Trade Costs in the First Wave of Globalization

This version: July 3, 2009

Abstract

What factors drove globalization in the late nineteenth century? We employ a new micro-founded measure of bilateral trade costs based on a standard model of trade in differentiated goods to address this question. These trade costs gauge the difference between observed bilateral trade and frictionless trade. They comprise tariffs, transportation costs, and all other factors that impede international trade but which are inherently difficult to observe. Trade costs fell on average by 10 to 16 percent between 1870 and 1913. We also use this measure to decompose the growth of trade over that period and find that roughly 44 percent of the rise in trade within our sample can be explained by reductions in trade costs; the remaining 56 percent is attributable to economic expansion.

1. Introduction

International trade costs are the costs of transaction and transport associated with the exchange of goods across national borders. As such they help determine the pattern of international economic integration. Economists know strikingly little about the magnitude, evolution, and determinants of these obstacles to international trade in today's global economy (Anderson and van Wincoop, 2004). Since trade costs matter for so many different phenomena in open economy macroeconomics, these forces are of wide interest (Obstfeld and Rogoff, 2000). It should also be clear that it would be impossible to study the main features of the nineteenth century international economy such as economic growth, industrialization, patterns of migration, and capital flows without a clear understanding of the dynamics of the barriers to international trade.

In light of this, substantial research on the nineteenth century trade boom has tracked certain costs like freight rates and tariffs reasonably well (O'Rourke and Williamson, 1999). But

the magnitude and impact of a host of other important impediments to trade that are inherently difficult to measure like non-tariff barriers, information costs, distribution channels, market micro-structures, legal frictions, financing costs and uncertainty remain unexplored. As a step towards a better understanding of these costs, our strategy is to move beyond the study of individual commodities and particular trade cost elements to a more general approach derived from recent advances in the economic theory of international trade applied to a wide-ranging historical data set on the value of bilateral trade.

We present a new comprehensive measure of international trade costs. By definition, the approach is capable of capturing and measuring precisely not only shipping costs and tariffs but all other informational, institutional and non-tariff barriers. Following Anderson and van Wincoop (2003, 2004) and Eaton and Kortum (2002), we acknowledge that many sizeable trade cost components such as language barriers, communication costs and non-tariff barriers are not directly observable or measurable in price differentials alone.

We base our investigation and derivation of trade costs on a micro-founded gravity model of trade that is fully consistent with the state-of-the-art literature (e.g., Anderson and van Wincoop, 2003). The gravity model is a likely starting point since it has proved very successful in many empirical studies in explaining the size and direction of trade both historically and in the present day. The framework is a multiple-country general equilibrium model of trade in differentiated goods developed by Novy (2007). We include bilateral trade costs as a driver of trade and emphasize that to be consistent with the theory these must be measured relative to trade costs with all other trade partners as well as relative to intra-national trade costs.

The innovation here is to model and control for these multilateral barriers in a tractable, yet previously un-noticed way. This makes it possible to back out the bilateral trade costs from

the model's gravity equation of international trade. Trade costs can be computed directly on the basis of bilateral trade, total trade and output data. Our methodology obviates attempts to measure trade costs via the estimation of arbitrary trade cost functions which is a typical feature of the current gravity literature. Moreover, while gravity models can tell us about the marginal impact of proxies for trade costs, our approach reveals the magnitude and dynamics of a comprehensive measure of trade costs.

Our focus is on the first wave of globalization from 1870 to 1913, a period that experienced dramatic changes in trade costs and enormous growth in international trade. During that time, the fall in trade costs does not appear as large as the roughly 2 percent annual decline in freight indices noted by Harley (1988) and Shah Mohammed and Williamson (2004). The average level of trade costs between three principal countries—the US, UK, and France—and 15 of their most important trading partners, fell by 10 to 16 percent in the forty years before World War I. Trade costs declined at a rate of about 0.3 percent per year for the average country pair. The difference can be reconciled in that transportation costs are only one input into trade costs, as emphasized by Anderson and van Wincoop (2004). A broader look at the factors contributing to declines in trade costs should include overall shipping and freight rates, the rise of the classical gold standard and the financial stability it implied, and improved communication technology. But there were also countervailing effects of trade policy. Globally, tariffs rose on average by 50 percent between 1870 and 1913. In addition, new non-tariff barriers were erected. Finally, relative prices also matter. In many cases, transport and communication costs fell more rapidly domestically than internationally raising the relative costs of international trade.[1]

---

[1] See Williamson (2006) on the global rise in tariffs measured as tariff revenue divided by import values. His world average rises from 12 percent in 1865 to 17.5 percent in 1900. See Saul (1967) for a discussion of non-tariff barriers. See Jacks (2005) on domestic integration based on wheat price data. He shows much faster within-country

Our results allow for an interpretation of the late nineteenth century in which overall declines in trade costs were much smaller than the observed decline in maritime freight rates. Nevertheless, this is still compatible with a "first wave of globalization" and even with the evidence from commodity price differentials. Small changes in trade costs (i.e., relative prices) are sufficient to generate large increases in trade flows as argued by Obstfeld and Rogoff (2000). We argue and demonstrate that one does not need to appeal to large changes in trade costs to see the doubling in the world export-to-GDP ratio reported by O'Rourke and Findlay (2003).

After examining the levels and trends in trade costs, we turn to their determinants. This exercise underscores the fact that our trade cost measure is reliable. In particular, our evidence suggests that standard variables like geographic proximity, trade policy, transportation networks, adherence to the gold standard, and membership in the British Empire matter in sensible ways for explaining trade costs.

Returning to the question of what drives globalization episodes, we use the micro-founded gravity equation to attribute the growth in global trade to two fundamental forces—the growth in productive capacity and the decline in trade costs. In line with the post-World War II experience (see Baier and Bergstrand, 2001 and Whalley and Xin, 2007), we find that roughly 56 percent of the global trade boom prior to World War I was due to the growth in productive capacity and 44 percent was due to the decline in trade costs. We also unmask a substantial degree of heterogeneity between core and periphery performance. For core countries, economic expansion contributes the lion's share of trade growth while trade cost declines dominate for the periphery.

---

integration than cross-border integration. A fall in the cost of domestic trade (all else equal) makes international trade relatively more costly.

2. Historical Perspectives on Trade Costs

Economic historians generally concede that the fifty years before World War I comprise a period of globalization akin to the present day in many respects. The world economy witnessed sustained increases in international commodity, capital, and labor flows (O'Rourke and Williamson, 1999, Obstfeld and Taylor, 2004, Hatton and Williamson, 2006). Historical accounts, as well as popular conceptions of trade in the years from 1870 to 1913, have generally stressed the singular role played by transportation and communication technologies in conquering time and space. The extension of the railroad and telegraph networks takes pride of place in promoting economic integration domestically and in helping move goods to ports. In this view, the increased use of steamships and persistent improvements in shipping technology play a similar role with respect to international markets (see Frieden, 2006, p. 19 and James, 2001, pp. 10-13).

In the most influential contribution to this literature, O'Rourke and Williamson accordingly write that the "impressive increase in commodity market integration in the Atlantic economy [of] the late nineteenth century" was a consequence of "sharply declining transport costs" (1999, p. 33). Their metric for integration is the narrowing of price gaps for key commodities such as wheat and iron. The data on this commodity price convergence throughout the nineteenth century is extensive and well-documented (O'Rourke and Williamson, 1994 and Jacks, 2005). However, O'Rourke and Williamson (1999) are quick to point out that a host of other factors could also be responsible for the dramatic boom in international trade during the period, chief among them increases in GDP and import demand.

What about other costs of trade besides transport? Recent research taking a further look at price gaps suggests a strong role for developments outside the communication and transportation

sectors. Jacks (2006) offers evidence from a number of North Atlantic grain markets between 1800 and 1913 that freight costs can only explain a relatively modest fraction of trade costs in those markets. Jacks concludes that trade costs were also powerfully influenced by the choice of monetary regime and commercial policy as well as the diplomatic environment in which trade took place.

A different strand in the literature focusing on trade values has examined integration based on the gravity approach to international trade. Estevadeordal, Frantz and Taylor (2003), Flandreau and Maurel (2005), Jacks and Pendakur (2009), López-Córdova and Meissner (2003) and Mitchener and Weidenmier (2008) find that distance, tariffs, monetary regime coordination as well as cultural and political factors played a very important role in explaining global trade patterns.

Contemporaries also perceived that the factors affecting trade were manifold but could be boiled down to technological, informational, and institutional ones. Such views are summarized in an 1897 study of trade costs in the British colonies conducted and published at the request of Joseph Chamberlain (Trade of the British Empire and Foreign Competition, 1897). The report surveyed colonial governors as to the reasons why non-Empire producers were gaining market share in the British Empire.

From their comments, it is obvious that determining international trade costs is more complex than adding together an ad valorem tariff value and unit shipping costs. Shipping costs were difficult to calculate directly as they varied by good, season, and with local economic conditions. Due to such fluctuations, the governor of the colony of Victoria in Australia hesitated to give an average of the freight costs from Europe. The diffusion of the steamship was no simple matter either as it favored certain classes of goods while sailing ships, still in heavy use

on many longer routes as late as 1894, favored others. There were also government subsidies on several, but not all, key liners traveling between East Asia and Europe. All of this suggests that any single freight index based on only a few commodities and routes is bound to be problematic if used as a summary measure of shipping costs. Likewise, the aggregate effect of tariffs is difficult to evaluate due to data limitations and general equilibrium effects on the price level (Irwin, 2007).

Other governors also noted how differential marketing techniques, proximity, information about local tastes and needs, credit practices, the relative quality and appearance of goods, exchange rate stability, and even the precise weights and measures used in the marketing process helped determine trade flows. Moreover, Saul (1967) discusses at length how non-tariff barriers were impeding trade. Discriminatory railway tariffs, health and safety regulations, along with conditional clauses to trade treaties and lengthy legal delays in challenging them featured in the late nineteenth century trading system.

What all of this evidence suggests is that our knowledge of the level and evolution of aggregate trade costs in the nineteenth century has a gap. Moving beyond the study of individual commodities and particular trade cost elements to a more general attack on the issue would be beneficial. We now show how to measure trade costs in a comprehensive way.

3. International Trade in General Equilibrium with Trade Costs

We base our trade cost measure on the gravity model of international trade, one of the most successful empirical models in economics. Such models generally hold that trade between two countries depends on the trade partners' size and trade frictions. In the historical period at hand, Estevadeordal, Frantz and Taylor (2003), Flandreau and Maurel (2005), Jacks and

Pendakur (2009), López-Córdova and Meissner (2003) and Mitchener and Weidenmier (2008) all show that the gravity model explains a high proportion of the variation in bilateral trade flows. This literature has decidedly advanced our understanding of trade patterns by studying the marginal impact on trade flows of various proxies for trade barriers.

The gravity model of trade has a strong general theoretical backing as well. A gravity model of trade can be derived from nearly all leading theories of trade including increasing returns models with complete specialization, Heckscher-Ohlin models based on differential factor endowments with incomplete specialization, and Ricardian models of trade (Evenett and Keller, 2002; Eaton and Kortum, 2002). Strikingly, all of these gravity models, which are derived from very different underlying assumptions, end up producing almost identical estimating equations describing bilateral trade. The canonical gravity relation shows that exports are a function of the product of both trading partners' market size and trade frictions. Because most models produce the same gravity equation, it has been hard for the literature to discriminate between trade theories. Therefore, our approach does not depend on assuming any specific model of trade. In particular, the analysis is in line with O'Rourke and Williamson (1999) who find evidence consistent with the Heckscher-Ohlin model. The intuition for this somewhat curious result is that gravity is simply an expenditure equation, and expenditure equations arise in any general equilibrium model of trade.

Overall, our methodology is closely related to a very large body of proven empirical and theoretical work. However, the novelty in our theoretical approach allows us, for the first time, to study the dynamics of all barriers to trade rather than the marginal impact of a select and small set of easily observed proxies. And while the commodity price convergence literature has advanced our understanding of the magnitude and evolution of barriers to trade based on several

specific commodities, our results rely on total trade values and hence provide greater systematic coverage. We emphasize that deriving a measure of aggregate trade costs based on price gaps would be impractical due to data limitations.

Recent theoretical advances in the trade literature have revived interest in trade costs. In their state-of-the-art contribution, Anderson and van Wincoop (2003) provide a now widely used method to empirically estimate the elasticity of trade with respect to bilateral trade barriers. Moreover, they show how to avoid an omitted variables bias in such an estimation. They demonstrate that the volume of trade between two countries is not only determined by their bilateral trade barrier but also by their trade barriers with all other trading partners. These multilateral barriers are appropriately weighted averages of all bilateral barriers. What matters for the volume of trade between two particular countries is how their bilateral barrier compares to other bilateral barriers.

Novy (2007) shows that multilateral trade barriers can simply be related to a country's total exports. The intuition is that the more a country of a given size exports, the lower must be its trade barriers with other countries. Given this way of controlling for time-varying multilateral barriers, the model goes on to derive an analytical solution for micro-founded bilateral trade costs that depends on observable variables such as trade and output data. It therefore becomes possible to compute bilateral trade costs over time. This is the strategy that we pursue in this paper.

It is important to stress that the model by Novy (2007) is based on the same multiple-country general equilibrium framework as the model by Anderson and van Wincoop (2003). In particular, goods are differentiated by country and consumers love variety, so we use a standard

CES Dixit-Stiglitz consumption index. Trade between countries is costly, as captured by iceberg trade costs.

The innovation of the theoretical model is twofold. First, as already mentioned, the model provides a convenient way of controlling for multilateral barriers so that it becomes possible to solve for bilateral trade costs. This simplification implies that we do not need to impose any particular structure on trade costs either as to the set of determinants or their underlying functional form.[2]

Second, the model relaxes the assumption made by Anderson and van Wincoop (2003), and nearly all of the gravity literature, that all goods are tradable. When computing trade costs, we explicitly allow for the fact that some goods are non-tradable. Below we test the sensitivity of all of our results to this modification and show that our central findings are robust.

Finally, it should be emphasized that we consider aggregate trade and, thus, a very large range of goods. The commodity price gap methodology is intuitively appealing, but is restricted to only a few goods due to data limitations and rests on the absence of price discrimination (see Section 4 in Anderson and van Wincoop, 2004). We base our results on a proven trade model, and as in any other gravity model, we impose assumptions on the elasticity of substitution and the aggregate tradability of the economy to generate an estimate of bilateral trade costs. But as we show in an appendix, neither of these two assumptions drive our analysis. Overall, we view our methodology as complementary to measures of commodity price gaps. Both approaches have their own advantages, and while focusing on different segments of the market, each can provide valuable insights into the integration of world markets.

---

[2] The gravity equations by Baier and Bergstrand (2001) and Anderson and van Wincoop (2003) include unobservable and highly nonlinear price indices. Baier and Bergstrand (2001) only consider transportation costs and tariffs, whereas Anderson and van Wincoop (2003) assume that trade costs are a function of distance and a border barrier.

3.1 A Gravity Equation with Trade Costs

This section provides a brief outline of the Novy (2007) model. The model is general equilibrium and comprises multiple countries that can vary in size. In each country, monopolistically competitive firms produce differentiated goods. Optimizing individuals receive utility from consuming a large variety of both domestic and foreign goods. When goods are shipped from country j to country k, exogenous iceberg trade costs $\tau_{j,k}$ are incurred, meaning that for each unit shipped the fraction $\tau_{j,k}$ melts away during the trading process as if an iceberg were shipped across the ocean. Modeling trade costs in this way is well established and customary in the literature; for example, see Samuelson (1954), Krugman (1980), and Anderson and van Wincoop (2003) whose representation of trade costs is equivalent to using iceberg trade costs. We refer to the working paper version for details of the model (Jacks, Meissner, and Novy, 2006).

We emphasize that all of our trade costs imply a normalization such that trade costs $\tau_{j,k}$ actually capture what makes international trade more costly over and above domestic trade. For more details on this point, see Novy (2007) and Anderson and van Wincoop (2004, p. 716).[3]

We also follow the literature by making the standard assumption of trade cost symmetry ($\tau_{j,k} = \tau_{k,j}$). But even if the two bilateral trade barriers are asymmetric, their geometric average corresponds precisely to the trade costs implied by the symmetry assumption. In that sense, our trade costs can be interpreted as an average of the barriers in both directions and the symmetry

---

[3] This point can be seen in the example of grain shipments from the US to the UK after 1850. Much of the decrease in the price gap between England and the US came through a narrowing of price gaps between the Midwest and the East coast. Transportation networks improved the links between the Midwest and the Atlantic ports. In this case, we might see commodity price convergence between Chicago and Liverpool but little change in trade shares. The price impact here for the bulk of the domestic market would be roughly the same as for consumers in the UK. Federico and Persson (2007) examine this issue in detail.

assumption is not restrictive. Identifying the degree of asymmetry from trade data is generally problematic (see Anderson and van Wincoop, 2003, p. 175).

The equilibrium solution of the model gives rise to the following micro-founded gravity equation

(1) $EXP_{j,k}EXP_{k,j} = s_j(GDP_j - EXP_j)s_k(GDP_k - EXP_k)(1-\tau_{j,k})^{2\rho-2},$

where $EXP_{j,k}$ are real exports from j to k, GDP_j is real output of country j, and $EXP_j \equiv \sum_{k \neq j} EXP_{j,k}$ are total real exports from j. The elasticity of substitution is given by ρ, and s_j is the fraction of the entire range of goods produced in country j that is *tradable*. A key feature of gravity equation (1) is that it relates a country's multilateral trade barriers to its total exports. Intuitively, the more a country exports, the lower must be its trade barriers with other countries. All else being equal, for a given bilateral trade barrier $\tau_{j,k}$ a drop in multilateral trade barriers (captured by increases in EXP_j and EXP_k) leads to less bilateral trade $EXP_{j,k}EXP_{k,j}$ as trade is diverted to other countries.

We need to make clear what is meant by the term *tradable* in this context. A non-tradable good is inherently impossible to trade at any level of trade costs. Other goods may be tradable but traded in only very small quantities or not at all due to prohibitive trade costs. For instance, beef from Argentina could have been exported to Europe but at very great cost prior to modern refrigeration technology, so we would classify this product as tradable throughout the period but not very heavily traded. Some portion of the range of goods produced, however, is inherently non-tradable such as government services and so forth.

Our gravity equation is not a function of a simple GDP term. As in any gravity equation, bilateral trade flows are an increasing function of productive capacity and a decreasing function of trade frictions. The innovation of micro-founded gravity equation (1) is to show that the total export terms encompass multilateral trade barriers in a convenient and practical way. In

particular, the *GDP-EXP* terms are theoretically appropriate controls for both size and multilateral resistance (see Jacks, Meissner, and Novy, 2006). For example, suppose that exports of country j with all other countries besides k increase so that EXP_j increases. Hold all else equal on the right hand side of equation (1). Then $EXP_{j,k}EXP_{k,j}$ must go down. The intuition is as follows. For total exports EXP_j to increase, country j's trade costs with other countries must have decreased, for instance $\tau_{j,l}$ with $l \neq k$. Trade with country k has therefore become relatively more costly, leading to the decrease in $EXP_{j,k}EXP_{k,j}$. Equation (1), thus, captures the point forcefully made by Anderson and van Wincoop (2003) that trade flows are not only determined by bilateral trade costs $\tau_{j,k}$ but also by multilateral trade barriers.

3.2 Measuring Trade Costs with the Gravity Model of Trade

Since equation (1) relates multilateral resistance to total export terms, it becomes possible to rearrange equation (1) so as to directly solve for trade costs $\tau_{j,k}$ as a function of observable variables, or

$$(2) \quad \tau_{j,k} = 1 - \left(\frac{EXP_{j,k}EXP_{k,j}}{s_j(GDP_j - EXP_j)s_k(GDP_k - EXP_k)} \right)^{\frac{1}{2\rho-2}}.$$

This is the key equation of the paper. Trade costs are not estimated. They are simply calculated directly as a function of the trade and GDP data.[4] Equation (2) shows that if trade flows between j and k have increased but productive capacity in the two countries has remained constant, then

---

[4] A potential concern in this regard may be measurement error in the GDP series. Suppose that GDP growth is overstated implying that early GDP figures—say, for 1870—are too low relative to later GDP figures—say, for 1913. Since our trade cost measure is positively related to GDP, we would compute relatively low trade costs for 1870 and relatively high trade costs for 1913, underestimating the true decline in trade costs. For the decomposition exercise below, we would attribute too little to the decline of trade costs and too much to the increase in GDP. Inevitably, we have to rely on the available data for GDP and are, therefore, vulnerable to potential measurement error. However, our robustness exercise in Appendix II shows that our trade cost measure is not overly sensitive to the share of tradable goods in the economy nor the value of the elasticity of substitution. Thus, we would not expect our trade cost measure to be overly sensitive to GDP measurement error.

trade costs must have come down to facilitate the increase in trade. Conversely, if trade flows between j and k have remained constant but productive capacity has increased, then trade costs must have gone up because the increase in output has not fed through to trade. We stress that $\tau_{j,k}$ is the geometric average of the bilateral trade barriers in both directions. Even if the two bilateral trade barriers are asymmetric, their geometric average would correspond precisely to $\tau_{j,k}$ in equation (2).

Note that productivity changes do not affect $\tau_{j,k}$. Consistent with the overwhelming majority of models in the New Open Economy Macroeconomics literature, the production function is assumed to be linear in productivity (see Obstfeld and Rogoff, 1995). An increase in the productivity of country j will feature multiplicatively in bilateral exports, in total exports, and in GDP and will, therefore, cancel out in equation (2). The intuition is that price changes arising from productivity changes affect all consumers both domestic and foreign. As trade costs here measure the relative cost of international versus domestic trade, $\tau_{j,k}$ is unaffected by price effects arising from productivity changes. There is a potential measurement issue if productivity improvements in the tradable and non-tradable sectors differ. Appendix I demonstrates that by employing equation (2) above we are, in effect, providing an upper-bound estimate of the potential contribution of trade cost declines to 19th century trade growth if productivity grew more quickly in the tradable than in the non-tradable sector. In any case, the potential quantitative impact for reasonable productivity growth rate differentials is not large.

We consider aggregate trade flows between j and k such that $\tau_{j,k}$ is a measure of aggregate trade costs. Thus, trade in particular goods like wheat or coal is not our focus. Our trade costs are also country-pair specific, and it is easy to compute the change of these trade costs over time. As

we show in the working paper version (Jacks, Meissner, and Novy, 2006), trade cost measure (2) is also valid in the more general case when countries run trade deficits or surpluses.

4. The Empirics of Trade Costs

4.1 Data and Methods

In this section, we provide an overview of trends in trade costs from 1870 to 1913. To compute trade costs, we make use of the expression given in (2). All that is required is bilateral and total trade data as well as GDP. The GDP data were taken from Maddison (1995) while the trade data were taken from the *Statistical Abstract of the United Kingdom* (various years), the *Statistical Abstract of the United States* (various years), and the *Tableau Général du Commerce de la France avec ses Colonies et les Puissances Etrangères* (various years). We consider all French, UK, and US destined or originated bilateral trade for which there is also a full set of GDP data (15 countries plus France, the UK, and the US).[5]

Thus, the full panel of trade costs is balanced and evenly weighted between French, UK, and US trade with 2,112 unique dyadic observations in total. In the regressions below, fifteen observations are lost for countries with no railways (Japan before 1872 and New Zealand before 1873), but this is not expected to impart any systematic bias.

Two parameter assumptions are necessary to compute trade costs. For the reported results, the fraction of tradable goods produced, *s*, was set to 0.8 while the elasticity of

---

[5] Our sample includes: Australia, Belgium, Brazil, Canada, Denmark, Dutch East Indies, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States. This sample accounts for over 60 percent of both world GDP and trade in 1913.

substitution, ρ, was set to eleven.[6] We direct the reader to Appendix II which demonstrates that the overall qualitative results are not too sensitive to these assumptions.

4.2 Results

The resulting trade cost series can be seen in Figures 1 and 2. Figure 1 presents the simple average of trade cost levels for the three countries. Figure 2 presents the indexed value of these trade costs over time (1870=100). A few important elements stand out. First, as seen in Figure 1, France and the United Kingdom enjoyed substantially lower trade costs than the United States for the entire period, perhaps reflecting not only the maturity of their trading relationships but also their greater proximity to many of the world's leading markets. Second, the initial level of trade costs seems to condition their subsequent evolution: the United States experienced a more dramatic decline in trade costs over time, 16 percent (7.7 percentage points) versus France's 13 percent decline and the UK's 10 percent (5.5 and 3.7 percentage points, respectively). Finally from Figure 2, it seems that most of the decline in trade costs, especially for France and the United Kingdom, was concentrated between 1870 and 1880. This episode illustrates the more general point that sorting out the contemporaneous effects of changes in freight rates, tariffs, and all other barriers to trade is a far-from-trivial exercise. We can note that for the early 1870s, most countries adopted the gold standard in this period, maritime transport indices fall the fastest here, and the telegraph begins to make an impact. However, Clemens and Williamson (2004) show that world average tariffs rise from the mid-1870s—the German rise in

---

[6] When the elasticity of substitution is set equal to eleven, this corresponds to a ten percent markup over marginal cost. Irwin (2003) shows rough evidence of a 9.8 percent markup in American steel and pig iron products in the late nineteenth century. Typical estimates of the elasticity of substitution parameter in the contemporary literature, based on recent data comprising goods that are more differentiated and therefore less substitutable, are around seven or eight as noted in Anderson and van Wincooop (2004). Evenett and Keller (2002) suggest that the share of output in recent years that is tradable is in the range of 0.3 to 0.8. Stockman and Tesar (1995) argue that the share of tradable output would be in the range of 0.65 and 0.82. Moreover, it is decreasing in the size of the service and public sectors which are typically non-tradable. Both sectors were much less significant in terms of total output in our period.

1879 being only the most famous and possibly most important instance of this. The French also begin implementing non-tariff and tariff barriers from 1881 culminating in the Meline Tariff of 1892.

4.3 A Comparison with Freight Rates and Price Gaps

Figure 3 gives the reader a sense of how our methodology matches up with one prominent means in the literature of computing commodity-specific trade costs, the price-gap methodology. The measurement of price gaps rests on the assumption that in well-functioning international markets for a particular commodity, say, wheat, commercial agents—given the prevailing costs of transport, tariffs and non-tariff barriers to trade, the costs of obtaining credit and contracting in foreign exchange markets, etc.—will exploit all profitable opportunities in terms of price differentials. Thus, the price gap (or differential) represents an estimate of the size of the trade costs separating two markets, assuming trade actually takes place between them.

We gather monthly commodity price data for two representative markets, Toronto and London, and one representative commodity, wheat, for the period under consideration from Coats (1910), Jacks (2006), and Michel (1931). Our choice of markets is determined by not only the availability of data but also the desire to consider a pair of markets for which a small number of commodities predominated. Even as late as the 1890s, grains constituted fully 14 percent of the United Kingdom's imports while an even higher figure holds for grains relative to total exports by Canada in the same period (Jacks, 2008). Our choice of wheat also follows a long precedent in the literature. We calculate the monthly price gap as a percentage of the London price, thus, arriving at an ad-valorem measure of the trade costs in wheat separating Toronto from London. Finally, we average the monthly figures over calendar years.

In addition, we are able to produce some evidence on prevailing maritime freight rates separating Montreal and London in the period from 1870 to 1885. This series is drawn from the global maritime freight rate database underlying Jacks and Pendakur (2009). Unfortunately, no freight rate series are available from Toronto to London; however, the historical literature suggests that wheat would have been transshipped from Toronto to Montreal and then loaded onto ocean-going vessels bound for the United Kingdom. We transform this annual freight rate series, dividing by the average London price for ease of comparison with the price gap estimate and our trade cost measure.

The first observation is that aggregate trade costs are much more than the cost of transportation. Comparing the equivalent figures for 1870, we find that the freight factor—freight rates divided by final price—is 0.1354 while our measure of aggregate trade costs is 0.3174. We note that this was also a time of very liberal commercial policy in the United Kingdom with wheat, in particular, being subject to no import restrictions and only nominal duties. Jacks (2006) calculates the ad-valorem equivalent of these duties to be 0.0028, thus, explaining about 1.5 percent of the difference (=0.1820) between the freight factor and our measure of aggregate trade costs. This underlines one of our key messages, namely that future work also needs to explore other important impediments to trade that are inherently difficult to measure like non-tariff barriers, information costs, distribution channels, market micro-structures, legal frictions, financing costs and uncertainty.

The second observation from Figure 3 is that the price-gap methodology generates a much steeper—and much more volatile—overall rate of decline for Anglo-Canadian trade costs from 1870 to 1909 than our methodology, 78 percent versus 9 percent. One final observation is that the correlation between the price gap series and our measure of trade costs is low at 0.05.

The difference in the two measures can be explained by the fact that we consider aggregate trade flows while the price gap literature considers only individual commodities. We emphasize that our approach of inferring trade costs from readily available data on trade and GDP holds clear advantages for applied research: the constraints on collecting suitable commodity price data for every individual traded good make it impossible to construct a summary bilateral trade cost measure based on commodity price gaps.

5. The Determinants of Trade Costs

Researchers have focused on transportation, communication costs, tariffs, national borders, and currency unions as determinants of trade costs. As our baseline, and following the bulk of previous work so as to provide comparable results, we consider a log-linear specification of iceberg trade costs of the following form:

(3) $\tau_{j,kt} = Dist_{j,k}^{\delta} e^{\beta_0 + \beta_1 X_{j,kt} + \eta_{j,kt}}$,

where $Dist_{j,k}$ is the great-circle distance between two countries' capitals, δ is the elasticity of iceberg trade costs with respect to distance, $X_{j,kt}$ is a set of covariates, and $\eta_{j,kt}$ is a composite error term. This implies the following estimating equation:

(4) $\ln(\tau_{j,kt}) = \beta_0 + \delta \ln(Dist_{j,k}) + \beta_1 X_{j,kt} + d_t + \upsilon_{j,k} + \varepsilon_{j,kt}$,

where we allow for the composite error term to consist of a country-pair specific component $\upsilon_{j,k}$ (that is, a fixed or random effect) and a country-pair white noise error term, $\varepsilon_{j,kt}$, clustered at the country-pair level. In all specifications, we include time fixed effects collected in the vector of year indicators d_t. Apart from the previously mentioned distance variable, we consider a parsimonious set of potential trade cost determinants $X_{j,kt}$ tariffs (defined as the log product of each partner's ratio of tariff revenue to imports), bilateral exchange rate volatility (measured as

the standard deviation of the change in the logged nominal monthly exchange rate), gold standard adherence, membership in the British Empire, and the density of railroads (defined as the log product of each partner's ratio of railroad mileage to land area). Table 1 provides the summary statistics of our data. See Appendix III for the data sources.

In Panel A of Table 2, we report two separate regression specifications of equation (4). The first column presents our preferred results from a random effects specification. The second column presents the results from a country-pair fixed effects specification. Country-pair fixed effects subtract the average level of trade costs for each country pair while the time fixed effects subtract the average level of trade costs across country pairs for each year. Thus, the remaining variation from which identification is obtained is that from the time series within country pairs over and above any common changes across country pairs. Country-pair fixed effects also control for un-observables or omitted factors at the country-pair level and, therefore, cannot separately estimate the impact of distance and membership in the British Empire. It can readily be seen that the inferences drawn from column 1 are highly robust to time-invariant heterogeneity at the country-pair level. We discuss the results from column 1 accordingly.

Nations further apart—reassuringly—had higher trade costs. Taking 0.07 as the distance elasticity from column 1, the standardized coefficient for distance is measured as 0.40. That is, a one standard deviation increase in the distance between countries would be associated with nearly a one-half standard deviation increase in trade costs.

The sign of the log product of tariffs is consistent with reasonable priors, although we should note that we lack country-pair specific information on tariff barriers—that is, these measures capture the general level of protection afforded in French and US markets, for example, but not the protection afforded against French goods in US markets and vice versa. The

point estimate suggests that a one percent rise in the log product of tariffs is associated with a two percent rise in trade costs. The standardized coefficient of 0.13 suggests a slightly weaker role in explaining trade costs than distance.

Adherence to the gold standard also appears to be associated with lower trade costs. Adoption of the gold standard is predicted to bring about a roughly 3.6 percent decline in trade costs with a standardized coefficient of 0.08. As previous work has shown, credible exchange rate stability seems to go along with greater trade. Interestingly, exchange rate volatility itself does not seem to have any association with trade costs. A potential explanation lies in the fact that exchange rate volatility and the gold standard are strongly correlated: adherence to the gold standard entails virtually zero exchange rate volatility. This view is confirmed by unreported regressions containing only exchange rate volatility; in this case, it is positively signed and significant.

When both countries are in the British Empire, this is associated with 50 percent lower trade costs. This high number does not, however, suggest absurdly low trade costs between the UK and its colonies. It must be kept in mind that the British Empire was a far-flung affair, with distances from London in our sample ranging from a "mere" 5,376 kilometers for Canada to over 18,000 for Australia and New Zealand. Despite this moderating effect of distance, the privileges of imperial membership are hard to deny, a result which is consistent with the emerging view on European overseas empire and trade (Mitchener and Weidenmier, 2008).

The period we are considering is widely regarded to be one of improved infrastructure and declining shipping costs. In our regressions, we find some support for the view that domestic transportation infrastructure matters for international trade costs. The standardized coefficient on railroad density is -0.14. In other words, a one standard deviation increase in the total length of a

dyad's railway network would have decreased trade costs by about one-seventh of a standard deviation.

Finally, it would be useful to get a sense of the importance of maritime freight rates in determining international trade costs, however imperfectly. In considering the available evidence, there is, of course, the well-known Isserlis (1938) series, which is based on British tramp shipping freights on routes worldwide. But the Isserlis series is simply a chained, unweighted average of a large number of disparate freight rate sub-series with no controls for commodities or routes and is, thus, country- and country-pair invariant. In a regression specification as in our paper, use of the Isserlis index on its own is not possible as it is perfectly collinear with the time fixed effects.

An alternative would be to consider the maritime freight rates indices which underlie a recent paper by Jacks and Pendakur (2009). An advantage of this particular series is that it varies across country pairs. A disadvantage of this particular series is that it is only available for UK destined/originated freights. Thus, all the trade cost data for France and the United States—barring those observations with the UK—are lost. These indices are also not comparable across countries in terms of levels, necessitating the use of a country-pair fixed effect specification. Here, we report results which incorporate these new data. They are reported in Panel B of Table 2 and are broadly consistent with those in Panel A. The Jacks-Pendakur maritime freight rate series registers as positive and statistically significant with a standardized coefficient of 0.03. A notable difference between Panels A and B is that the inclusion of this new freight rate series renders the railroad density variable insignificant, a result which may be indicative of the UK's heavy reliance on maritime trade.

Overall, we find that our trade cost measure is sensibly related with standard proxies for known trade barriers. This should be the case since what we have undertaken is only one small, but non-obvious, step beyond what standard gravity models of trade do when they use a vector of trade cost proxies in regressions explaining bilateral trade. Our regressions show that an overall decline of trade costs of 10 to 15 percent over the entire period can be interpreted as follows: trade costs are a function of many variables, and over time some rose, some declined and others stayed roughly constant. For example, rising tariffs partially offset declining freight rates. Other trade cost components related to factors that are more difficult to measure likely fell but not massively. Being more precise in delineating these factors is the goal of ongoing research (Jacks, Meissner, and Novy, 2009).

Finally, to understand how each of the trade cost proxies used above affects actual trade volumes, one would need further information on the elasticity of substitution. For instance, we find that the gold standard may have decreased trade costs by 3.6 percent while other studies report seemingly larger effects of the gold standard on stimulating bilateral trade (roughly 30 percent or more). Reconciling these two figures is straightforward in that the estimated impact of the gold standard on trade costs must be scaled up by the elasticity of substitution as in (1).

6. Accounting for the Increases in Global Trade 1870-1913

In this section, we return to our key question: what accounts for the marked increase in global trade flows between 1870 and 1913? The existing literature on the pre-World War I and post-World War II waves of globalization offers likely suspects. On the one hand, much of the historical literature has emphasized reductions in trade costs, specifically those arising from endogenous changes in commercial policy and exogenous changes in transport technology

(O'Rourke and Williamson, 1999). On the other hand, much of the contemporary literature has emphasized secular patterns in income growth and convergence (Baier and Bergstrand, 2001). What we aim for in this section is to relate changes in bilateral trade flows to changes in productive capacity and changes in trade costs in an accounting sense. Our micro-founded gravity model provides a straightforward way of doing this. To arrive at a decomposition of the factors affecting the growth of trade we perform the following exercise. We take the natural logarithm and then the difference of gravity equation (1) between the years 1913 and 1870 to obtain:

(5) $\Delta \ln(EXP_{j,kt} EXP_{k,jt}) = \Delta \ln\left((GDP_{jt} - EXP_{jt})(GDP_{kt} - EXP_{kt})\right) + (2\rho - 2)\Delta \ln(1 - \tau_{j,kt})$.

Then we divide everything by $\Delta \ln(EXP_{j,kt} EXP_{k,jt})$ to get the following expression:

(6) $1 = 100\% = \dfrac{\Delta \ln\left((GDP_{jt} - EXP_{jt})(GDP_{kt} - EXP_{kt})\right)}{\Delta \ln(EXP_{j,kt} EXP_{k,jt})} + (2\rho - 2)\dfrac{\Delta \ln(1 - \tau_{j,kt})}{\Delta \ln(EXP_{j,kt} EXP_{k,jt})}$.

The first term on the right-hand side accounts for increases in bilateral trade due to economic growth. The second term accounts for increases in trade due to a decline in bilateral trade costs. It is readily seen from (6) that the contribution of the decline in trade costs is invariant to the value of the elasticity of substitution because the share going to the GDP terms is given by the data. This is true even if the elasticity changes over time.

In deriving (6) we have implicitly assumed that the parameters s_j and s_k, which indicate the fraction of all goods that are tradable, remain constant over time. For the post-World War II period, this proves to be a realistic assumption as the increase in the range of tradable goods has been offset by the increase in non-tradable services (Novy, 2007). If the output of tradable goods in fact increased faster than the output of non-tradable goods, this would make the decline in trade costs less important in explaining the growth of trade but it would not affect the

contribution of economic expansion. In that sense, the numbers that we report in this section can be seen as an upper bound for the contribution of the decline in trade costs.

In Table 3, we report the growth in trade for our balanced sample between 1870 and 1913 and the respective contributions of economic expansion and the decline in trade costs in explaining this trade boom. We carry out this exercise for various subsamples of our data set. The first row presents results for the full sample. Here, we see that about 56 percent of the expansion of trade can be accounted for by changes in trading partners' productive capacity, whereas declines in trade costs account for about 44 percent of the growth in trade. These results suggest a slightly larger role for trade costs than the findings of Baier and Bergstrand (2001) who argued that two-thirds of the growth in trade amongst OECD countries between 1958 and 1988 was explained by the growth of output.

For trade between the more economically advanced and proximate countries in Europe, economic expansion contributes the lion's share to the expansion of trade. But the decline in trade costs is much more important for the markets outside of Europe and America. Declines in trade costs with partners in Asia and Oceania are responsible for 65 and 56 percent of the increase in trade, respectively.

This geographical difference is consistent with the idea that real freight rates fell the most in core-periphery trade. There was also an expansion of trading networks through pro-active marketing strategies in new markets, the establishment of new shipping lines, and an improvement in telegraph connections with the less industrialized world. These factors together expanded trade with the less developed world despite the rapidly rising tariffs of many trading partners documented in Williamson (2006). The results from the core are consistent with the fact that the majority of their communication and transport infrastructure was in place well before

1880 and that the tariff backlash in Europe increased trade costs, making any potential trade growth more dependent upon economic expansion.

The decline in trade costs has the most explanatory power for the growth in US trade and the least explanatory power for the growth in British trade (see Table 3). One reason for this heterogeneity is that, prior to our sample period, the UK had already become well integrated into the world economy and generally had managed to lower trade costs far below those of the US and France (see Figure 1). This was due to its early free trade stance, its colonial connections, and the proximity of its economic activity to the coast.

Thus, to some extent the US and France caught up with the UK in reaping the benefits from lower trade costs as they penetrated markets that were once the domain of Britain. In explaining this phenomenon, the economic history literature has focused on productivity versus trade barriers broadly defined (see the industry-specific essays in Aldcroft, 1968). Our results appear consistent with the idea that the US and France increased their international market shares more by lowering trade costs than by scoring productivity gains.

Given that falling trade costs can only explain about 44 percent of the pre-World War I trade boom, an overriding role for communication and transportation technologies in the first wave of globalization is muted. This is for two reasons. First, secular increases in income were key in fuelling the growth of trade. Second, increases in tariffs put downward pressure on the fraction of the growth in trade attributable to falling trade costs. Overall, we are suggesting a view in which the primary mover of increased trade volumes is the secular increase in income with ancillary contributions from policy and technology.

We should emphasize again that we obtain these decomposition results by using a framework of trade in differentiated goods with trade costs that is widely used and accepted in

the literature (see Anderson and van Wincoop, 2003 and 2004). In particular, a unit income elasticity is a standard feature of this work. Evenett and Keller (2002) derive gravity models from several leading theories of international trade, all of which are characterized by unit income elasticities.[7]

Thus, even if we allow for differences in the underlying modeling strategy, or the value of parameters underlying our trade cost calculations, the fact remains that changes in income explain a majority of the growth in bilateral trade for this period. As in all of the standard gravity literature, an implicit assumption in our paper is, of course, that aggregate trade costs are exogenous to economic expansion and the growth of trade. If trade cost declines cause additional income growth, then the role of trade costs in explaining trade growth could, of course, be higher. This is an open question in the literature and remains outside the scope of this paper. However, the causal effect from lower trade costs to increased trade flows and, then, to economic growth would have to be fairly large at each step for this to have a large bearing on our results. At the same time, the exploration of endogenous trade costs is certainly a fruitful avenue for future research.

7. Conclusion

We have studied the evolution and determinants of trade costs between 1870 and 1913. The theoretical foundation for these trade costs represents a new way of explaining international trade integration that is much easier to implement empirically than existing general equilibrium gravity models of international trade. We now relate multilateral resistance terms to observable

---

[7] Anderson and van Wincoop (2003) allow for non-unit income elasticities by assuming that the share φ of income spent on tradables equals Y^α despite the fact that they themselves argue "there is no clear theoretical foundation for specifying the fraction spent on tradables as Y^α." More alarmingly for proponents of the idea that trade costs are the key driver of integration, Anderson and van Wincoop note that α is likely to be greater than zero, implying an income elasticity greater than one. To the extent that their argument is valid, an imposed unit income elasticity provides an upper bound for the impact of trade costs.

variables. This provides a convenient way to compute, and not estimate, bilateral international trade costs. Our measure can easily be extended to provide a quantitative grasp of qualitative observations made by country specialists and historians. They can also be used in empirical research in international economics where a measure of trade costs is needed.

The patterns we have found suggest that overall trade costs did not decline dramatically after 1870 since tariffs and non-tariff barriers rose. But in the face of a shipping cost plunge and the elimination of exchange rate uncertainty for many trading partners, overall trade costs seem to have fallen by roughly 10 to 16 percent. Slightly over 50 percent of the variation in these trade costs can be explained by proximity, policies, infrastructure, and the British Empire. Finally, economic expansion and the decline in trade costs appear to be almost equally responsible for increasing international trade between 1870 and 1913. The trade boom of the nineteenth century, therefore, does not seem to be all about policy or all about shipping and communications. Economic growth and productivity advances were also important drivers of the first wave of globalization.

Appendix I: Differential productivity growth in the tradeable and non-tradeable sectors

Consistent with the New Open Economy Macroeconomics literature, the model is based on a production function that is linear in labor and that depends multiplicatively on a country-specific technology (i.e., productivity) factor A_j. The higher A_j, the more advanced is country j's technology. In our paper, we solve for trade costs as:

$$\tau_{j,k} = 1 - \left(\frac{EXP_{j,k} EXP_{k,j}}{s_j (GDP_j - EXP_j) s_k (GDP_k - EXP_k)} \right)^{\frac{1}{2\rho-2}}.$$

The model can also be solved allowing for different productivity levels across the tradable and non-tradable sectors, A_j^T and A_j^{NT}. Note that these may differ across countries. Relaxing the assumption of common productivity levels across the two sectors, we obtain a modified solution for trade costs:

$$\tau_{j,k} = 1 - \left(\frac{EXP_{j,k} EXP_{k,j}}{s_j (GDP_j - EXP_j) s_k (GDP_k - EXP_k) PROD_j PROD_k} \right)^{\frac{1}{2\rho-2}},$$

where $PROD_j \equiv \left(s_j + (1 - s_j) \left(\frac{A_j^{NT}}{A_j^T} \right)^{\rho} \right)^{-1}.$

The term $PROD_j$ captures the productivity differential of the tradable sector relative to the non-tradable sector in country j. If productivity in the tradable sector grows over time relative to the non-tradable sector, $PROD_j$ will increase. Ceteris paribus, this will lead to a higher trade cost value, $\tau_{j,k}$.

Thus, neglecting such an increase in relative productivity of the tradable sector would lead to an underestimation of trade cost levels and, therefore, an overestimation of the decline in trade costs over time. Intuitively, suppose an observed increase in trade flows could in reality partly be ascribed to productivity improvements in the tradable sector. But one would erroneously ascribe the entire increase in trade flows to declines in trade costs. By not allowing for differential productivity improvements in the tradable and non-tradable sectors we are, in effect, providing an upper-bound estimate of the potential contribution of trade cost declines to 19th century trade growth.

Ultimately, of course, data limitations preclude us from empirically incorporating productivity differentials across sectors into the analysis. However, simple numerical examples suggest that the effect of even big productivity differentials—say, productivity in the tradable sector is initially at par with non-tradable sector productivity and then over time grows to be five times as large—is rather limited. This robustness is consistent with Appendix II where we show that changes in the size of the tradable sector, s_j, also have a limited quantitative effect on inferred trade costs.

Appendix II: The Sensitivity of Trade Costs to Parameter Assumptions

This appendix demonstrates that our results are not highly sensitive to the assumed elasticity of substitution and the tradable share. The relative ordering of trade costs is stable with respect to uniform changes across all dyads of both the elasticity of substitution and the tradable shares. Our reported regression results, which estimate the elasticity of trade costs with respect to a change in the observable trade cost proxies, are strongly robust to shifts in the assumed parameters.

The following two figures plot the evolution of the log change of trade costs for plausible ranges of the elasticity of substitution and tradable shares for Canada and the United States between 1870 and 1913. We assume that the elasticity of substitution is 11. But suppose in fact it is a fairly distant 7. For this particular series, the change between 1870 and 1913 is off by about one-eighth (see annual changes in Figure A.1). In such a circumstance, our headline number of a 13.7 percent fall in Canadian-US trade costs would have to be revised to a 12.1 percent fall. Such a revision would not alter our qualitative findings.
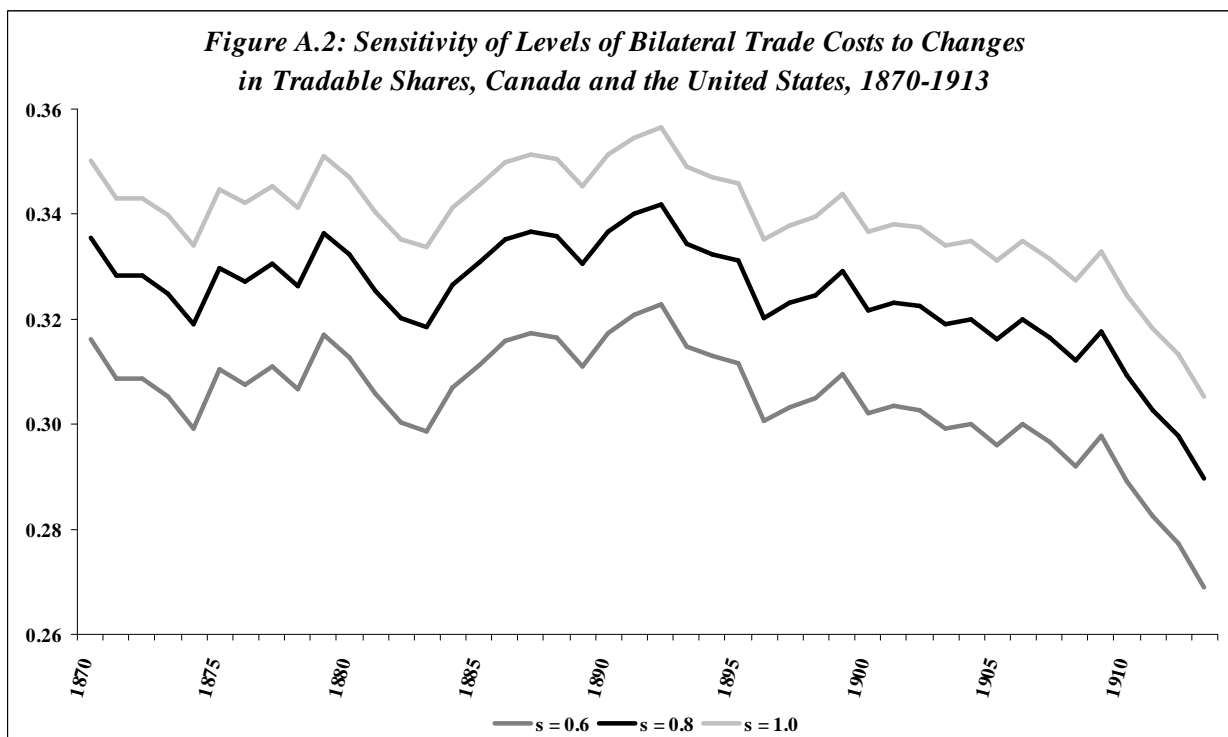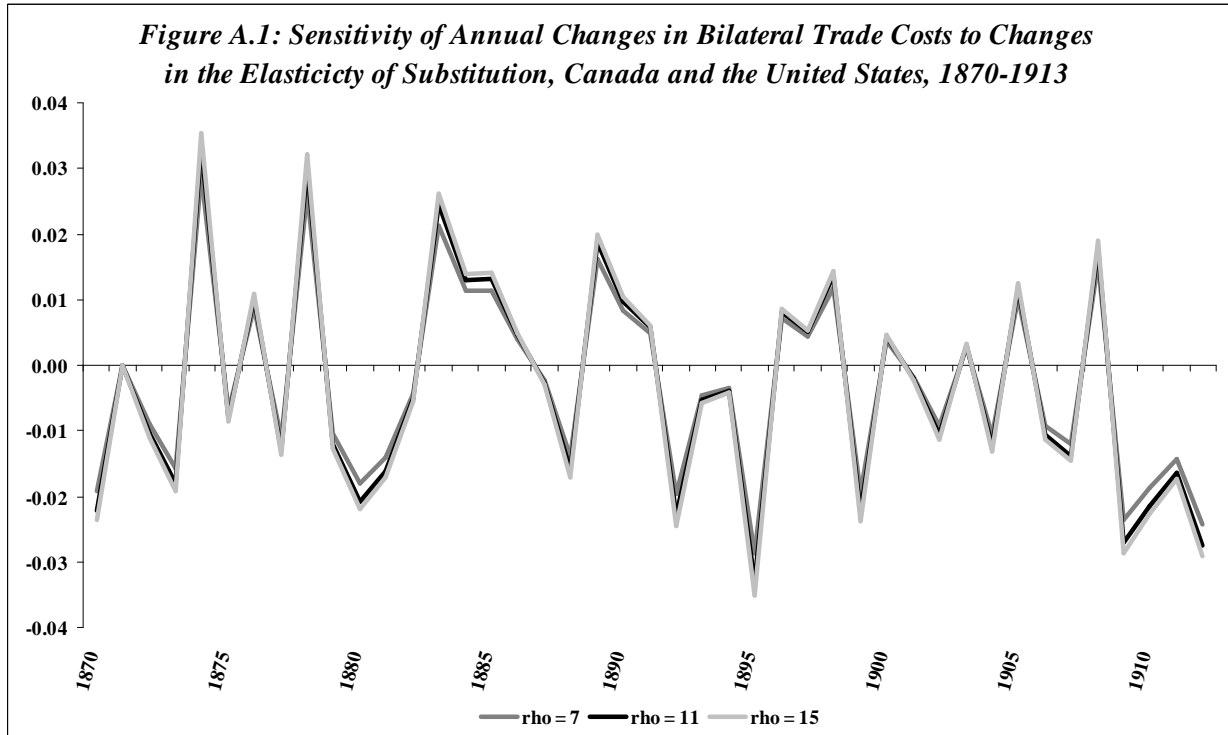
There is, however, a large difference in the levels in any given year for such a change. The levels are around 50 percent higher when moving from 11 down to 7. If the elasticity of substitution is far from its assumed value, it would not be prudent to take the exact levels of trade costs at face value. Also, we do not explore what happens when the elasticity moves over time. But as Broda and Weinstein (2006) suggest for the post-1970 period, this parameter is quite stable at high levels of aggregation of the trade data.

For large perturbations in the tradable share of goods, s, the levels of trade costs are fairly stable. Figure A.2 below shows only slight variation in levels when s moves from 0.6 to 1.0. There is no change in the first differences of trade costs for different values of tradable shares as this parameter enters multiplicatively. But what happens if the tradable share changes over time? The assumption of a constant s would tend to overstate any decline in trade costs in the case of a sizeable (but implausibly large) increase from, say, 0.6 to 0.8. Conversely, any trade cost declines are understated when s actually falls.

So what is the most plausible path of the fraction of all goods produced that are tradable, s, in the nineteenth century case? It seems likely that s stayed fairly constant. Tradability is not the same as whether a good is highly traded. It is also not simply the fraction of measured GDP devoted to trade. A non-tradable good is inherently impossible to trade at any level of trade costs. A "non-traded" good refers to the fact that little or no trade in a particular good will occur when trade costs are prohibitively high. If we see trade in a particular class of goods increase over time in the nineteenth century, we believe that the vast majority is attributable to changes in trade costs and general economic growth rather than to a large increase in the fraction of goods that can be traded. For example, Argentina did, in fact, export some dressed beef to Great Britain prior to refrigeration. However, this trade increased exponentially in the face of large reductions in their trade costs. Also, while there must have been some increase in the number of varieties produced that could be traded, it is equally the case that the period saw the advent of new economic activity that was inherently non-tradable. Government provision of services and the service sector became increasingly more important in most of these economies. If s fell somewhat, we may be understating the fall in trade costs but probably by not more than ten percent, as the second figure in this appendix illustrates.

Finally, consider the non-linearities associated with trade costs in equation (1). Seemingly small changes in trade costs can create large increases in trade. Take American-

Canadian trade in 1900. A decrease in trade costs of fifteen percent, all else being equal, implies a doubling of both the bilateral trade flows between the two nations.

Figure A.1: Sensitivity of Annual Changes in Bilateral Trade Costs to Changes in the Elasticicty of Substitution, Canada and the United States, 1870-1913

Figure A.2: Sensitivity of Levels of Bilateral Trade Costs to Changes in Tradable Shares, Canada and the United States, 1870-1913

Appendix III: Data Sources

Bilateral trade: Taken from the *Statistical Abstract of the United Kingdom* (various years), *Statistical Abstract of the United States* (various years), and *Tableau Général du Commerce de la France avec ses Colonies et les Puissances Etrangères* (various years). Trade was converted into real 1990 US dollars using the US CPI deflator in Officer and Williamson (2007).
GDP: Taken from Maddison (1995).
Population: Taken from Mitchell (2003a, 2003b, 2003c).
Tariffs: Measured as total customs revenue divided by imports taken from Mitchell (2003a, 2003b, 2003c). Many observations come from data kindly provided to us by Michael Clemens and Jeffrey Williamson and are based on Clemens and Williamson (2004). Belgium is from Degrève (1982). Switzerland is from Ritzmann-Blickenstorfer (1996).
Gold standard adherence: Based on data underlying Meissner (2005) and equals one when both countries adhere to the gold standard.
Exchange rate volatility: Defined as the standard deviation of the monthly difference of logged nominal exchange rates in a given year. Taken from the Global Financial Database.
Distance: Measured as kilometers between capital cities. Taken from indo.com
Railroads and land area: Taken from Mitchell (2003a, 2003b, 2003c).
British Empire: Based on authors' recollection and equals one if both countries were members of the British Empire.

References

Aldcroft, D.H., 1968. The development of British industry and foreign competition, 1875-1914: Studies in industrial enterprise. George Allen and Unwin, London.

Anderson, J.E., 1979. A theoretical foundation for the gravity equation. American Economic Review 69 (1), 106-116.

Anderson, J.E. and E. van Wincoop, 2003. Gravity with gravitas: a solution to the border puzzle. American Economic Review 93 (1), 170-192.

Anderson, J.E. and E. van Wincoop, 2004. Trade costs. Journal of Economic Literature 42 (3), 691-751.

Baier, S.L. and J.H. Bergstrand, 2001. The growth of world trade: tariffs, transport costs, and income similarity. Journal of International Economics 53 (1), 1-27.

Board of Trade, various years. Statistical Abstract for the United Kingdom. HMSO, London.

Broda, C.M. and D.E.Weinstein, 2006. Globalization and the gains from variety. Quarterly Journal of Economics 121 (3), 541-585.

Clemens, M. and J.G. Williamson, 2004. Wealth bias in the first global capital market boom. Economic Journal 114 (2), 304-337.

Coats, R.H., 1910. Wholesale Prices in Canada, 1890-1909. Ottawa: Government Printing Bureau.

Degrève, D., 1982. Le Commerce Extérieur de la Belgique, 1830-1913-1939, Présentation Critique des Données Statistiques.

Direction générale des douanes, various years. Tableau général du commerce de la France avec ses colonies et les puissances étrangères. Imprimerie Nationale, Paris.

Eaton, J. and S. Kortum, 2002. Technology, geography and trade. Econometrica 70 (5), 1741-1779.

Estevadeordal, A., B. Frantz, and A.M. Taylor, 2003. The rise and fall of world trade, 1870-1939. Quarterly Journal of Economics 118 (2), 359-407.

Evenett, S.J. and W. Keller, 2002. On theories explaining the success of the gravity equation. Journal of Political Economy 110 (2), 281-316.

Federico, G. and K.G. Persson, 2007. Market integration and convergence in the world wheat market, 1800-2000. In: K.H. O'Rourke et al. (Eds.), The New Comparative Economic History: Essays in Honor of Jeffrey G. Williamson. MIT Press, Cambridge, pp. 87-114.

Flandreau, M. and M. Maurel, 2005. Monetary union, trade integration and business fluctuations in 19th century Europe: just do it. Open Economies Review 16(2), 135-152.

Frieden, J.A, 2006. Global Capitalism: Its Fall and Rise in the Twentieth Century. W.W. Norton & Co., New York.

Harley, C.K., 1988. Ocean freight rates and productivity, 1740-1913. Journal of Economic History 48 (4), 851-876.

Hatton, T.J. and J.G. Williamson, 2006. Global Migration and the World Economy: Two Centuries of Policy and Performance. MIT Press, Cambridge.

Irwin, D.A., 2003. Explaining America's surge in manufactured exports, 1880-1913. Review of Economics and Statistics 82 (2), 364-376.

Irwin, D.A., 2007. Tariff incidence in America's gilded age. Journal of Economic History 67 (3), 582-607.

Jacks, D.S., 2005. Intra- and international commodity market integration in the Atlantic economy, 1800-1913. Explorations in Economic History 42 (3), 381-413.

Jacks, D.S., 2006 .What drove nineteenth century commodity market integration? Explorations

in Economic History 43 (3), 383-412.

Jacks, D.S., 2008. On the death of distance and borders: evidence from the nineteenth century. Simon Fraser University, Mimeo.

Jacks, D.S., C.M. Meissner, and D. Novy, 2006. Trade costs in the first wave of globalization. NBER Working Paper 12602.

Jacks, D.S., C.M. Meissner, and D. Novy, 2009. Trade booms, trade busts, and trade costs. NBER Working Paper.

Jacks, D.S. and K. Pendakur, 2009. Global trade and the maritime transport revolution. Review of Economics and Statistics, forthcoming.

James, H., 2001. The End of Globalization. Harvard University Press, Cambridge.

Krugman, P., 1980. Scale economies, product differentiation and the pattern of trade. American Economic Review 70 (4), 950-959.

López-Córdova, J.E. and C.M. Meissner, 2003. Exchange rate regimes and international trade: evidence from the classical gold standard era. American Economic Review 93 (1), 344-353.

Maddison, A., 1995. Monitoring the World Economy 1820-1992, OECD: Paris.

Meissner, C.M., 2005. A new world order: explaining the international diffusion of the gold standard, 1870-1913. Journal of International Economics 66 (2), 385-406.

Michel, H., 1931. Statistical Contributions to Canadian Economic History, Statistics of Prices, Vol. II. Toronto: Macmillan.

Mitchell, B.R., 2003a. International Historical Statistics. Africa, Asia & Oceania 1750-2000. Stockton Press, New York.

Mitchell, B.R., 2003b. International Historical Statistics. Europe 1750-2000. Stockton Press, New York.

Mitchell, B.R., 2003c. International Historical Statistics. The Americas 1750-2000. Stockton Press, New York.

Mitchener, K.J. and M. Weidenmier, 2008. Trade and empire. Economic Journal 118(6), 1805-1834.

Novy, D., 2007. Is the iceberg melting less quickly? International trade costs after World War II. Mimeo, University of Warwick.

Obstfeld, M. and K. Rogoff, 1995. Exchange rate dynamics redux. Journal of Political Economy 103 (4), 624-606.

Obstfeld, M. and K. Rogoff, 2000. The six major puzzles in international macroeconomics: Is there a common cause? In B.S. Bernanke and K. Rogoff (Eds.), NBER Macroeconomics Annual, MIT Press, Cambridge.

Obstfeld, M. and A.M. Taylor, 2004. Global Capital Markets: Integration, Crisis and Growth. Cambridge University Press, Cambridge.

Officer, L.H. and S.H. Williamson, 2007. Purchasing power of money in the United States from 1774 to 2006. Downloaded from http://MeasuringWorth.com.

O'Rourke, K.H. and J.G. Williamson, 1994. Late nineteenth-century Anglo-American factor-price convergence: Were Heckscher and Ohlin right? Journal of Economic History 54 (4), 892-916.

O'Rourke, K.H. and J.G. Williamson, 1999. Globalization and History: The Evolution of a Nineteenth-Century Atlantic Economy. MIT Press, Cambridge.

O'Rourke, K.H. and R. Findlay, 2003. Commodity market integration, 1500-2000. In: A.M.

Taylor et al. (Eds.), Globalization in Historical Perspective, University of Chicago Press, Chicago, pp. 13-62.

Ritzmann-Blickenstorfer, H., 1996. Statistique Historique de la Suisse. Chronos, Zurich.

Samuelson, P., 1954. The transfer problem and transport costs: Analysis of effects of trade Impediments. Economic Journal 64(3), 264-289.

Saul, S.B., 1967. Studies in British overseas trade, 1870-1914. Liverpool University Press, Liverpool.

Sessional Papers, 1897. Trade of the British Empire and Foreign Competition: Despatch from Mr. Chamberlain to the Governors of the Colonies and the High Commissioner of Cyprus and the Replies Thereto, Vol. lx of Parliamentary Papers, HMSO, London.

Shah Mohammed, S. I. and Williamson, J.G., 2004. Freight rates and productivity gains in British tramp shipping, 1869-1950. Explorations in Economic History 41 (3), 172-203.

Stockman, A.C. and L. Tesar, 1995. Tastes and technology in a two-country model of the business cycle: Explaining international comovements. American Economic Review 85 (1), 168-185.

United States Department of Commerce, various years. Statistical Abstract of the United States: US GPO, Washington, D.C.

Whalley, J. and X. Xin, 2007. Regionalization, changes in home bias, and the growth of world trade. NBER Working Paper 13023.

Williamson, J.G., 2006. Explaining world tariffs, 1870-1913: Stolper-Samuelson, strategic tariffs, and state revenues. In: H. Lindgren et al. (Eds.), Eli Heckscher, International Trade, and Economic History. MIT Press: Cambridge, pp. 199-228.

Table 1: Summary Statistics of Data

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Trade costs	Log of bilateral trade costs	2097	-0.9449	0.2143	-1.4697	-0.4155
Distance	Log of great-circle distance in kilometers	2097	8.1150	1.2586	5.5835	9.8509
Tariffs	Log of the product of tariff revenues over import values	2097	-4.6885	1.3046	-8.5980	-0.4391
ER volatility	Standard deviation of the change in logged nominal exchange rates	2097	0.0077	0.0118	0.0000	0.1226
Gold standard	Gold standard indicator equal to one if both countries adhere	2097	0.6018	0.4896	0.0000	1.0000
British Empire	British Empire indicator equal to one if both countries are members	2097	0.0615	0.2403	0.0000	1.0000
Railroads	Log of the product of railroad length over area	2097	-7.1549	2.0385	-14.6003	-3.8911

Table 2: The Determinants of Trade Costs, 1870-1913

Panel A: Full sample

	Random effects			Country-pair fixed effects		
	Coefficient	Std Error	p-value	Coefficient	Std. Error	p-value
Distance	**0.0676**	**0.0168**	**0.00**	---	---	---
Tariffs	**0.0215**	**0.0127**	**0.09**	**0.0219**	**0.0128**	**0.10**
ER volatility	0.0851	0.2045	0.68	0.0945	0.2057	0.65
Gold standard	**-0.0365**	**0.0098**	**0.00**	**-0.0365**	**0.0098**	**0.00**
British Empire	**-0.5006**	**0.0786**	**0.00**	---	---	---
Railroads	**-0.0143**	**0.0063**	**0.02**	**-0.0144**	**0.0063**	**0.03**
N:	2097			2097		
R-squared:	0.5354			0.9660		

Panel B: With maritime freight rates (UK only)

				Country-pair fixed effects		
				Coefficient	Std. Error	p-value
Distance				---	---	---
Tariffs				0.0292	0.0257	0.28
ER volatility				**0.5424**	**0.2296**	**0.04**
Gold standard				**-0.0305**	**0.0107**	**0.02**
British Empire				---	---	---
Railroads				-0.0157	0.0117	0.21
Maritime freight rates				**0.0105**	**0.0055**	**0.08**
N:				567		
R-squared:				0.9728		

NB: Time fixed effects not reported; standard errors clustered on country pair.

Table 3: Accounting for Changes in Trade by Region, 1870-1913		Growth of international trade	Contribution of output growth	Contribution of trade cost decline
Full sample	with all countries N=48	392.10% **100**	**55.7**	**44.3**
	with the Americas N=8	296.10% **100**	**79.5**	**20.5**
	with Asia N=6	572.30% **100**	**35.3**	**64.7**
	with Europe N=30	342.10% **100**	**58.1**	**41.9**
	with Oceania N=6	545.00% **100**	**44.3**	**55.7**
France	with all countries N=17	350.10% **100**	**57.3**	**42.7**
	with the Americas N=3	255.30% **100**	**80.4**	**19.6**
	with Asia N=2	484.70% **100**	**34.7**	**65.3**
	with Europe N=10	275.00% **100**	**60.6**	**39.4**
	with Oceania N=2	732.60% **100**	**28.8**	**71.2**
UK	with all countries N=17	277.30% **100**	**64.1**	**35.9**
	with the Americas N=3	244.80% **100**	**87.7**	**12.3**
	with Asia N=2	581.90% **100**	**28.3**	**71.7**
	with Europe N=10	211.40% **100**	**63.8**	**36.2**
	with Oceania N=2	351.60% **100**	**66.4**	**33.6**
US	with all countries N=17	520.80% **100**	**50.9**	**49.1**
	with the Americas N=2	434.30% **100**	**65.7**	**34.3**
	with Asia N=2	650.30% **100**	**42.8**	**57.2**
	with Europe N=11	507.50% **100**	**52.1**	**47.9**
	with Oceania N=2	550.90% **100**	**37.8**	**62.2**

Notes: All values in percent

18 countries in total

  11 in Europe (Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden, UK)

  3 in America (Brazil, Canada, US)

  2 in Asia (Dutch East Indies, Japan)

  2 in Oceania (Australia, New Zealand)

Balanced sample of trade costs (US, UK, France with 17 partners each)

Total observations: 48=3*17-3 (eliminating 3 double observations due to symmetry, e.g. US-UK=UK-US)

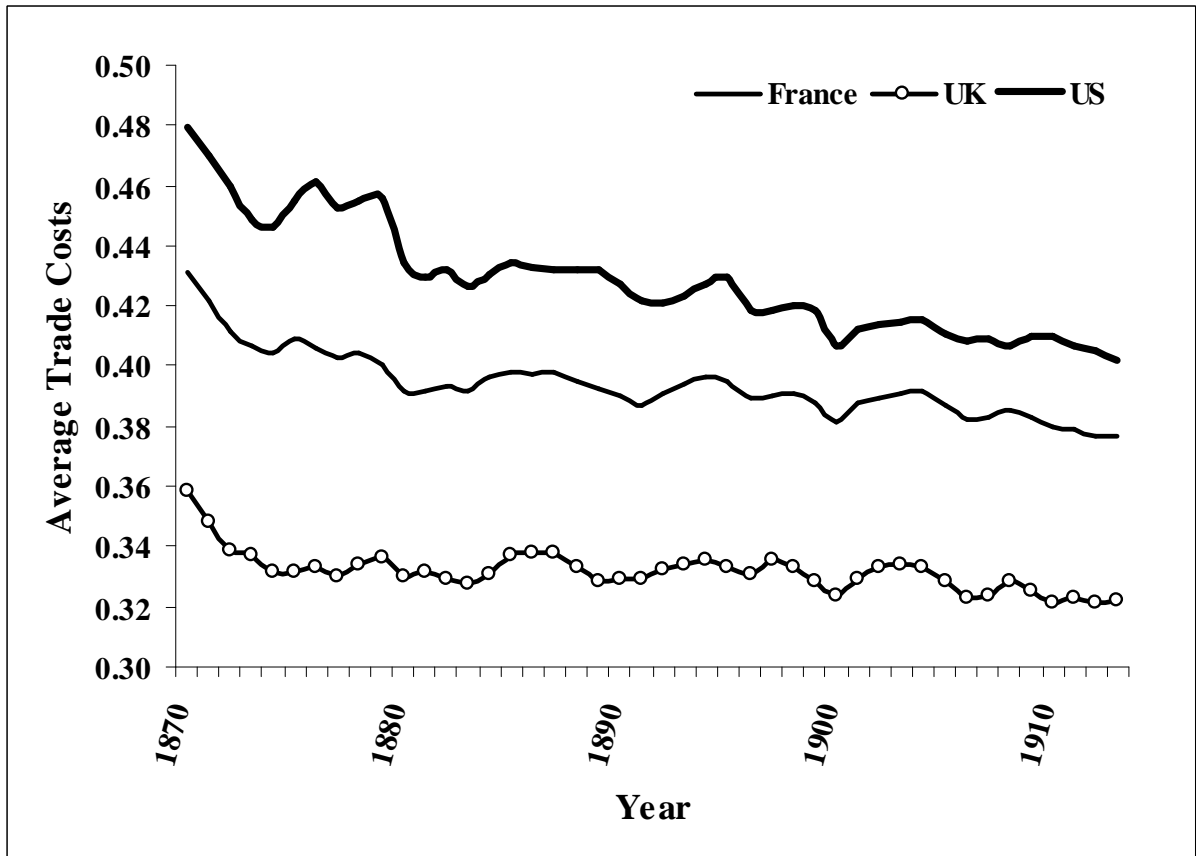**Figure 1: Average Trade Costs for France, the UK, and the US, 1870-1913**

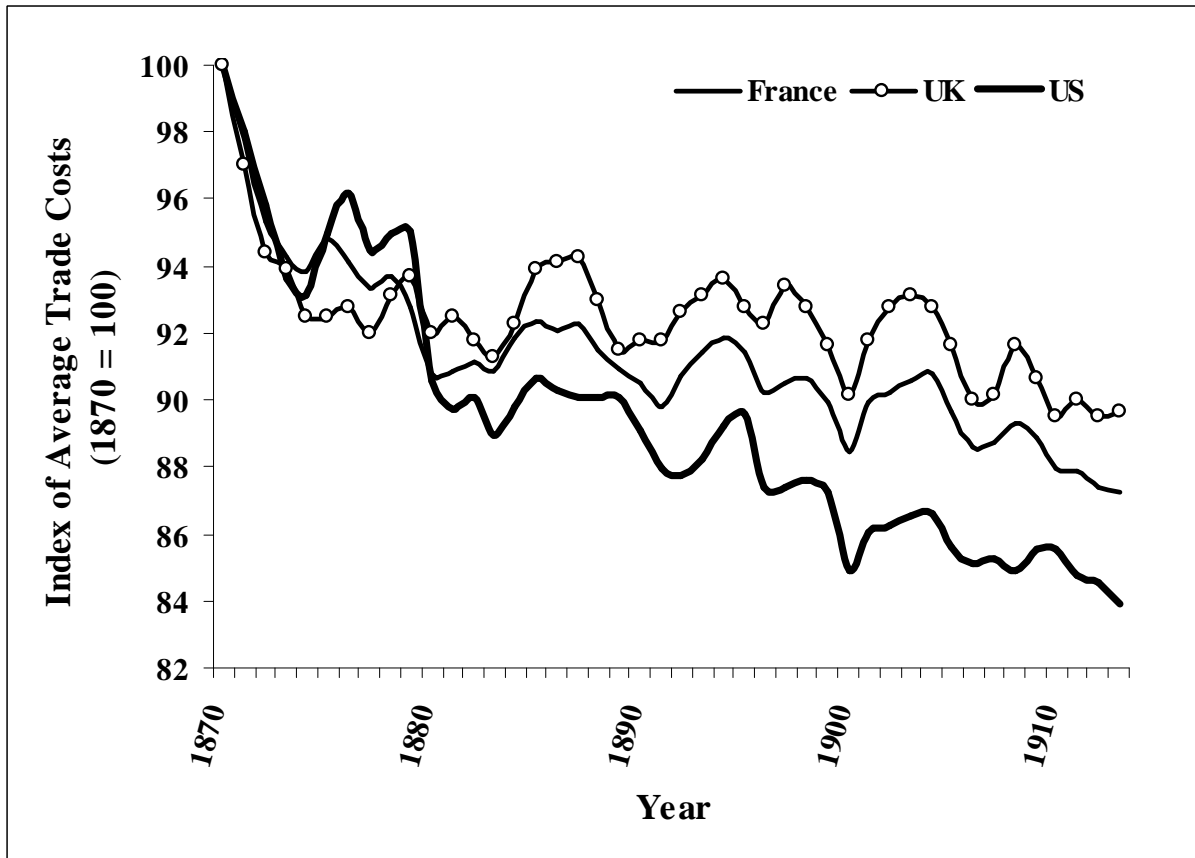**Figure 2: Index of Average Trade Costs for France, the UK, and the US, 1870-1913**

Figure 3: Freight Rates, Price Gaps, and Trade Costs for Canada and the UK, 1870-1909

Freight rates (left axis)   Price gaps (left axis)   Trade costs (right axis)