	LANDLAB
PAPM	1.000	-0.829	-0.956
WR	-0.829	1.000	0.889
LANDLAB	-0.956	0.889	1.000
Panel B. 1828-1936			
	PAPM	WR	LANDLAB
PAPM	1.000	-0.340	0.058
WR	-0.340	1.000	-0.859
LANDLAB	0.058	-0.859	1.000

Source: see text.

Table 4. Granger-Causality Tests, 1565-1936

Panel A. 1565-1828. Lags included: 1 (20)			
Causality from\to?	PAPM	WR1	LANDLAB
PAPM	----------------	No (No)	Yes** (No)
WR1	No (No)	----------------	Yes** (No)
LANDLAB	Yes** (Yes)	No (No)	----------------
Endogenous?	Yes (Yes)	Yes (No)	Yes (No)

Panel B. 1828-1936. Lags included: 1 (10)			
Causality from\to?	PAPM	WR1	LANDLAB
PAPM	----------------	No (No)	No (Yes)
WR1	Yes* (No)	----------------	No (Yes*)
LANDLAB	No (No)	No (No)	----------------
Endogenous?	Yes (No)	No (No)	No (Yes)

Source: see text

Table 5. Closed-Economy Theory:
The Determinants of Commodity and Factor Prices, 1565-1936

	(1)	(2)	(3)	(4)	(5)
L.H.S. variable	PAPM	PAPM	WR1	PAPM	WR1
Time period	1565-1828	1565-1800	1565-1828	1828-1936	1828-1936
C	9.152	9.048	-1.153	4.545	9.148
	(85.722)	(59.158)	(-6.234)	(33.606)	(33.857)
LANDLAB	-0.882	-0.866	0.907	0.017	-0.973
	(-52.921)	(-36.680)	(31.422)	(0.598)	(-17.390)
R-squared	0.914	0.852	0.790	0.003	0.739
Adjusted R-squared	0.914	0.851	0.789	-0.006	0.736
S.E. of regression	0.081	0.076	0.140	0.111	0.222
Sum squared resid	1.708	1.335	5.128	1.327	5.295
Log likelihood	290.753	275.775	145.631	85.615	10.172
Durbin-Watson stat	0.268	0.022	0.116	0.267	0.103
Mean dependent var	3.508	3.441	4.653	4.625	4.464
S.D. dependent var	0.276	0.196	0.305	0.111	0.433
Akaike info criterion	-2.188	-2.320	-1.088	-1.534	-0.150
Schwarz criterion	-2.160	-2.291	-1.061	-1.485	-0.101
F-statistic	2800.645	1345.412	987.336	0.358	302.421
Prob(F-statistic)	0.000	0.000	0.000	0.551	0.000
Included observations	264	236	264	109	109

Source: see text.

Table 6. Open-Economy Theory:
The Determinants of the Wage-Rental Ratio, 1565-1936

	(1)	(2)
Time period	1565-1828	1828-1936
C	0.053	-4.500
	(0.047)	(-1.691)
LANDLAB	0.666	1.013
	(5.481)	(3.706)
PAPM	0.158	-0.770
	(1.560)	(-5.496)
@TREND(1565)	-0.002	0.024
	(-6.092)	(7.268)
R-squared	0.821	0.882
Adjusted R-squared	0.819	0.879
S.E. of regression	0.130	0.151
Sum squared resid	4.372	2.384
Log likelihood	166.686	53.659
Durbin-Watson stat	0.134	0.321
Mean dependent var	4.653	4.464
S.D. dependent var	0.305	0.433
Akaike info criterion	-1.232	-0.911
Schwarz criterion	-1.178	-0.812
F-statistic	398.067	262.437
Prob(F-statistic)	0.000	0.000
Included observations	264	109

Table 7

Wage/Rental Ratio Trends in Europe, the Mediterranean and the New World, 1870-1939

Period	Land Abundant			Land Scarce						
	Australia	Canada	USA	Britain	Denmark	France	Germany	Ireland	Spain	Sweden
1870-1874	4.095		2.302	0.529	0.445	0.638	0.851		1.192	0.423
1875-1879	2.489		1.922	0.574	0.433	0.632	0.807	0.592	1.010	0.434
1880-1884	2.353		1.856	0.606	0.446	0.675	0.830	0.695	1.101	0.503
1885-1889	2.128		1.794	0.683	0.563	0.741	0.867	0.831	1.006	0.573
1890-1894	1.340		1.709	0.738	0.664	0.807	0.989	0.993	0.986	0.647
1895-1899	1.453		1.724	0.816	0.875	0.922	1.091	1.188	0.952	0.780
1900-1904	1.279	0.879	1.699	0.853	1.033	1.035	1.085	1.085	0.922	0.872
1905-1909	0.963	1.008	1.308	0.916	0.992	1.067	1.055	0.989	1.013	0.917
1910-1914	0.990	1.032	0.996	0.960	0.995	1.001	1.010	0.936		0.982
1915-1919	1.093	1.450	1.229	1.430		1.242				1.422
1920-1924	1.350	1.581	1.206	1.846		1.571				1.354
1925-1929	1.132	2.551	1.577	1.565		1.175				1.153
1930-1934	0.967	2.366	1.628	1.778		1.335				1.340
1935-1939	1.088	2.429	2.366	1.929		1.688				

Sources and Notes: The base year is 1913=1.00, except for Denmark and Spain, where the figures are indexed 1912=1.00 and 1909=1.00 respectively. The Canadian figure for 1900-1904 is actually 1901-1904, the British figure for 1935-1939 is actually 1935-1936, the Danish figure for 1910-1914 is actually 1910-1912, the Irish figure for 1875-1879 is actually 1876-1879, the Irish and German figures for 1910-1914 are actually 1910-1913, and the Swedish figure for 1930-1934 is actually 1930. The source is O'Rourke, Taylor and Williamson (1996) for series until 1913, except for Canada. For the period 1914-1939, the sources are the following: Australian data from Scott (1969); US nominal wages from Mitchell (1975) and rents from Lindert (1988); British nominal wages from Mitchell (1980) and rents from Turner, Beckett and Afton (1997) and Rhee (1949); French nominal wages from Mitchell (1980) and rents from Leby-Leboyer (1972); Swedish nominal wages from Bagge, Lundberg and Svennilson (1935) and rents from Lindahl, Dahlgreen and Koch (1937). Finally, Canadian nominal wages are from Dick (1982) for 1870-1900, and from Mitchell (1983) for 1901-1939, and rents are from the Sixth Census of Canada (1921), the Seventh Census of Canada (1931) and the Eighth Census of Canada (1941). A fuller description of these revisions, extensions and sources can be found in Wiliamson (1999c).

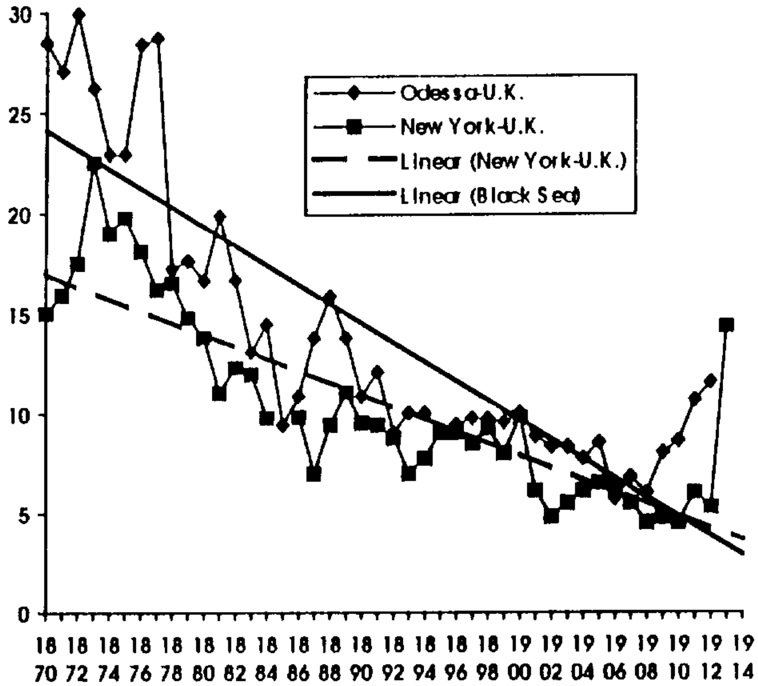
Table 8

Wage/Rental Ratio Trends in the Third World, 1870-1939

Period	Land Abundant						Land Scarce		
	Argentina	Uruguay	Burma	Siam	Egypt	The Punjab	Japan	Korea	Taiwan
1870-1874		11.1248		38.6017		3.0993			
1875-1879		8.9130		32.1084	3.1857	3.1278			
1880-1884	6.9115	7.2825		25.5321	5.0566	2.3202			
1885-1889	4.0139	4.0021		19.1536	9.9072	2.3759	0.9106		
1890-1894	4.3427	3.7719	1.8652	11.0961	7.4498	1.7136	0.7822		
1895-1899	3.7043	3.0361	1.8553	2.4754	2.9276	1.4502	1.0401		
1900-1904	3.4503	2.3299	1.8252	1.4211	3.0476	1.5729	1.0950		0.6805
1905-1909	1.6100	1.6777	1.3625	0.4698	1.1779	1.4557	1.2586	0.8301	0.8507
1910-1914	1.0001	1.1788	1.0445	0.9020	1.4581	1.2620	1.2253	0.9847	0.9645
1915-1919	0.6379	1.2083	1.6095	1.6605	1.5258	1.3009	1.1953	0.8835	1.1106
1920-1924	0.6324	1.5026	1.1097	1.2973	2.2715	1.2787	1.8926	1.7560	1.3985
1925-1929	0.6072	1.5018		0.9440	2.2079	1.1439	2.3062	1.6903	1.3467
1930-1934	0.6951	1.7434		0.9288	2.1249	0.7949	2.6160	1.5671	1.3057
1935-1939	0.7089	2.1353		0.9993	1.6635	0.5231	1.7082	1.7400	1.2342

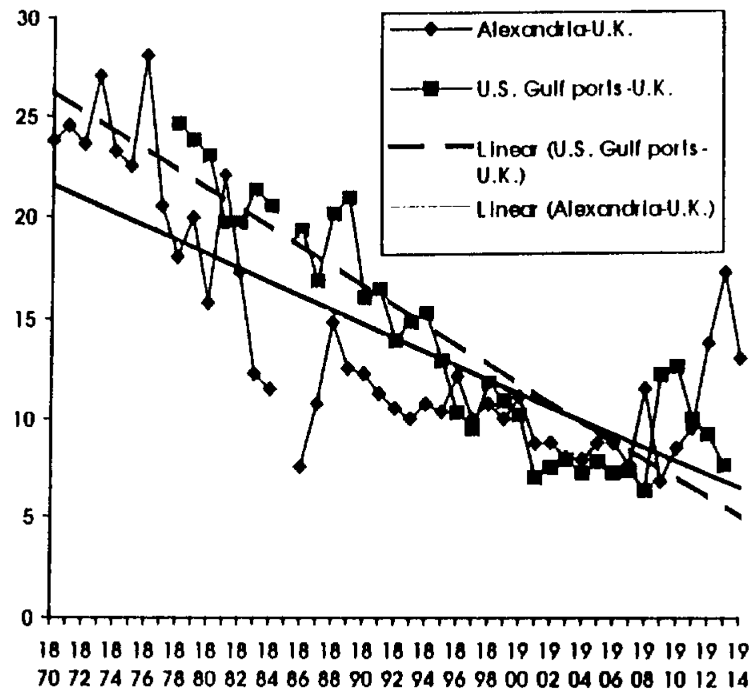
Sources and Notes: The base year is 1913=1.00. The Argentine figure for 1880-1884 is actually 1883-1884, the Burmese figure for 1920-1924 is actually 1920-1923, the Egyptian figure for 1875-1879 is actually 1877-1879, the Punjab figure for 1870-1874 is actually 1873-1874, the Japanese and Korean figures for 1935-1939 are actually 1935-1938, the Korean figure for 1905-1909 is actually 1909 and the Taiwanese figure for 1900-1904 is actually 1904. Sources are Williamson (1999d, Table 3), except for Uruguay, which is taken from ongoing research by Luis Bértola, and Burma and Siam, both taken from Williamson (1999c), where a much fuller description of sources and notes for all these time series is given.

Figure 1
Freight Rates on Grain Shipped from the Black Sea and the US East Coast to British Ports 1870-1914



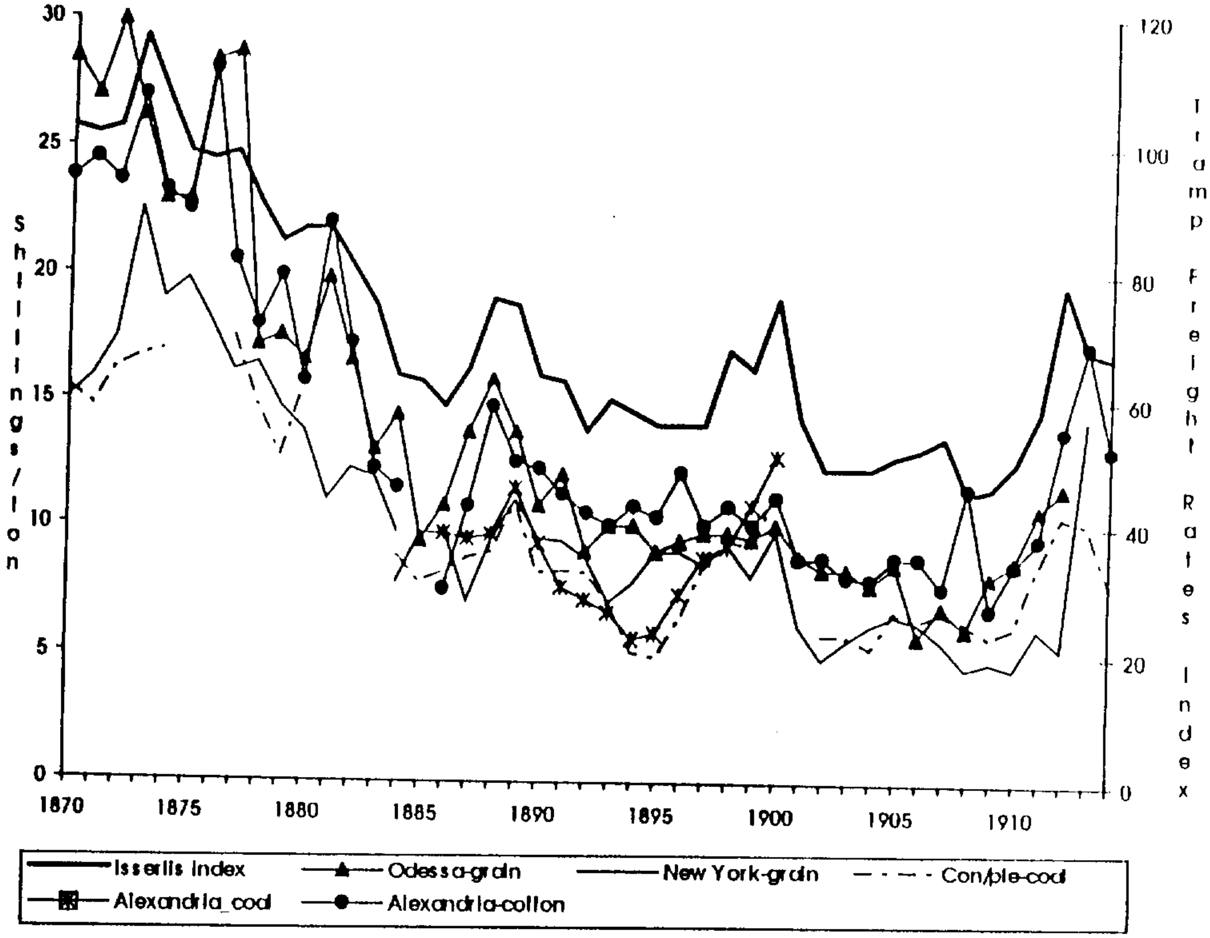
Source: Harlaftis and Kardasis (1999), Figure 9.2, nominal rates in shillings per ton.

Figure 2
Freight Rates on Cotton Shipped from Egypt and the US Gulf to British Ports 1870-1914



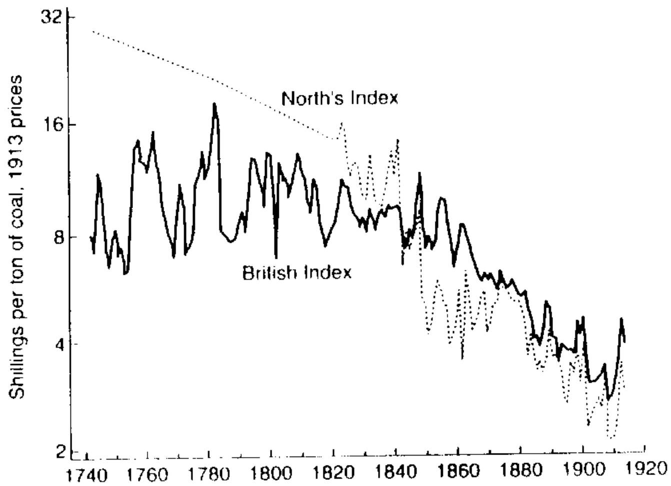
Source: Harlaftis and Kardasis (1999), Figure 9.6, nominal rates in shillings per ton.

Figure 3
Freight Rates Along Mediterranean and Atlantic Routes and the Tramp Freight Rates Index 1870-1914



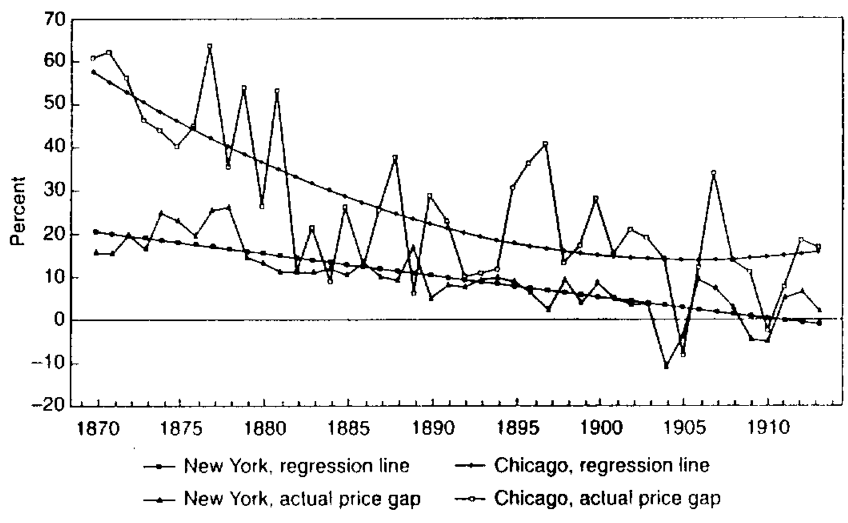
Source: Harlaftis and Kardasis (1999), Figure 9.7, nominal rates in shillings per ton and index 1896=100.

Figure 4
Real Freight Rate Indexes 1741-1913



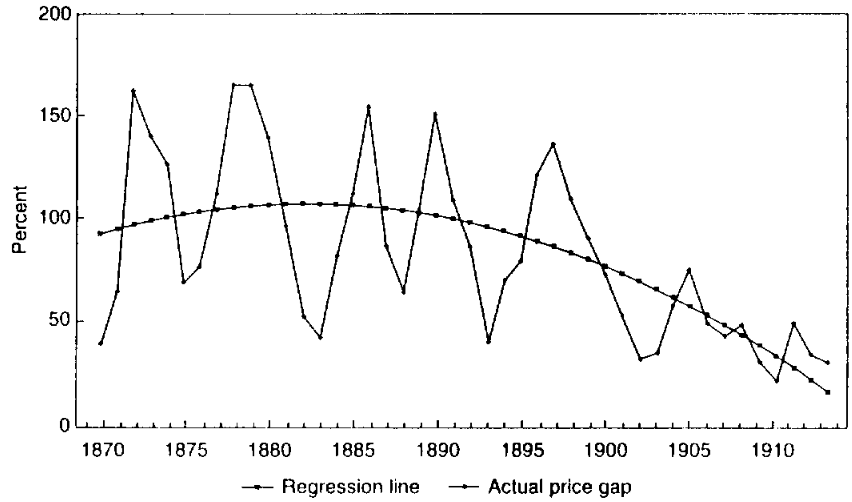
Source: Harley (1988, Figure 1), nominal rates deflated by UK GNP deflator.

Figure 5
Wheat Price Differentials: Britain-United States 1870-1914
(as percent of US)



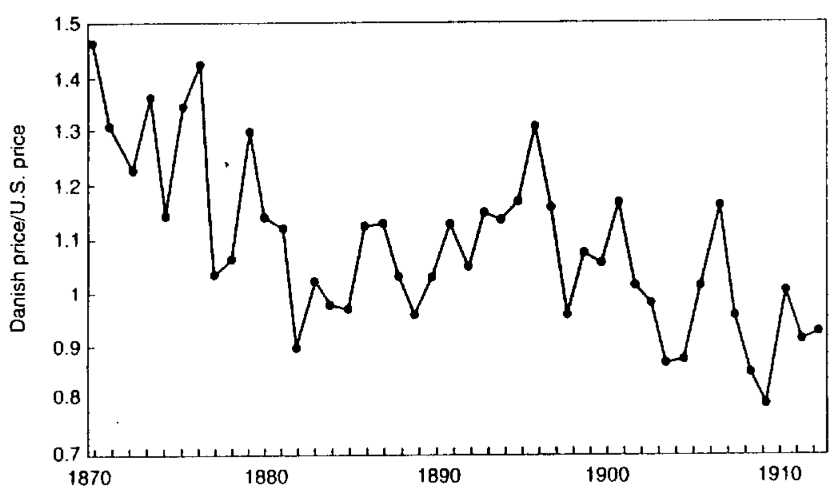
Source: O'Rourke and Williamson (1999), Figure 3.4.

Figure 6
Meat Price Differentials: Britain-United States 1870-1914
(as percent of US)



Source: O'Rourke and Williamson (1999), Figure 3.5.

Figure 7
Wheat Price Differentials: Denmark-United States 1870-1913
(as percent of US)



Source: O'Rourke and Williamson (1999), Figure 3.7.

Figure 8A
Trends in Land-Labor Ratios, Wage-Rental Ratios and Relative Prices of Agricultural Goods: England 1565-1828

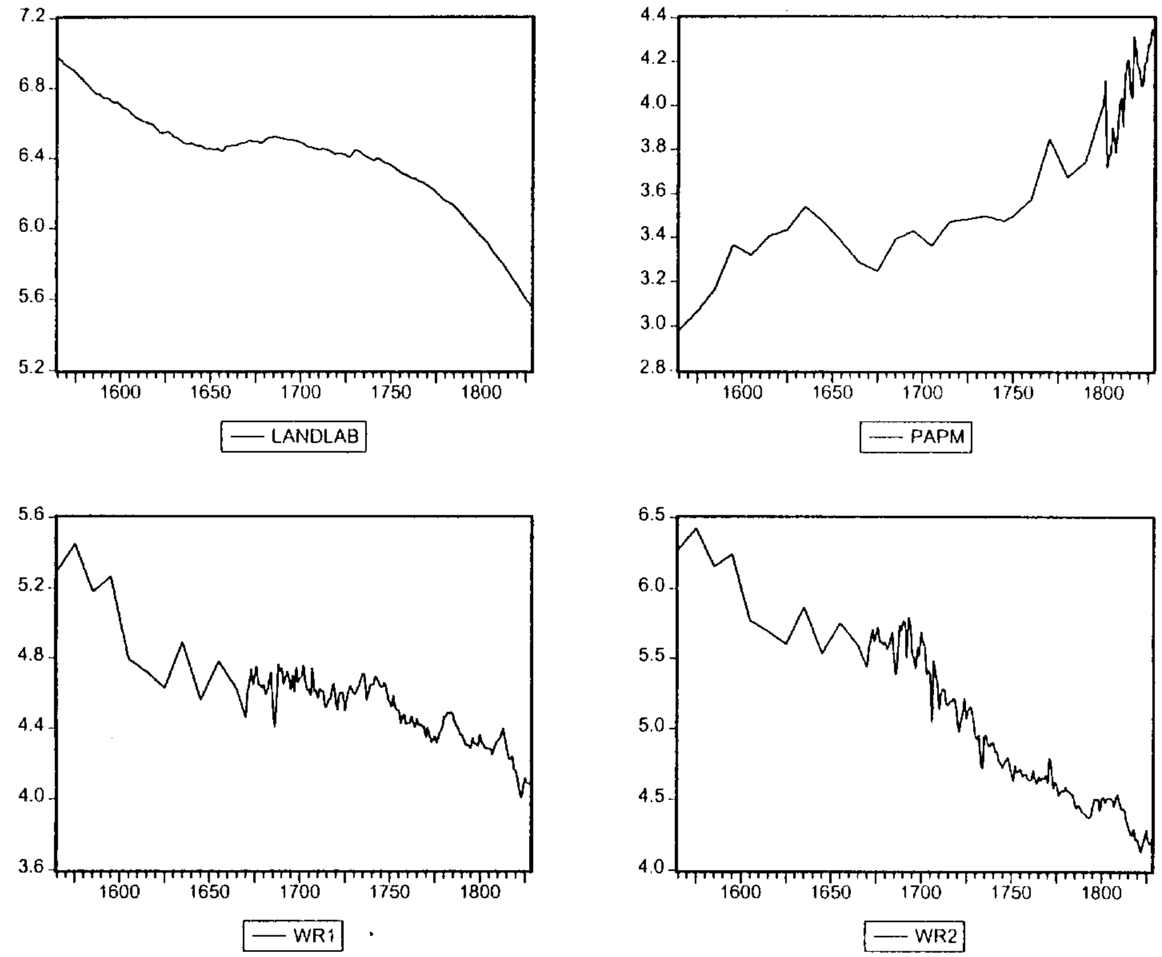


Figure 8B
Trends in Land-Labor Ratios, Wage-Rental Ratios and Relative Prices of Agricultural Goods: England 1828-1936

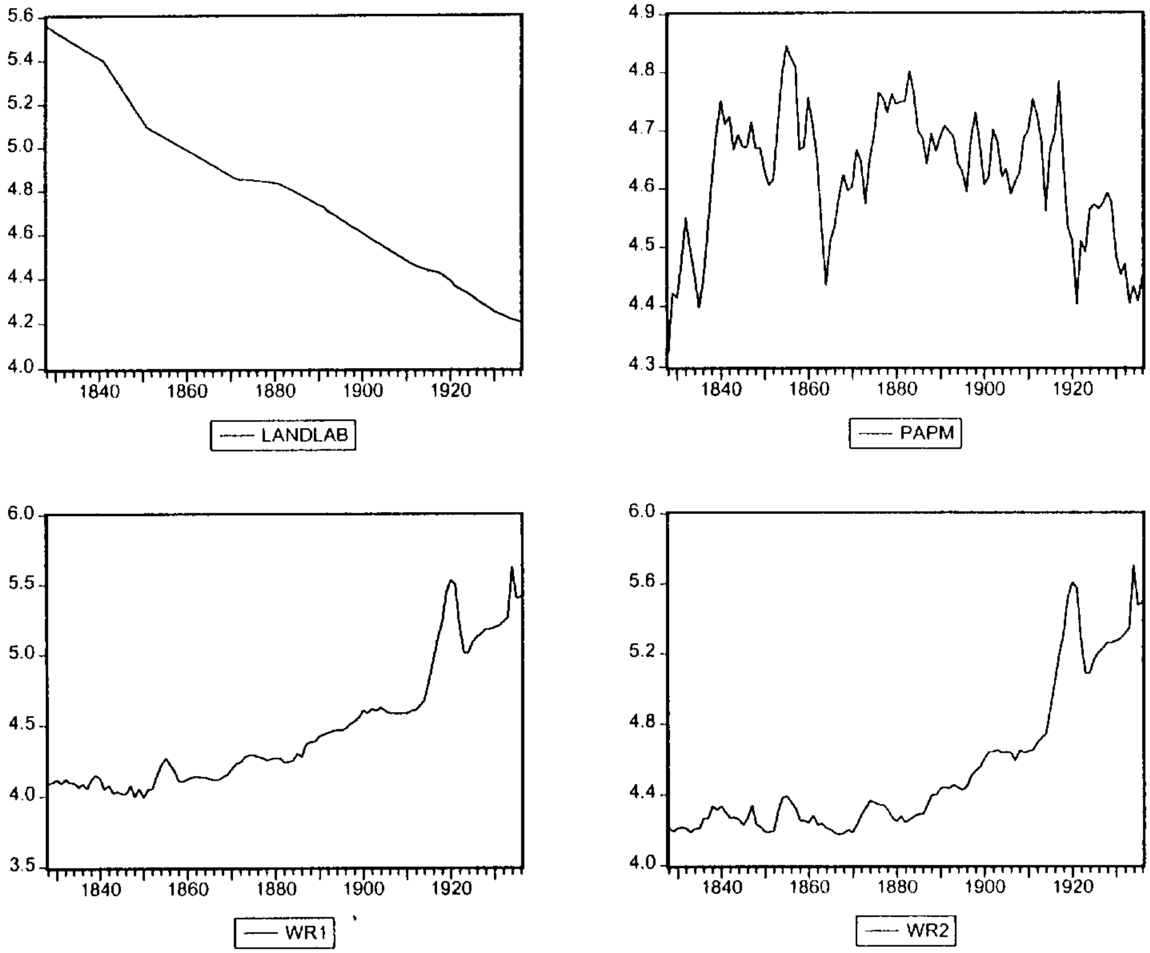


Figure 9A
Response to One S.D Innovations:
One Year Lag 1565-1828

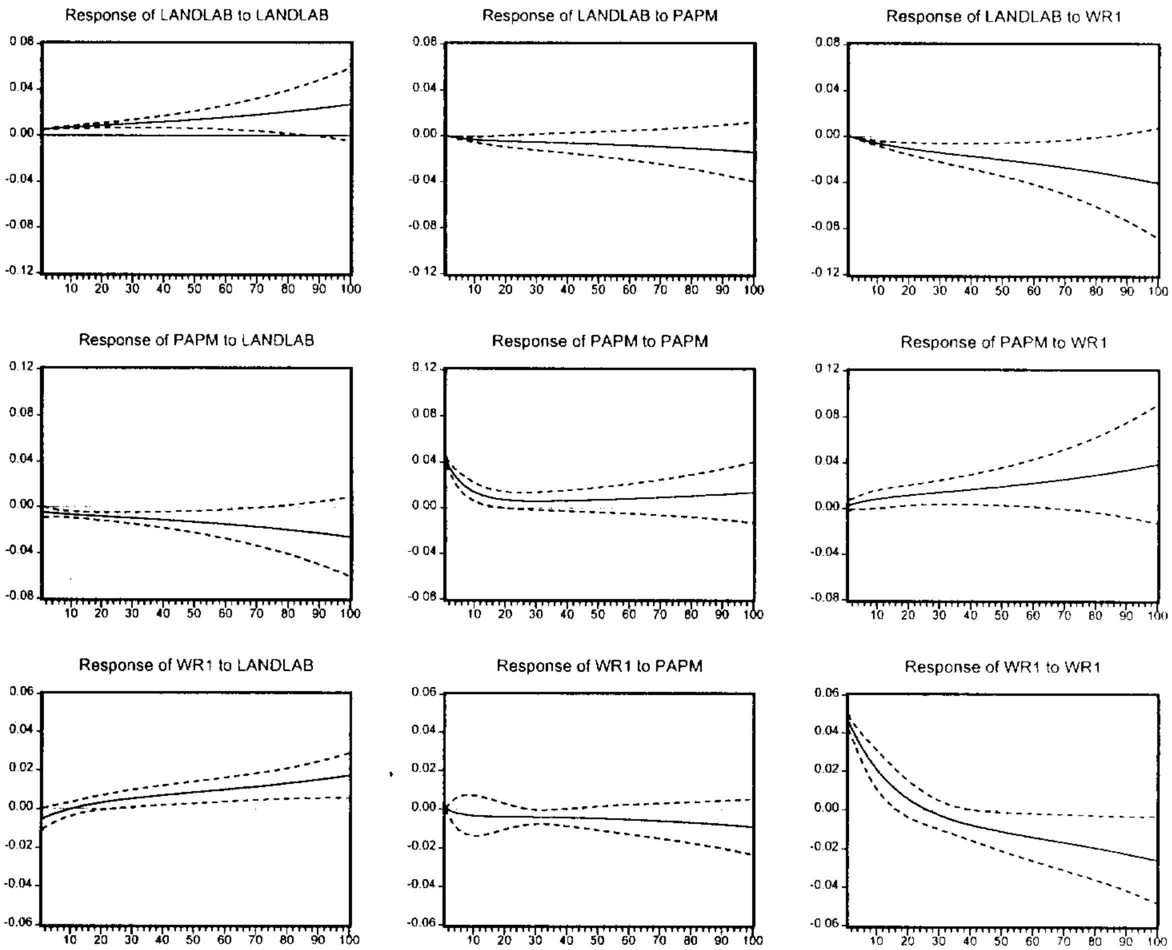


Figure 9B
Response to One S.D. Innovations:
20 Year Lag 1565-1828

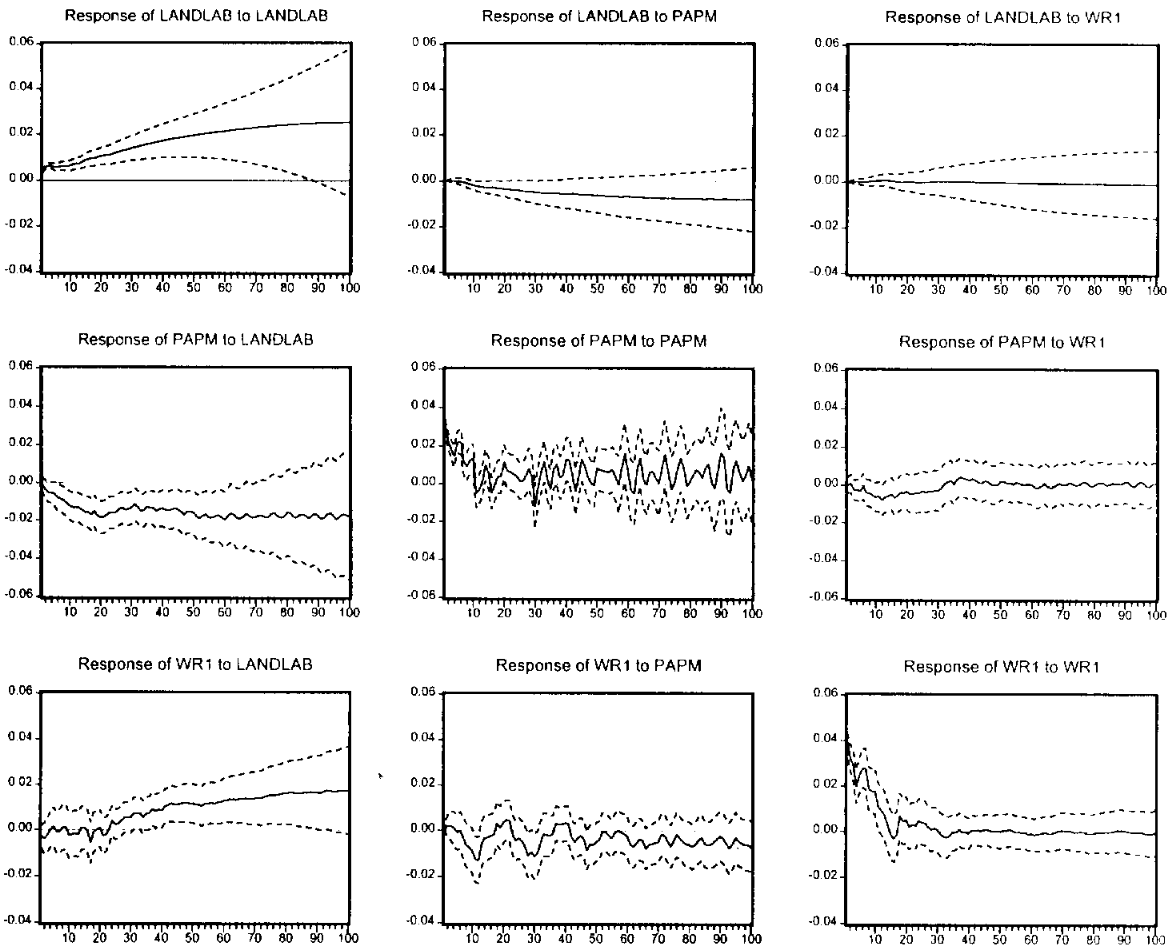


Figure 10A
Response to One S.D. Innovations:
One Year Lag 1828-1936

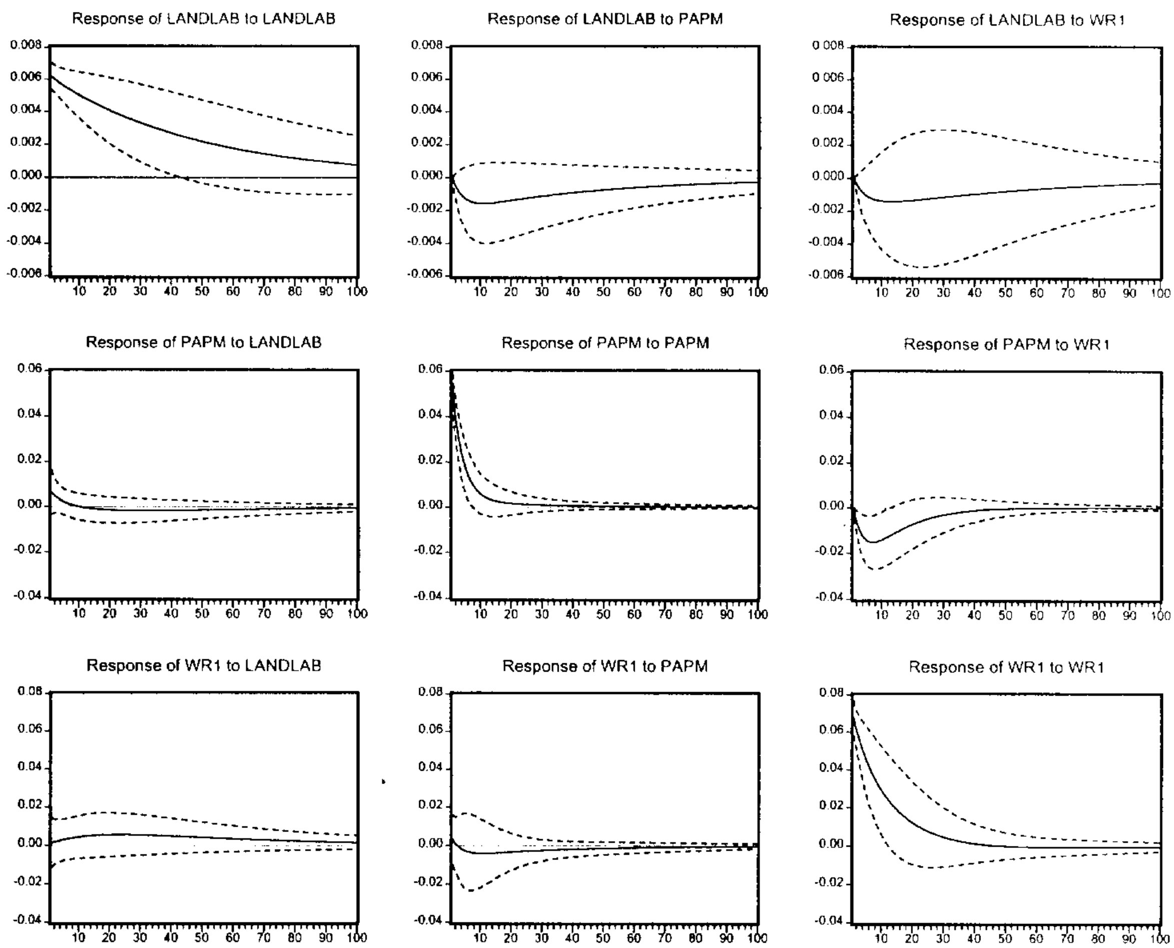
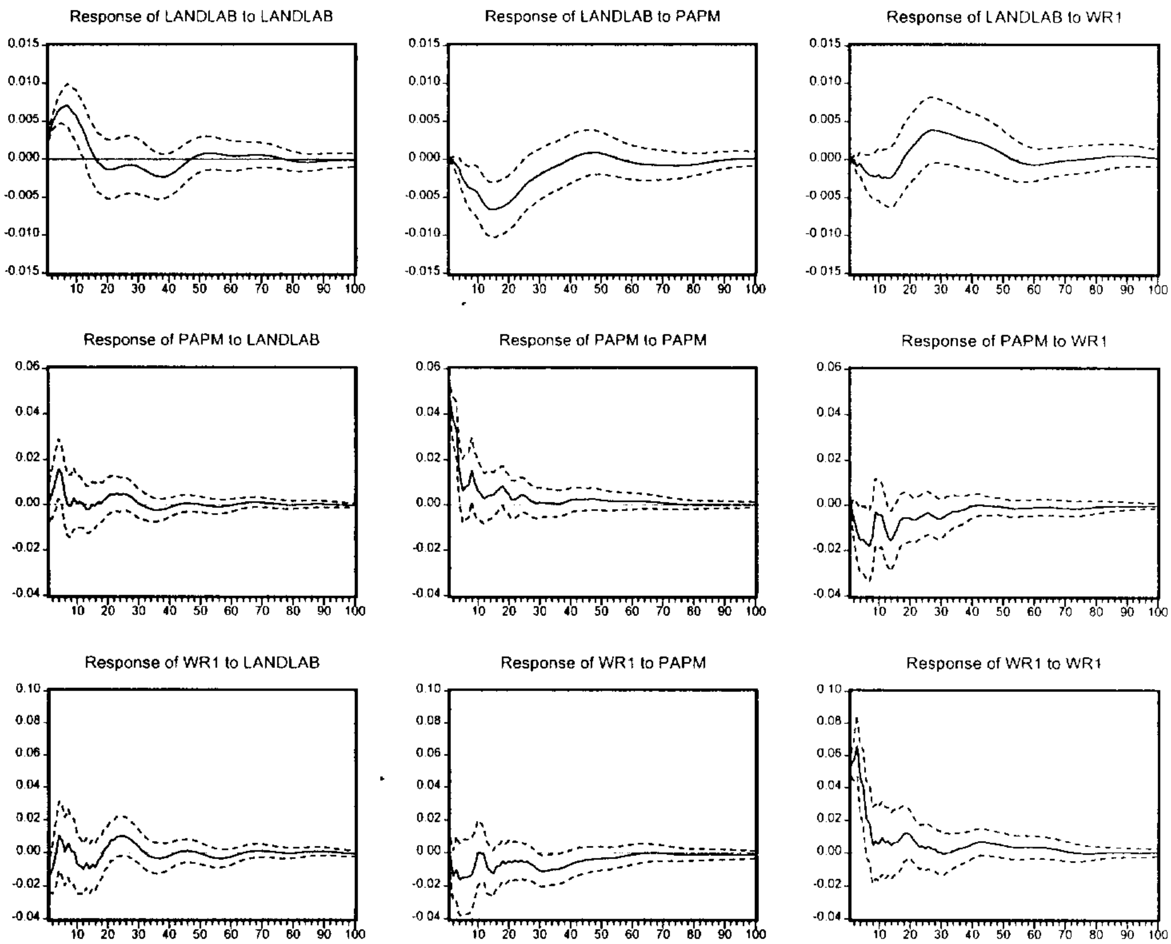


Figure 10B
Response to One S.D. Innovations:
10 Year Lag 1828-1936



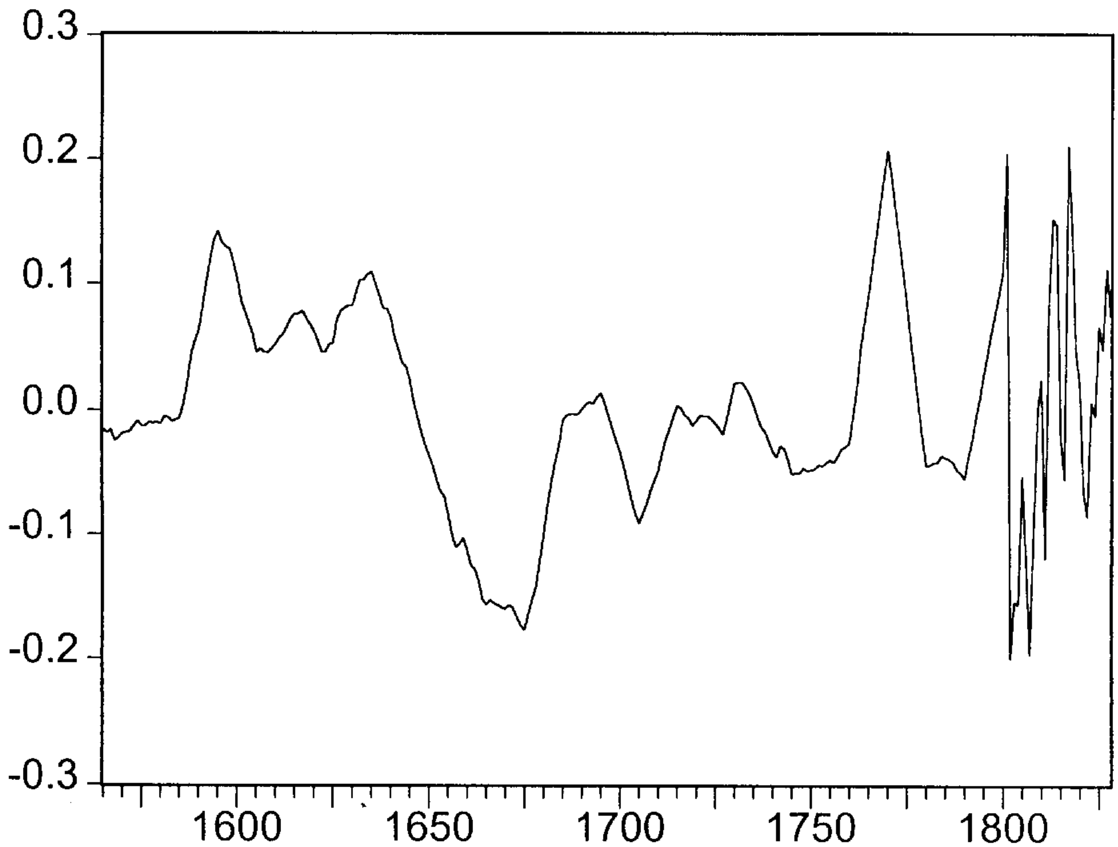


Figure 11A
Residuals from Regression (1) in Table 5

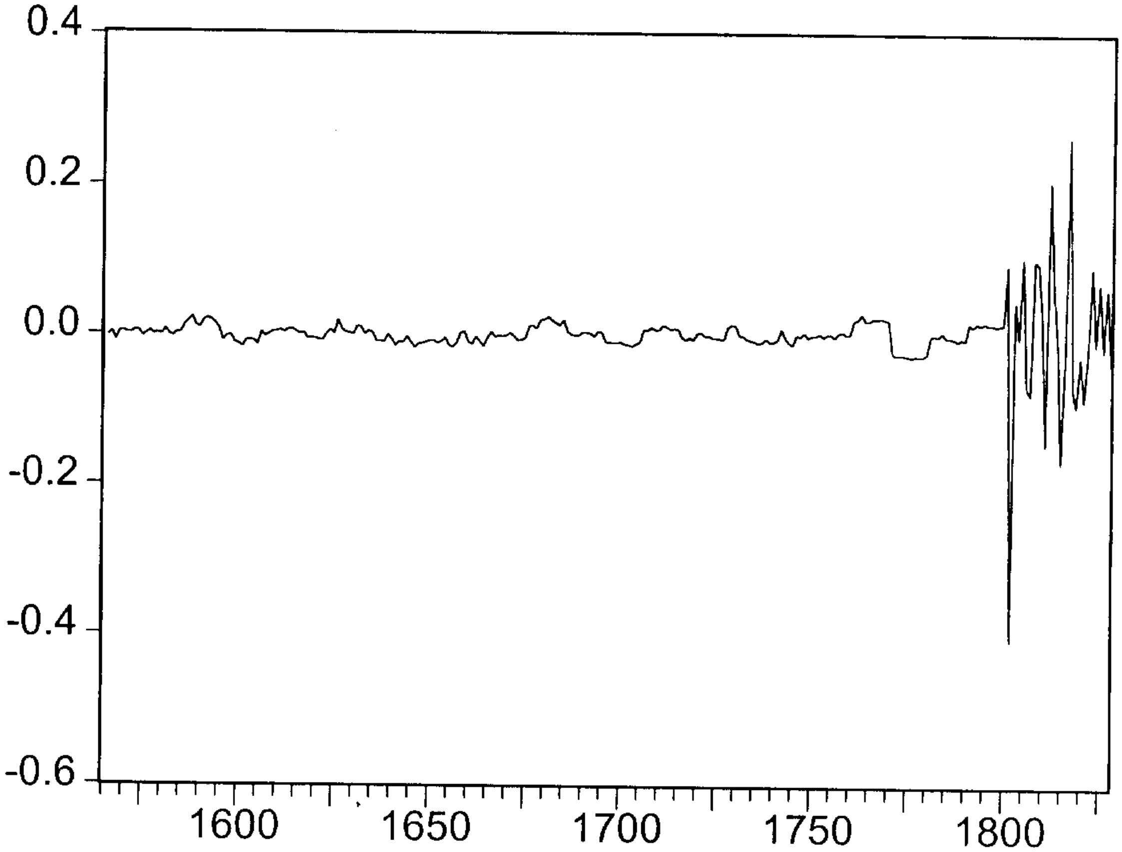


Figure 11B
First Difference of Residuals from Regression (1) in Table 5