Trade Booms, Trade Busts, and Trade Costs

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Abstract
What has driven trade booms and trade busts in the past and present? We employ a micro-founded measure of trade frictions consistent with leading trade theories to gauge the importance of bilateral trade costs in determining international trade flows. We construct a new balanced sample of bilateral trade flows for 130 country pairs across the Americas, Asia, Europe, and Oceania for the period from 1870 to 2000 and demonstrate an overriding role for declining trade costs in the pre-World War I trade boom. In contrast, for the post-World War II trade boom we identify changes in output as the dominant force. Finally, the entirety of the interwar trade bust is explained by increases in trade costs.

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1. Introduction

Over the past two centuries, the world has witnessed two major trade booms and one trade bust. Global trade increased at a remarkable pace in the decades prior to World War I as well as in decades following World War II. In contrast, global trade came to a grinding halt during the interwar period. What are the underlying driving forces of these trade booms and busts? The goal of this paper is to address this question head-on by examining new data on bilateral trade flows for a consistent set of 130 country pairs over the period from 1870 to 2000, covering on average around 70 percent of global trade and output. We explore three eras of globalization: the pre-World War I Belle Époque (1870-1913), the fractious interwar period (1921-1939), and the post-World War II resurgence of global trade (1950-2000). Thus, the paper is the first to offer a complete quantitative assessment of developments in global trade from 1870 all the way to 2000.[1]

Inevitably, any long-run view of international trade faces the notion that trade patterns can be driven by different reasons. For example, international trade during the nineteenth century is often viewed as being determined by relative resource endowments (O'Rourke and Williamson, 1999) or differences in Ricardian comparative advantage (Temin, 1997).[2] More recently, international trade has been related to not only Ricardian factors (Eaton and Kortum, 2002) but also to the activities of heterogeneous firms (Melitz, 2003). The challenge for a long-run view is therefore to find a unifying framework that accommodates a variety of divergent explanations for international trade. We invoke the gravity equation to help us resolve this issue by exploiting the fact that gravity is consistent with a wide range of leading trade theories. While technical details might differ across models, many micro-founded trade models produce a gravity equation of bilateral trade. In turn, typical gravity equations have in common that they relate bilateral trade to factors within particular countries such as size and productivity, and factors specific to country pairs such as bilateral trade costs. The intuition is that gravity is simply an expenditure equation that arises in any general equilibrium trade model. It describes how consumers allocate spending across countries—regardless of the motivation behind international trade, be it international product differentiation or differences in comparative advantage. In Section 2 below, we run standard gravity regressions and demonstrate that gravity exerts its inexorable pull in all three sub-periods.

[1] We do, however, follow in the footsteps of other researchers that have looked at different periods in isolation. For instance, Estevadeordal, Frantz, and Taylor (2003) examine the period from 1870 to 1939. The work of Baier and Bergstrand (2001) is the closest predecessor to our own. However, they only consider the period from 1958 to 1988. We also track changes in trade due to all trade costs while their data contained only rough proxies for freight costs and tariffs.

[2] In addition, Brown (1995) has found evidence of international trade prior to World War I being driven by product differentiation and imperfect competition.

As a departure from previous work, we investigate the long-run evolution of trade costs. These are all the costs of transaction and transport associated with the exchange of goods across national borders. We define trade costs in a broad sense, including obvious barriers such as tariffs and transport costs but also many other barriers that are more difficult to observe such as the costs of overcoming language barriers and exchange rate risk. Even though trade costs are currently of great interest (Anderson and van Wincoop, 2004; Obstfeld and Rogoff, 2000; Hummels, 2007), little is known about the magnitude, determinants, and consequences of trade costs. In particular, there has been very little work on consistently measuring all of the trade barriers over the last two waves of globalization and the one intervening spell of de-globalization. This paper is the first step in filling the gap on both counts of comprehensiveness and consistency.

Specifically, in Section 3 we derive a micro-founded measure of aggregate bilateral trade costs that is consistent with leading theories of international trade. Following Head and Ries (2001) we are able to obtain this measure by backing out the trade cost wedge that is implied by the gravity equation. This wedge gauges the difference between observed trade flows and a hypothetical benchmark of frictionless trade. We, therefore, infer trade costs from trade flows. This approach allows us to capture the combined magnitude of tariffs, transport costs, and all other macroeconomic frictions that impede international market integration but which are inherently difficult to observe. We emphasize that this approach of inferring trade costs from readily available trade data holds clear advantages for applied research: the constraints on enumerating—let alone, collecting data on—every individual trade cost element even over short periods of time makes a direct accounting approach impossible.

In Section 4, we take the trade cost measure to the data. We find that in the forty years prior to World War I, the average level of the trade cost measure (expressed in tariff equivalent terms) fell by thirty-three percent. From 1921 to the beginning of World War II, the average level increased by thirteen percent. Finally, the average trade cost measure has fallen by sixteen percent in the years from 1950. In contrast to Jacks, Meissner, and Novy (2008) where we focus on France, the UK and the US, we significantly expand the data set and document the heterogeneity of experiences across different regions.

After describing the trends in the trade cost measure, in Section 5 we examine its reliability. Our evidence suggests that standard trade cost proxies are sensibly related to our measure. Factors like geographic proximity, adherence to fixed exchange rate regimes, common languages, membership in a European empire, and shared borders all matter for explaining the trade cost measure. These factors alone account for roughly 30 to 50 percent of the variation. However, the three sub-periods exhibit significant differences, allowing us to document important changes in the global economy over time such as the growing importance of distance in determining the level of the trade cost measure over time and the diminishing effects of fixed exchange rate regimes and membership in European empires.

In Section 6 we return to the central question of what drives trade booms and busts. We use our micro-founded gravity equation to attribute changes in global trade to two fundamental forces: changes in global output and changes in trade costs. For the pre-World War I period, we find that declines in the trade cost measure explain roughly sixty percent of the growth in global trade. The contribution of these declines is particularly large for trade with Asian countries. Conversely, we find that only thirty-one percent of the present-day global trade boom can be explained by the decline in the trade cost measure. This latter finding is consistent with previous studies for the post-World War II period (see Baier and Bergstrand, 2001; Whalley and Xin, 2009), although the contribution of trade cost declines is significantly higher for trade within Europe. The comparison of the two trade booms suggests that major technological breakthroughs in the nineteenth century such as the steamship, the telegraph, and refrigeration may have been relatively more important than technological innovations in the second half of the twentieth century such as containerization and enhanced handling facilities. Finally, we find that the entire interwar trade bust can be explained by the precipitous rise in the trade cost measure associated with the Great Depression, highlighting the critical role of commercial policy, the collapse of the gold standard, and the evaporation of trade credit at the time.

2. Gravity in Three Eras of Globalization

An ever expanding literature documents the applicability of gravity over the long run. In chronological order, we can point to the recent work of Accominotti and Flandreau (2008) which considers bilateral trade flows in the period from 1850 to 1870, finding little role for bilateral trade treaties and most-favored nation clauses in promoting trade flows. López-Córdova and Meissner (2003), Jacks and Pendakur (2010), and Mitchener and Weidenmier (2008) all employ extensive datasets in the period from 1870 to 1913 to discern the effects, respectively, of the classical gold standard, the maritime transport revolution, and the spread of European overseas empires on bilateral trade flows. For the interwar period, Eichengreen and Irwin (1995) are able to document the formation of currency and trade blocs by using an early variant of gravity, while Estevadeordal, Frantz and Taylor (2003) trace the rise and fall of world trade over the longer period from 1870 to 1939, offering a revisionist history where the collapse of the resurrected gold standard and the increase in maritime freight costs all play a role in explaining the interwar trade bust. Finally, for the post-World War II period, a non-exhaustive list of nearly 100 gravity oriented papers is cataloged by Disdier and Head (2008).

It is clear that the validity of the gravity model of international trade has been firmly established theoretically and empirically, both now and in the past. But what has been lacking is a unified attempt to exploit gravity to explain the three eras of globalization. In what follows, we present the results of just such an attempt. A typical estimating equation for gravity models of trade often takes the form of:

$$(1)\quad \ln(x_{ijt}) = \alpha_t + \alpha_i + \alpha_j + \gamma \ln(y_{it} y_{jt}) + z_{ijt}\beta + \varepsilon_{ijt}$$

where x_{ijt} represents nominal bilateral exports from country i to j in time t; α_t represents annual dummies; the α_i and α_j terms represent exporter and importer fixed effects intended to capture differences in resource endowments, differences in productivity, and any other time-invariant attributes which might determine a country's propensity for export or import activity; the y_{it} and y_{jt} terms represent nominal gross domestic products in countries i and j; and z_{ijt} is a row vector of variables representing the various bilateral frictions that limit the flow of goods between countries i and j and includes familiar standbys in the literature such as the physical distance separating countries.

We use expression (1) along with the annual trade and output data detailed in Appendix A to chart the course of gravity in three eras of globalization: the pre-World War I Belle Époque (1870-1913), the fractious interwar period (1921-1939), and the post-World War II resurgence of global trade (1950-2000).[3] The 27 countries in our sample include Argentina, Australia, Austria, Belgium, Brazil, Canada, Denmark, France, Germany, Greece, India, Indonesia, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, the Philippines, Portugal, Spain, Sri Lanka, Sweden, Switzerland, the United Kingdom, the United States, and Uruguay, yielding 130 country pairs.[4] Figure 1 summarizes the sample graphically and Table 1 provides a list of all country pairs in our sample. Table 2 reports the top five bilateral trading relationships in 1870, 1913, 1921, 1939, 1950, and 2000 measured by the sum of bidirectional trade. It clearly shows the replacement of the UK by the US as the top trader in the world over the period. One can also trace out the slow replacement of the UK-US pairing by Canada-US.

[3] As explained in Appendix A, the trade and output data are expressed in real 1990 US dollars, not in nominal terms. However, this does not affect the coefficients of interest reported in Tables 3a and 3b as the deflators are absorbed by the fixed effects.

[4] There would potentially be 27*(27-1)/2=351 country pairs. However, the 130 pairs in our sample are generated by our decision to maintain a balanced panel. Our selection criterion for inclusion into the sample was that an observation on bilateral trade had to be successively reported in 1870, 1913, 1921, 1939, 1950 and 2000. Moreover, we did not include pairs for which a zero was observed since particularly in the earlier period, it is difficult to tell whether an observation is a true zero or unrecorded. Nevertheless, the sample constitutes on average 72 percent of world exports and 68 percent of world GDP over the entire period. We also note that the various sub-samples are highly balanced. Given the 130 country pairs in our sample, there are 29,640 possible bilateral trade observations (2*130 times 114 years) of which we are able to capture 99.9 percent.

Figure 2 plots the long-run evolution of trade flows by regions over the entire period. Finally, we incorporate measures for distance, the establishment of fixed exchange rate regimes, the existence of a common language, historical membership in a European overseas empire,[5] and the existence of a shared border.[6] The results of estimating gravity in the three sub-periods separately are reported in Table 3a (OLS estimation). In Table 3b, we present results from a Poisson pseudo-maximum likelihood estimation to deal with heteroscedasticity as suggested by Silva Santos and Tenreyro (2006).

In Panel A of Table 3a, we estimate equation (1) using GDP, the five variables proxying for trade costs mentioned above as well as year dummies and exporter and importer fixed effects. The results are reassuring. The coefficients on GDP—although different across the three eras of globalization—are precisely estimated and, perhaps with the exception of the first period, fall within the bounds established by previous researchers.[7] Likewise, distance is found to be negatively and significantly related to bilateral trade flows. Fixed exchange rate regimes, common languages, and shared borders are all found to be positively and significantly associated with bilateral trade flows. We also note that these regressions confirm the emerging story on the pro-trade effects of empires, specifically the very strong stimulus to trade afforded by European empires in the pre-World War I period (Mitchener and Weidenmier, 2008) which slowly faded in light of the disruptions of the interwar period and the decolonization movement of the 1950s and 1960s (Head, Mayer, and Ries, 2010). In addition, this simple specification explains a high percentage of the variation in bilateral trade flows for each of the separate periods as the adjusted R-squared ranges from a low of 0.70 in the Belle Époque period to a high of 0.86 in the period from 1950 to 2000.

A more exacting specification consistent with the recent gravity literature (Anderson and van Wincoop, 2003 and Baldwin and Taglioni, 2007) would be that in Panel B of Table 3a. Along with the proxies for trade costs, this specification allows the exporter and importer fixed effects to vary each year, and omits the GDP terms due to collinearity. The sign and significance of the remaining variables is remarkably consistent with those in Panel A of Table 3a. As an additional check, we estimate gravity

[5] For all intents and purposes, this may be thought of as an indicator variable for the British Empire. The sole exception in our sample is the case of Indonesia and the Netherlands.

[6] Another obvious candidate is commercial policy, and especially tariffs. Only one consistent measure of tariffs is available for the period from 1870 to 2000 in the form of the customs duties to declared imports ratio as in Clemens and Williamson (2001). This measure seems to be a reasonably good proxy for tariffs in the pre-World War I and interwar periods. However, after 1950 and the well-known rise of non-tariff barriers to trade, this measure becomes unreliable, sometimes registering unbelievably low levels of protection. The measure also—somewhat paradoxically—becomes less readily available after World War II; the United Kingdom, for instance, stops reporting the level of customs duties in 1965.

[7] The small coefficient on GDP in the first period seems to be driven by very small trade flows for country pairs involving one large but poor country (i.e., India or Indonesia). The first decade of the sample (1870-1880) pulls this coefficient down dramatically. When we consider 1880 onwards, the coefficient rises. This might reflect measurement error either in GDP or in the trade flows or both. The coefficient rises to 0.62 in the Poisson model in Table 3b for the same time period.

by Poisson pseudo-maximum likelihood in Table 3b. The results are qualitatively similar to those in Table 3a.

To conclude, the fundamental result of this section has been the consistency of gravity in determining international trade flows, both in the past and the present. This is a key result which we argue motivates a common gravity framework for the three eras of globalization. We develop such a framework in the following section.

3. Gravity Redux

Our goal in the remainder of the paper is to study two fundamental drivers of trade—output and trade costs. To undertake such an analysis, we now introduce a theoretical gravity framework that incorporates trade costs and that is consistent with many classes of trade models. In particular, we use the gravity equation by Anderson and van Wincoop (2003) to formally show that it can be solved for an expression of implied trade costs. We argue that these implied trade costs are an informative summary statistic to describe international trade frictions. In Section 5, we also demonstrate this empirically.

Anderson and van Wincoop (2003) derive the following gravity equation:

$$(2)\quad x_{ij} = \frac{y_i y_j}{y^W}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma},$$

where y^W is nominal world output and Π_i and P_j are outward and inward multilateral resistance variables. The latter can be interpreted as average trade barriers. $t_{ij} \geq 1$ is the bilateral trade cost factor (one plus the tariff equivalent), and $\sigma > 1$ is the elasticity of substitution. In empirical applications, trade costs are typically proxied by variables such as bilateral distance and a border dummy. But it is difficult to find empirical proxies for the multilateral resistance variables. Anderson and van Wincoop (2003) caution against the use of price indices since they might not capture non-pecuniary trade barriers. Instead, the procedure that has been adopted most frequently in recent regression-based gravity applications is to include country fixed effects.

As an alternative, we follow Head and Ries (2001) and Novy (2010) in eliminating the multilateral resistance variables from the gravity equation. The counterpart of equation (2) for domestic trade x_{ii} is

$$(3)\quad x_{ii} = \frac{y_i y_i}{y^W}\left(\frac{t_{ii}}{\Pi_i P_i}\right)^{1-\sigma}.$$

When equation (2) is multiplied by its counterpart for bilateral trade from *j* to *i*, x_{ji}, we obtain the product of all multilateral resistance variables on the right-hand side, $\Pi_i \Pi_j P_i P_j$. These multilateral resistance indices can be eliminated by dividing by the product of domestic trade flows, $x_{ii} x_{jj}$:

$$(4) \quad \frac{x_{ij} x_{ji}}{x_{ii} x_{jj}} = \left(\frac{t_{ij} t_{ji}}{t_{ii} t_{jj}} \right)^{1-\sigma}.$$

We solve for the trade costs as the key parameters of interest. The parentheses on the right-hand side of equation (4) contain the product of two trade cost ratios. These ratios represent the extent to which bilateral trade costs t_{ij} and t_{ji} exceed domestic trade costs t_{ii} and t_{jj}. Finally, we take the square root to form their geometric average and subtract by one to get an expression for the tariff equivalent. The resulting expression is

$$(5) \quad \tau_{ij} \equiv \left(\frac{t_{ij} t_{ji}}{t_{ii} t_{jj}} \right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii} x_{jj}}{x_{ij} x_{ji}} \right)^{\frac{1}{2(\sigma-1)}} - 1,$$

where τ_{ij} is the trade cost wedge that captures bilateral relative to domestic trade costs.[8]

To grasp the intuition behind this trade cost measure, imagine the two extremes of a frictionless world and a closed economy. In a frictionless world, all trade cost factors t_{ij}, t_{ji}, t_{ii} and t_{jj} are equal to 1. It follows that $\tau_{ij} = 0$. In contrast, a closed economy is characterized by bilateral trade flows, $x_{ij} x_{ji}$, that are zero. In that case, τ_{ij} approaches infinity. τ_{ij} can therefore be interpreted as a trade cost wedge that measures just how far bilateral trade integration is away from a hypothetical frictionless world.

This trade cost measure does not impose bilateral trade cost symmetry. Bilateral trade costs, t_{ij} and t_{ji}, may differ under this framework but here, we can only identify their geometric average but not the extent to which they diverge. In addition, we do not impose zero domestic trade costs. Finally, we note that non-unitary income elasticities, as found by Santos Silva and Tenreyro (2006), do not pose a problem for our methodology. It is easy to show that if the income elasticity in gravity equation (2) differed from unity, the trade cost measure in equation (5) would not be affected.[9]

[8] Head and Ries (2001) were the first authors to derive such a trade cost measure from a monopolistic competition model of trade. Also see Anderson and van Wincoop (2004), and Head and Mayer (2009). We refer to the robustness check in Appendix B where we estimate a version of equation (4).

[9] Suppose the income elasticities in gravity equations (2) and (3) were $\nu \neq 1$ instead of unity with $\nu > 0$. When forming the ratio of bilateral over domestic trade flows, one would obtain the same equation as in (4) and thus the same trade cost measure as in (5). The intuition is that the income terms cancel out once the ratio of trade flows is considered.

We have derived the trade cost measure in equation (5) from the well-known Anderson and van Wincoop (2003) gravity model. However, as shown by Novy (2010), isomorphic trade cost measures can also be derived from other leading trade models developed in the last decade such as the Ricardian trade model by Eaton and Kortum (2002), the trade models with heterogeneous firms by Chaney (2008) and Helpman, Melitz, and Rubinstein (2008), and the heterogeneous firms model by Melitz and Ottaviano (2008) with a linear, non-CES demand structure.[10]

This confirms the appeal of gravity: although the driving forces behind international trade differ across these models—say, Ricardian comparative advantage versus love of variety—they all predict a gravity equation for international expenditure patterns.[11] It turns out that the particular motivation behind foreign trade is not crucial to understand the role of bilateral trade frictions.[12]

4. The Trade Cost Measure over Time

We use equation (5) along with the trade and output data detailed in Appendix A to construct bilateral trade cost measures for the 130 country pairs in our sample. Lacking consistent data on domestic trade, we use GDP less aggregate exports instead. A potential problem arises: the GDP data are value-added whereas trade data are typically reported as gross values. For the period after 1970, it becomes possible to track how well this proxy performs by comparing it to domestic trade constructed as gross production less total exports. We refer to Appendix B where we describe this problem in detail and present trade cost measure series based on gross production data.

[10] Earlier gravity contributions include Anderson (1979) who explained the multiplicative form of the equation and allowed for disaggregation. Bergstrand (1985, 1989, 1990) established the applicability of the gravity equation to a number of preference and substitution structures and to alternate models of international trade: the Heckscher-Ohlin factor endowments approach, trade based on monopolistic competition, and a hybrid model of different factor proportions among monopolistically competitive sectors. Deardorff (1998) argues that in a Heckscher-Ohlin world with bilateral trade barriers, a model similar to the one by Anderson and van Wincoop (2003) applies.

[11] Grossman (1998, p. 29-30) neatly summarizes this situation: "*Specialization* lies behind the explanatory power [of the gravity equation], and of course some degree of specialization is at the heart of any model of trade…This is true no matter what supply-side considerations give rise to specialization, be they increasing returns to scale in a world of differentiated products, technology differences in a world of Ricardian trade, large factor endowment differences in a world of Heckscher-Ohlin trade, or (small) transport costs in a world of any type of endowment-based trade." [Emphasis in original]

[12] However, not all micro-founded trade models deliver a gravity equation from which the trade cost measure can be derived. Fieler (2010) introduces nonhomotheticity such that rich countries produce and demand a different bundle of goods than poor countries. Nonhomotheticity would be a problem for our application if it applied differentially to imports and domestic production. Irarrazabal, Moxnes, and Opromolla (2010) introduce per-unit trade costs as opposed to ad-valorem iceberg trade costs. Atkin (2009) introduces habit formation in an overlapping generations model which gives rise to an endogenous home bias in consumption, whereas our trade cost measure is based on the assumption of identical preferences across countries.

The elasticity of substitution, σ, typically falls in the range (5,10) as surveyed by Anderson and van Wincoop (2004).[13] We set the value of σ to eight, which roughly corresponds to the midpoint of the range (5,10). But we show in Appendix C that although the level of inferred trade costs is sensitive to the assumed parameter value, their change over time is hardly affected.

We generate average trade cost measure series for each of the three eras of globalization by regressing the constructed bilateral trade cost measures on a set of year fixed effects and country-pair fixed effects. We repeat this exercise for both global trade and six sub-regions: within the Americas, within Asia/Oceania, within Europe, between the Americas and Asia/Oceania, between the Americas and Europe, and between Asia/Oceania and Europe. Figures 3 through 5 track these averages over time. There, the averages have all been normalized to 100 for the initial observation in each period, i.e., 1870, 1921, and 1950, so that they are not strictly comparable in terms of levels across periods.[14] Our goal instead is to highlight the changes within a given period. We weight these averages by the sum of the two countries' GDPs in each pair to reduce the influence of country pairs which trade infrequently or inconsistently. Still, large countries may trade proportionately less and consequently have higher measured international trade costs. Figure 7 presents a view with alternative weighting schemes.

Thus, for the first wave of globalization from 1870 to 1913, we document an average decline in measured trade costs of thirty-three percent.[15] This was led by a fifty percent decline between Asia/Oceania and Europe, probably generated from a combination of Japanese reforms that increased engagement with the rest of the world, the consolidation of European overseas empires, and radical improvements in communication and transportation technologies which linked Eurasia. These gains were apparently not limited to the linkages between the countries of Asia/Oceania and the rest of the world as the intra-Asian/Oceanic trade cost measure declined on the order of thirty-seven percent. Thus, the late nineteenth century was a time of unprecedented changes in the relative commodity and factor prices of the region as has been documented by Williamson (2006).

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[13] As (σ-1) in equation (5) corresponds to the Fréchet parameter ζ in the trade cost expression based on the Eaton and Kortum (2002) gravity equation and to the Pareto parameter γ based on the Chaney (2008) gravity equation, it is instructive to also consider estimates for those parameters. Eaton and Kortum (2002) report a baseline estimate of 8.3 for ζ. Chaney (2008) estimates the ratio $\gamma/(\sigma-1)$ to be near two, which suggests a value of γ above σ.

[14] However, in Figure 6 we present inferred trade costs levels for reference. The trade cost measure was lower in 1913 than in 1870, higher in 1921 than in 1913 and higher in 1939 than in 1921. It was lower in 2000 than in 1950, reaching its 1913 level in approximately 1975. Figure 7 presents average inferred trade cost levels computed with various weighting schemes. In Appendix C we also show that secular trends in the elasticity of substitution lead to similar inferred trade cost changes over time.

[15] The distribution of spikes in 1874 and 1881 in the Asia and Americas-Asia series may seem odd. However, these are explained by the small number of underlying observations (n=7 and n=6, respectively) and can be attributed to sporadic trade volumes for Japan as it integrated—sometimes by fits and starts—into the global economy.

Bringing up the rear was intra-American trade, albeit with a still respectable average decline of nineteen percent. This performance masks significant heterogeneity across North and South America: measured trade costs within North America declined by twenty-nine percent, while the trade cost measure between North and South America fell by only fifteen percent. Most likely, this reflects South America's continued orientation towards European markets and the fleeting connections uniting South America and North America—save the United States—at the time. Likewise, intra-European measured trade costs only declined by twenty-one percent. This performance reflects the maturity as well as the proximity of these markets. We should also note that a substantial portion of the decline is concentrated in the 1870s. This was, of course, a time of simultaneously declining freight rates and tariffs as well as increasing adherence to the gold standard. In subsequent periods, the decline in freight rates was substantially moderated, while tariffs climbed in most countries, dating from the beginning of German protectionist policy in 1879.

Turning to the interwar period from 1921 to 1939, we can see that the various attempts to restore the pre-war international order were somewhat successful at reining in international trade costs. A fitful return to the gold standard was launched in 1925 when the United Kingdom returned to gold convertibility at the pre-war parity. By 1928, most countries had followed its lead and stabilized their currencies. At the same time, the international community witnessed a number of attempts to normalize trading relations, primarily through the dismantling of the quantitative restrictions erected in the wake of World War I (Findlay and O'Rourke, 2007). Associated with these events, the trade cost measure fell on average by seven percent up to 1929. Although much less dramatic than the fall for the entire period from 1870 to 1913, this average decline was actually twice as large as that for the eight-year period from 1905 to 1913, pointing to a surprising resilience in the global economy of the time. The leaders in this process were again trade between Asia/Oceania and Europe with a respectable fifteen percent decline and intra-European trade with a ten percent decline. On the other end of the spectrum, inferred trade costs within the Americas and between the Americas and Europe barely budged, both registering a three percent decline. And again, these aggregate figures for the Americas mask important differences across North and South America: the trade cost measure within North America ballooned by eight percent—arguably reflecting the adversarial commercial policy of Canada and the United States in the 1920s—while it declined by seven percent between North and South America.

The Great Depression marks an obvious turning point for all the series. It generated the most dramatic increase in average inferred trade costs in our sample as they jump by twenty-one percentage points in the space of the three years between 1929 and 1932. This, of course, exactly corresponds with the well-documented implosion of international trade (Maddison, 2003), highly protectionist trade policy (Madsen, 2001), tight commercial credit (Hynes, Jacks, and O'Rourke, 2009), and a generally uneasy trading environment. The trade cost measures within Asia/Oceania, within Europe, and between Asia/Oceania and Europe experienced the most moderate increases at eighteen percentage points each. Within the Americas it rose very strongly by thirty-five percentage points, driven more by the trade disruptions between North and South America (+38 percentage points) than within North America (+28 percentage points). Over time though, the trade cost measure declined from these heights just as recovery from the Great Depression began in 1932/1933 and nations made halting attempts to liberalize trade, even if only on a bilateral or regional basis (Findlay and O'Rourke, 2007). Yet these were not enough to recover the lost ground: average inferred trade costs stood thirteen percent higher at the outbreak of World War II than in 1921.

Finally, the second wave of globalization from 1950 to 2000 registered declines in the average trade cost measure on the order of sixteen percent. The most dramatic decline was within Europe at thirty-seven percent, a decline that is related to the formation of the European Economic Community and subsequently the European Union. The most recalcitrant performance was for the Americas and Asia/Oceania, both of which registered small increases over this period. In the former case, this peculiar result is solely generated by inferred trade costs between North and South America which rose by twenty-two percent. This most likely reflects Argentina, Brazil, and Uruguay's adherence to import-substituting industrialization up to the debt crisis of the 1980s and the reorientation of South American trade away from its heavy reliance on the United States as a trading partner which had emerged in the interwar period. In contrast, inferred trade costs within North America fell by a remarkable sixty percent, at least partly reflecting the Canada-US Free Trade Agreement and the North American Free Trade Agreement. In the case of Asia/Oceania, the rise in the trade cost measure is primarily generated by India which in its post-independence period simultaneously erected formidable barriers to imports and retreated from participation in world export markets. This India effect is most pronounced for former fellow members in the British Empire, that is, Australia, New Zealand, and Sri Lanka.

Most surprisingly, the decline in the trade cost measure during the second wave of globalization is mainly concentrated in the period before the late 1970s. Indeed, in the global and all sub-regional averages—save the Americas—the trade cost measure was lower in 1980 than in 2000. In explaining the dramatic declines prior to 1973, one could point to the various rounds of the GATT up to the ambitious Kennedy Round which concluded in 1967 and slashed tariff rates by 50 percent and which more than doubled the number of participating nations. Or perhaps, it could be located in the substantial drops—but subsequent flatlining—in both air and maritime transport charges up to the first oil shock documented in Hummels (2007). This phenomenon demands further attention but remains outside the scope of this paper.

5. The Determinants of the Trade Cost Measure

Having traced the course of the trade cost measure, we now consider some of its likely determinants. This exercise serves two purposes. First, it addresses—albeit imperfectly—the natural question of what factors have been driving the evolution of trade costs over time. Second and more importantly, it helps further establish the reliability of our measure—that is, are trade costs as constructed in this paper reasonably correlated with other variables commonly used as proxies in the literature? Below, we demonstrate that this is the case. We also refer the reader to Appendix B where we provide robustness checks confirming the reliability of the measure.

The trade cost measure in our paper is derived from a gravity equation rather than estimated as is typically the case in the literature. Commonly, log-linear versions of equation (1) are estimated by substituting an arbitrary trade cost function for z_{ijt} and using fixed effects for the multilateral resistance variables. Such gravity specifications, to the extent that the trade cost function and the econometric model are well specified, could be used to provide estimated values of bilateral trade costs. In fact, as demonstrated above, such specifications are highly successful in explaining a significant proportion of the variance in bilateral trade flows. Nevertheless, there is likely a substantial amount of unexplained variation at the bilateral level due to unobservable trade costs and, thus, potential omitted variable bias and measurement error.

We consider a function for trade costs that is widely used in the gravity literature:

(6) $\tau_{ijt} = \alpha\, dist_{ij}^{\rho} \exp(x_{ijt}\beta + \varepsilon_{ijt}),$

where *dist* is a measure of distance between two countries, x is a row vector of observable determinants of trade costs, and ε is an error term composed of unobservables. We log-linearize equation (6). The determinants we consider are the same as those in Section 2 and include the distance between two countries, the establishment of fixed exchange rate regimes, the existence of a common language, membership in a European overseas empire, and the existence of a shared border. In all regressions, we include time-invariant country fixed effects as well as year fixed effects.[16] The reported regressions pool across all periods and then separate the data for the 130 dyads between 1870 and 1913, 1921 and 1939, and 1950 and 2000. The results are reported in Table 4.

[16] By construction τ_{ij} nets out the multilateral resistance terms so that time-varying country fixed effects are not required.

Considering the pooled results first, we find that a one standard deviation rise in distance raises the trade cost measure by 0.38 standard deviations. Fixed exchange rates, a common language, joint membership in a European empire, and sharing a border are all associated with lower inferred trade costs, with the latter two coefficients being roughly double the estimated effect of fixed exchange rate or sharing a common language. This pooled approach demonstrates that standard factors that are known to be frictions in international trade are sensibly related to the trade cost measure. The results also show that the trade cost measure determines trade patterns in ways largely consistent with the gravity literature covering more geographically comprehensive samples.

At the same time, the pooled approach masks significant heterogeneity across the periods. Here, we highlight a few of these differences. First, fixed exchange rate regimes appear noticeably stronger in the pre-World War I and post-World War II environments—a result consistent with the tenuous resurrection of the classical gold standard in the interwar period (Chernyshoff, Jacks, and Taylor, 2009). Second, a common language seems to have exerted a slightly stronger influence (roughly 75 percent) on the trade cost measure in the period from 1870 to 1913 than subsequently. Third, we document a clearly diminished association of European empires with lower levels of the trade cost measure: a coefficient of -0.46 from 1870 to 1913 is reduced to -0.15 in the period from 1950 to 2000—a result which is consistent with recent work by Head, Mayer, and Ries (2010).[17] Finally, distance seems to have become more important in the post-1950 world economy, with the coefficient increasing by 50 percent as compared to 1870-1913 or almost tripling when compared to 1921-1939. This result is in line with Disdier and Head (2008) who find that the estimated distance coefficient has been on the rise from 1950 in their meta-analysis of the gravity literature. Whether this reflects upward pressures in transport costs (Hummels, 2007), the regionalization of trade or changes in the composition of traded goods remains an open question, but it does accord with the empirical evidence on the decreasing distance-of-trade from the 1950s (Berthelon and Freund, 2008; Carrère and Schiff, 2005).

6. A Long-Run View of Trade Booms and Trade Busts

In order to determine what drives trade booms and busts, we now turn to a decomposition of the growth of trade flows in the three periods. We are interested in whether trade booms are mainly related to secular increases in output or falling trade costs. Similarly, we are interested in whether trade busts

[17] Interestingly, much of this decline had already happened prior to 1950 as the coefficient registers a value of -0.20 during the interwar period.

are mainly related to output slumps or increasing trade costs. The gravity framework laid out above easily lends itself to answering these questions.[18]

We rewrite equation (4) as

$$(7)\quad x_{ij}x_{ji} = y_i y_j \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma} \frac{x_{ii}x_{jj}}{y_i y_j} = y_i y_j \left(1+\tau_{ij}\right)^{2(1-\sigma)} \frac{x_{ii}x_{jj}}{y_i y_j}.$$

As we are interested in the growth of bilateral trade, we log-linearize equation (7) and take the first difference between years (denoted by Δ). This yields

$$(8)\quad \Delta\ln\left(x_{ij}x_{ji}\right) = \Delta\ln\left(y_i y_j\right) + 2(1-\sigma)\Delta\ln\left(1+\tau_{ij}\right) + \Delta\ln\left(\frac{x_{ii}x_{jj}}{y_i y_j}\right).$$

Following Helpman (1987) and Baier and Bergstrand (2001), we split the product of outputs into the sum of outputs and output shares, $y_i y_j = \left(y_i + y_j\right)^2 s_i s_j$ with $s_i = y_i / \left(y_i + y_j\right)$, such that we obtain our final decomposition,

$$(9)\quad \Delta\ln\left(x_{ij}x_{ji}\right) = 2\Delta\ln\left(y_i + y_j\right) + \Delta\ln\left(s_i s_j\right) + 2(1-\sigma)\Delta\ln\left(1+\tau_{ij}\right) + \Delta\ln\left(\frac{x_{ii}x_{jj}}{y_i y_j}\right).$$

Equation (9) decomposes the growth of bilateral trade into four components. The first term on the right-hand side represents the contribution of output growth to bilateral trade growth. The second term is the contribution of increasing income similarity, as first stated by Helpman (1987). All else being equal, two countries of the same size are expected to generate more international trade than two countries of unequal size. The third term reflects the contribution of changes in trade costs as measured by τ_{ij}.[19] The fourth term represents changes in multilateral factors. Its precise interpretation depends on the underlying trade model. For example, as equation (3) shows, if multilateral trade barriers fall over time, the ratio of domestic trade to output x_{ii} / y_i goes down so that the contribution of the fourth term to bilateral trade growth becomes negative. This can be interpreted as a trade diversion effect that is consistent with the models by Anderson and van Wincoop (2003), Eaton and Kortum (2002), and Chaney (2008).[20]

We consider the growth of bilateral trade between the initial years (1870, 1921 and 1950) and the end years (1913, 1939 and 2000) of our three sub-periods. We compute averages across dyads

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[18] We outline our approach based on the Anderson and van Wincoop (2003) gravity model but we note that identical results can be obtained based on the models by Eaton and Kortum (2002), Chaney (2008), and Melitz and Ottaviano (2008).
[19] Since (1-σ) is negative, a decline in τ_{ij} implies a positive third term on the right-hand side of equation (9).
[20] In the Melitz and Ottaviano (2008) model, the fourth term would also capture changes in the degree of competition in a country as indicated by the number of entrants and the marginal cost cut-offs above which domestic firms decide not to produce.

weighted by the sum of the two countries' GDPs in each pair. The results are reported in Table 5 below. To be clear about our approach, we do not estimate equation (9). Instead, we decompose the growth of bilateral trade conditional on our theoretical gravity framework. The purpose of the decomposition is to uncover whether bilateral trade growth is mainly associated with output growth or changes in the bilateral trade cost measure. We are also interested in how the relative contribution of changes in output and the trade cost measure differs across the three sub-periods. We note that our results do not depend on the value of σ—even if it changes over time. The reason is that the first, second and fourth terms on the right-hand side of equation (9) are given by the data. As predicted by the models outlined in Section 3, the trade cost term follows as the residual.[21]

As can be seen from the final column in Table 5, the percentage growth in trade volumes is highly comparable in the two global trade booms of the late 19th and 20th centuries at 486 and 484 percent, respectively. But the main insight is that the principal driving forces are reversed. In the period from 1870 to 1913, declines in the trade cost measure account for a majority (290 percentage points) of the growth in international trade, while in the period from 1950 to 2000 they account for a distinct minority (148 percentage points) of trade growth. This is congruent with traditional narratives of the late nineteenth century as a period of radical declines in international transport costs and payments frictions as well as studies on the growth of world trade in the contemporary world which suggest that such changes may have been more muted (cf. Baier and Bergstrand, 2001; Hummels, 2007). The contributions of increasing income similarity and changes in multilateral factors are negligible throughout the entire period.

At the same time, both periods encompass a wide variety of experiences across regional subgroups. For 1870 to 1913, the average trade growth of 486 percent masks a relatively anemic growth of 324 percent within Europe versus an explosive growth of trade between Asia/Oceania and Europe of 647 percent. European trade growth is evenly associated with output growth and declines in inferred trade costs, while the overwhelming majority of trade growth between Asia/Oceania and Europe is related to trade cost declines. The former result is consistent with the fact that the majority of European communication and transport infrastructure was in place well before 1870 and that a "tariff backlash" in Europe increased trade costs (Jacks, Meissner, and Novy, 2010). The latter result is

[21] As in all of the standard gravity literature, an implicit assumption in our paper is 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 to have a large bearing on our results.

consistent with the idea that core-periphery trade between 1870 and 1913 was subject to much more radical changes: the expansion of trading networks through pro-active marketing strategies in new markets, the development of new shipping lines, and better internal communications.

For 1950 to 2000, the results for trade within Europe are reversed: intra-European trade is now in the lead at 633 percent followed by trade between Asia and Europe at 544 percent, while intra-American growth lags at 363 percent. European trade growth is again equally associated with output growth and declines in the trade cost measure, whereas in all other regions changes in output clearly dominate. The results for the Americas are consistent with the evidence on trade costs documented above in light of South America's drive to self-sufficiency under import-substituting industrialization.

Finally, the role of the trade cost measure is dominant in the interwar period. Based on output growth alone, one would have expected world trade volumes to increase by 88 percent. The fact that they failed to budge underlines the critical role of commercial policy, the collapse of the gold standard, and the lack of commercial credit in determining trade costs at the time. Yet again, the interwar trade bust was anything but uniform: there was impressive trade growth between the Americas and Asia/Oceania of 48 percent set against an actual contraction of trade between the Americas and Europe of 45 percent. Output growth dominates trade costs in the case of the Americas and Asia/Oceania. The opposite is true in the case of the Americas and Europe. Indeed, the increase in the trade cost measure implies that barring output growth trade between the two would have ground to an absolute halt.

Figure 8 concentrates on the full sample and further disaggregates the sub-periods to the decadal level. It helps to more clearly illustrate the forces at work in the interwar period: whereas the 1920s witnessed significant and mainly output-related expansion in trade volumes, the 1930s gave rise to a demonstrable trade bust in the context of positive, albeit meager output growth. In this sense, the 1930s share with the 1980s and 1990s the distinction of being the only periods in which output growth outstrips trade growth. In contrast, the 1870s and the 1970s are the periods in which the relative contribution of declines in the trade cost measure to world trade growth was at its greatest.

7. Conclusion

In this paper, we have attempted to answer the question of what has driven trade booms and trade busts in the past 130 years. Our results assign an overarching role for our trade cost measure in the nineteenth century trade boom and the interwar trade bust. In contrast, when explaining the post-World War II trade boom, we identify a more muted role for the trade cost measure.

Thus, the role of trade costs in explaining trade has, if anything, diminished over the long run. Prior to World War II, eliminating the physical costs of distance and improving information seem to have mattered more than economic growth. Over the past fifty years, trade has increasingly sustained its growth due to economic expansion, and this process seems to have had a bigger impact than the transportation and communications revolutions of the last several decades. Unlocking the sources of this reversal remains for future work.

Another contribution of this paper has been to consistently and comprehensively track changes in a micro-founded bilateral trade cost measure by using a newly compiled dataset on aggregate bilateral trade. The gravity model has been successful in the past, especially in providing estimates of the marginal impact of a range of trade costs. We build on this success exploiting the fact that a large variety of general equilibrium models of international trade can be used to calculate a trade cost wedge akin to the Solow residual in growth models or the 'labor wedge' used in structural macro-labor models (e.g., Shimer, 2009).

We have also been able to relate this trade cost measure to proxies suggested by the literature such as geographical distance and adherence to fixed exchange rate regimes, confirming its reliability. Further work might investigate more closely other properties of the trade cost measure. Promising avenues for research include augmenting the list of trade cost proxies and studying their impact on the trade cost measure, detailed case studies for particular countries to better illuminate the nature of trade costs, and addressing the uncertainty that surrounds the trade cost function. This is obviously not an exhaustive list but it should highlight one aspect: the determinants of bilateral trade frictions are still poorly understood. This is problematic since trade costs may be as important as the traditional determinants of trade, if not more important. Further work on international trade—no matter the period—can no longer ignore these fundamental factors.

Finally, there are two empirical observations from the experience of the last ten years or so (which are not studied in our sample) suggesting that the gravity models most often used in the literature may need to be developed further. The first is the substitution of international for domestic supply chains, or 'vertical specialization.' Such a structural change implies that trade may become more sensitive to trade costs (Yi, 2003), and this is not explicitly modeled yet in a gravity framework. Second, the trade collapse of 2008 demonstrates that high frequency changes in trade are substantially more volatile than GDP measures. It is an open question to what extent standard gravity equations can explain the crash of trade flows relative to GDP and whether trade costs played an important role during the crisis.

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Appendix A: Data Sources

Bilateral trade: Translated into real 1990 US dollars using the US CPI deflator in Officer and Williamson (2009) and the following sources:

Annuaire Statistique de la Belgique. Brussels: Ministère de l'intérieur.
Annuaire Statistique de la Belgique et du Congo belge. Brussels: Ministère de l'intérieur.
Annual Abstract of Statistics. London: Her Majesty's Stationery Office.
Barbieri, Katherine. 2002. *The Liberal Illusion: Does Trade Promote Peace?* Ann Arbor: University of Michigan Press.
Bloomfield, Gerald T. 1984. *New Zealand, A Handbook of Historical Statistics*. Boston: G.K. Hall.
Canada Yearbook. Ottawa: Census and Statistics Office.
Confederación Española de Cajas de Ahorros. 1975. *Estadísticas Básicas de España 1900-1970*. Madrid: Maribel.
Direction of Trade Statistics. Washington: International Monetary Fund.
Historisk Statistik för Sverige. 1969. Stockholm: Allmänna förl.
Johansen, Hans Christian. 1985. *Dansk Historisk Statistik 1814-1980*. Copenhagen: Gylendal.
Ludwig, Armin K. 1985. *Brazil: A Handbook of Historical Statistics*. Boston: G.K. Hall.
Mitchell, Brian R. 2003a. *International Historical Statistics: Africa, Asia, and Oceania 1750-2000*. New York: Palgrave Macmillan.
Mitchell, Brian R. 2003b. *International Historical Statistics: Europe 1750-2000*. New York: Palgrave Macmillan.
Mitchell, Brian R. 2003c. *International Historical Statistics: The Americas 1750-2000*. New York: Palgrave Macmillan.
National Bureau of Economic Research-United Nations World Trade Data.
Ruiz, Elena Martínez. 2006. "Las relaciones económicas internacionales: guerra, política, y negocios." In *La Economía de la Guerra Civil*. Madrid: Marcial Pons, pp. 273-328.
Statistical Abstract for British India. Calcutta: Superintendent Government Printing.
Statistical Abstract for the British Empire. London: Her Majesty's Stationery Office.
Statistical Abstract for the Colonies. London: Her Majesty's Stationery Office.
Statistical Abstract for the Principal and Other Foreign Countries. London: Her Majesty's Stationery Office.
Statistical Abstract for the Several Colonial and Other Possessions of the United Kingdom. London: Her Majesty's Stationery Office.
Statistical Abstract for the United Kingdom. London: Her Majesty's Stationery Office.
Statistical Abstract of the United States. Washington: Government Printing Office.
Statistical Abstract Relating to British India. London: Eyre and Spottiswoode.
Statistical Yearbook of Canada. Ottawa: Department of Agriculture.
Statistics Bureau Management and Coordination Agency. 1987. *Historical Statistics of Japan, vol. 3*. Tokyo: Japan Statistical Association.
Statistisches Reichsamt. 1936. *Statistisches Handbuch der Weltwirtschaft*. Berlin.
Statistisk Sentralbyrå. 1978. *Historisk statistikk.* Oslo.
Tableau général du commerce de la France. Paris: Imprimerie royale.
Tableau général du commerce et de la navigation. Paris: Imprimerie nationale.
Tableau général du commerce extérieur. Paris: Imprimerie nationale.
Year Book and Almanac of British North America. Montreal: John Lowe.
Year Book and Almanac of Canada. Montreal: John Lowe.

Fixed exchange rate regimes: Throughout the paper we rely almost completely on de facto exchange rate regime information. For the post-World War II period, we use the de facto measure of exchange rate pegs developed by Reinhart and Rogoff (2004) and coded by Meissner and Oomes (2009), which correlates highly with other thorough post-war de facto categorizations such as Shambaugh (2004). Prior to World War II, no comparable investigation of de facto regimes exists. Sources for the interwar period include Eichengreen (1992) and for the pre-World War I period Meissner (2005). Meissner (2005) presents data on whether a country was on or off the gold standard both de facto and de jure where the domestic currency must be freely exchangeable for gold at a fixed price. For the interwar period, a pair is coded as having a fixed exchange rate if both were on the gold standard de facto or in an exchange rate bloc like the sterling bloc. Prior to World War II, when countries were not on the gold standard, they were nearly always floating against everyone else, i.e., there was sufficient nominal exchange rate volatility in the non-gold cases to deem them floating and little by way of de facto pegging. In the pre-World War I period, Austria from 1892 and Italy from 1902 are perhaps two exceptions in the sense that they shadowed the gold standard but did not allow free convertibility of their currencies into gold. Our results are robust to coding these countries as sharing a peg with other gold standard countries.

GDP: Maddison, Angus. 2003. *The World Economy: Historical Statistics*. Paris: Organization for Economic Cooperation and Development. Reported in real 1990 US dollars.

Distance: Measured as kilometers between capital cities. Taken from indo.com.

Appendix B: The Reliability of the Trade Cost Measure

The trade cost measure versus gravity residuals: In a further attempt to establish the reliability of our trade cost measure, we present the results of comparing it to the residuals of a very general gravity equation. Bilateral trade can be attributed to factors in the global trading environment that affect all countries proportionately—for instance, global transportation and technology shocks; characteristics of individual countries—for instance, domestic productivity; and factors at the bilateral level including bilateral trade costs. To this end, we estimate the following regression equation:

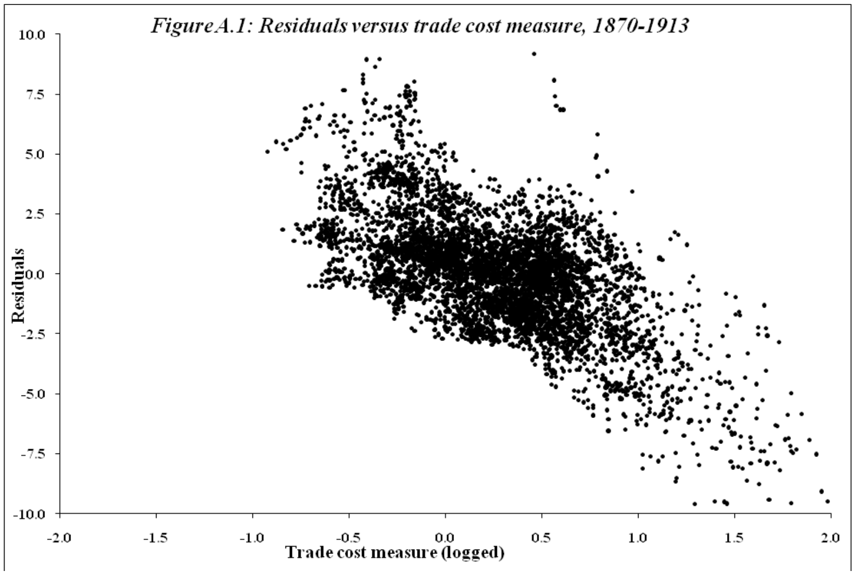
(A.1) $\ln(x_{ijt}x_{jit}) = \delta_t + \alpha_{it} + \alpha_{jt} + \varepsilon_{ijt}$,

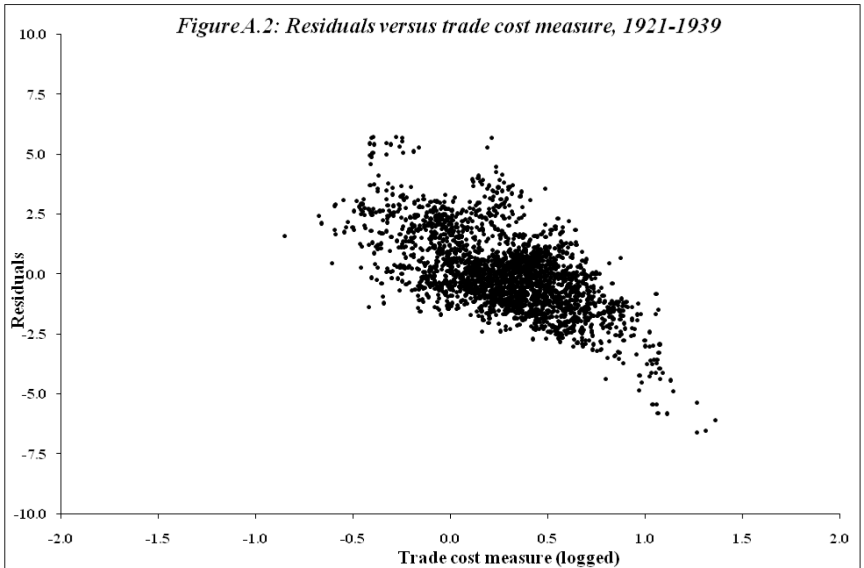
The first term captures factors in the global trading environment which affect all countries proportionately, while the second and third terms capture characteristics of individual countries over time. The residual term absorbs all country-pair specific factors including trade costs.

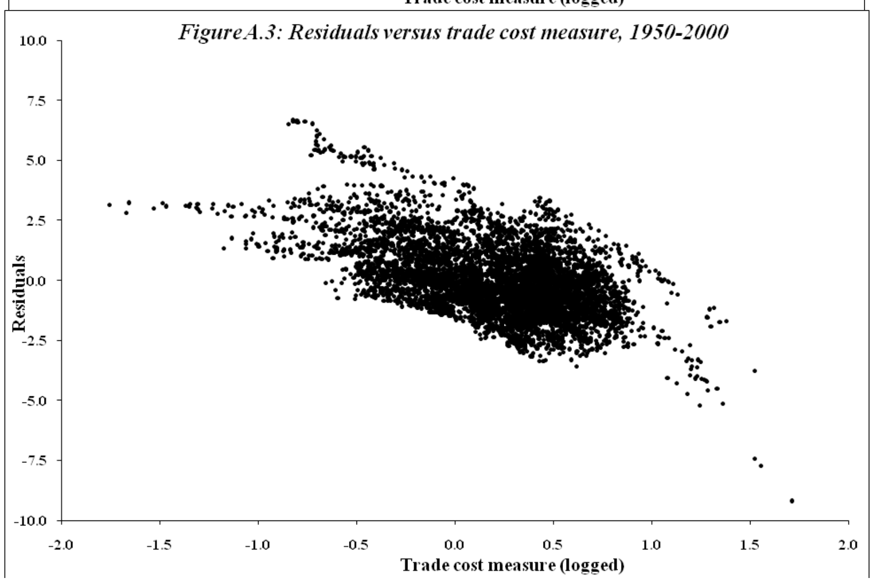
The correlation between the logged values of our trade cost measure and these residuals is consistently high: -0.64 for the period from 1870 to 1913; -0.62 for the period from 1921 to 1939; and -0.53 for the period from 1950 to 2000. The correlation has the expected (negative) sign. For example, if Germany and the Netherlands experience a particularly large volume of trade in a given year relative to past values or contemporaneous values for a similar country pair—say, Germany and Belgium—then the residual should be positive as the linear projection from the coefficients will under-predict the volume of trade between Germany and the Netherlands for this particular year. The primary means by which trade is stimulated in our model, holding all else constant, would be a lowering of bilateral trade costs. Thus, relatively higher trade volumes should be associated with lower trade costs.

Figures A.1 through A.3 plot the trade costs measure against the residuals from regression (A.1). Naturally, the magnitudes are different, but with appropriate adjustment of the scale it is clear that the correspondence between the two series is high, albeit not perfect.

Figure A.1: Residuals versus trade cost measure, 1870-1913







Gravity based on equation (4): In this robustness test we present estimates by sub-period for the underlying gravity model used in our decomposition exercise. Equation (4) can be rewritten as:

$$\text{(A.2)}\quad \ln(x_{ij}x_{ji}) = \ln(x_{ii}) + \ln(x_{jj}) + (1-\sigma)\ln\left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)$$

To estimate this equation, we substitute the trade cost function from equation (6), add year fixed effects and a white noise error term at the country-pair year level. Results are provided in Table A.1. The R-squareds are excellent, never explaining less than 99 percent of the variance. The signs of the coefficients on the trade cost proxies are as expected from Tables 3a and 3b. In the post-World War II period, and the interwar period, we cannot reject the null hypothesis that the coefficients on the size terms are equal to one. In the pre-World War I period, we cannot reject the hypothesis that the size term for country *j* is one but we do so for country *i*. This result could easily be due to the weakness in the GDP data in that period. In any case, when we form the log of product of the size terms in this period, the estimated coefficient is 1.167 and we cannot reject the hypothesis that this coefficient is one (p-value = 0.23). The main message is that the gravity equation above, which is consistent with all the models explored earlier, is reliable and provides a good basis for the decomposition exercise.

Table A.1: Gravity Based on Equation (4)

Dependent variable: ln(xijxji)

	1870-1913		1921-1939		1950-2000	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
ln (xii)	**1.59**	**0.19**	**1.02**	**0.12**	**1.11**	**0.10**
ln (xjj)	**0.69**	**0.20**	**1.08**	**0.15**	**1.20**	**0.12**
ln (Distance)	**-1.16**	**0.23**	**-0.65**	**0.18**	**-1.67**	**0.13**
Fixed exchange rate regime	**1.73**	**0.37**	**1.47**	**0.29**	**1.75**	**0.43**
Common language	0.14	0.75	1.18	0.54	0.96	0.43
Imperial membership	2.61	1.33	0.47	1.11	0.17	0.83
Shared border	**1.92**	**0.69**	0.88	0.51	0.68	0.53
Observations	5709		2470		6628	
R-squared	0.99		0.99		0.99	
Test ln (xii) = 1 (p-value)	0.00		0.87		0.27	
Test ln (xjj) = 1 (p-value)	0.17		0.62		0.11	

NB: Year fixed effects not reported; robust standard errors; bold values significant at the 1% level.

GDP vs. gross production data: The expression for our trade cost measure in equation (5) requires data for domestic trade x_{ii}. As these are not readily available, they have to be constructed. Domestic trade in the Anderson and van Wincoop (2003) model is given as total income minus total exports, i.e., $x_{ii} = y_i - x_i$, where x_i are total exports of country i. As the default in the paper we use GDP as a proxy for total income and subtract total exports to construct domestic trade.

However, there are two concerns about combining GDP and trade data. First, GDP data are based on value added, whereas trade data are reported as gross shipments. To be consistent one should use the gross shipment counterpart of GDP, i.e., gross output. As gross output is by construction larger than value-added GDP, the use of GDP would lead to an *under*estimation of domestic trade such that implied trade costs τ_{ij} in equation (5) would be understated. Formally, suppose $x_{ii} = a_i x_{ii}^*$ where x_{ii}^* is the 'true' value of domestic trade and a_i is a country-specific factor that captures the deviation of x_{ii}^* from its proxy based on GDP data, x_{ii}. The first concern implies a_i<1.

The second concern is that GDP data include services which are not covered by the trade data. The use of GDP and its inclusion of services could therefore lead to an *over*estimation of domestic trade such that trade costs τ_{ij} are overstated. Formally, the second concern implies a_i>1. In summary, the overall bias on the trade cost measure arising from the use of GDP data is ambiguous.

To address these two concerns and to investigate the possible bias, we construct an alternative measure for y_i that better matches the trade data. In particular, we follow the approach by Wei (1996) in constructing y_i as the gross production value for agriculture, mining and total manufacturing without considering the services sector. We construct domestic trade by subtracting total exports from this alternative measure for y_i. Annual gross production data are taken from the OECD Structural Analysis (STAN) database, deflated with GDP deflators provided by the IMF International Financial Statistics (IFS) with 1990 as the base year, and translated into US dollars using average exchange rates for the base year from the IMF IFS. Gross production data are only available for a subset of twelve countries over the period from 1970 to 2000. These countries are Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and the United States. The German data cover West Germany only until 1990. Only manufacturing data are available over the entire period for Belgium, France, Sweden, the United Kingdom, and the United States. Our overall dataset comprises 61 bilateral pairs for this subset of countries.

Figures A.4a and A.4b plot trade cost indices for these 61 pairs based on GDP data and gross production data, respectively. They are constructed in the same way as Figures 3-5 (weighted by the sum of countries' GDPs in the pair). The average decline in the trade cost measures is steeper based on gross production data (26 percent vs. 15 percent). The more moderate decline based on GDP data reflects the rise of the services sector in the GDP data and the relative decline of manufacturing in those countries (see the second concern above). The decline has been particularly steep between Europe and Japan (36 percent vs. 26 percent) and in the Americas (US-Canada only in this subsample, 35 percent vs. 24 percent). The correlation between the two average series is 0.89. The correlations range between 0.74 for Americas-Europe and 0.98 for Europe-Japan.

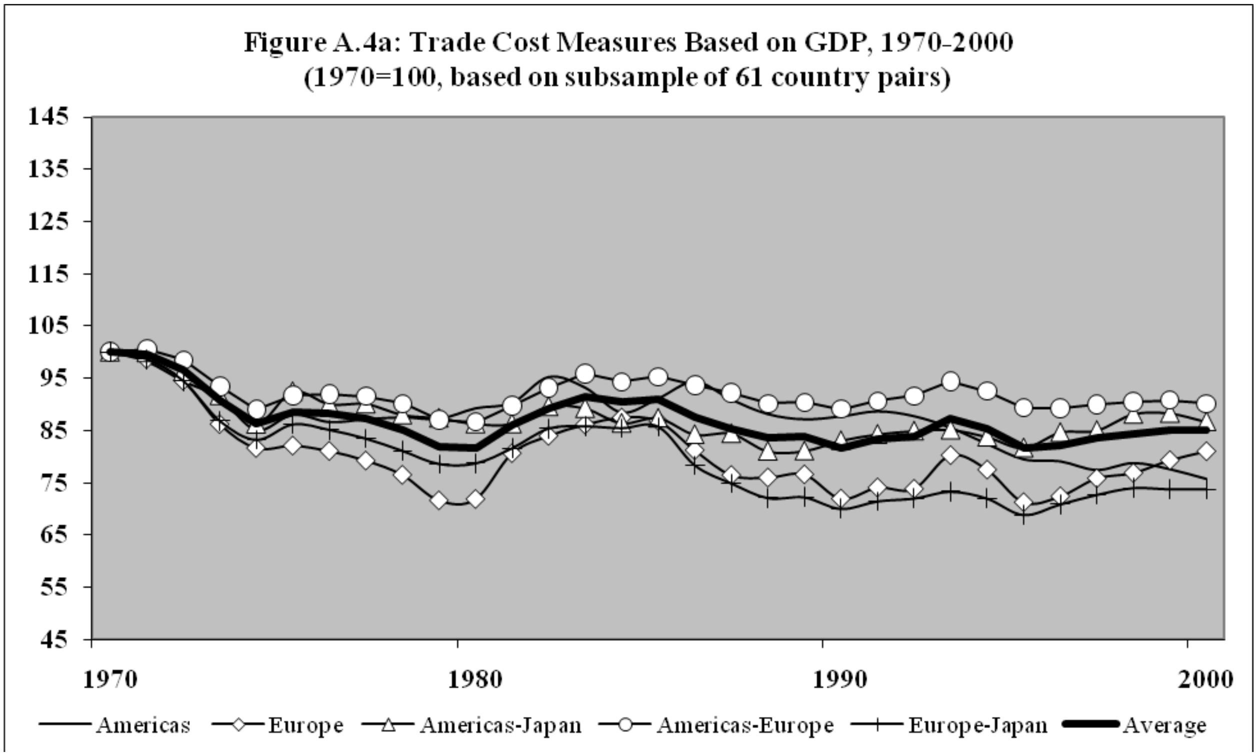


Figure A.4a: Trade Cost Measures Based on GDP, 1970-2000
(1970=100, based on subsample of 61 country pairs)
145
135
125
115
105
95
85
75
65
55
45
1970
1980
1990
2000
Americas
Europe
Americas-Japan
Americas-Europe
Europe-Japan
Average

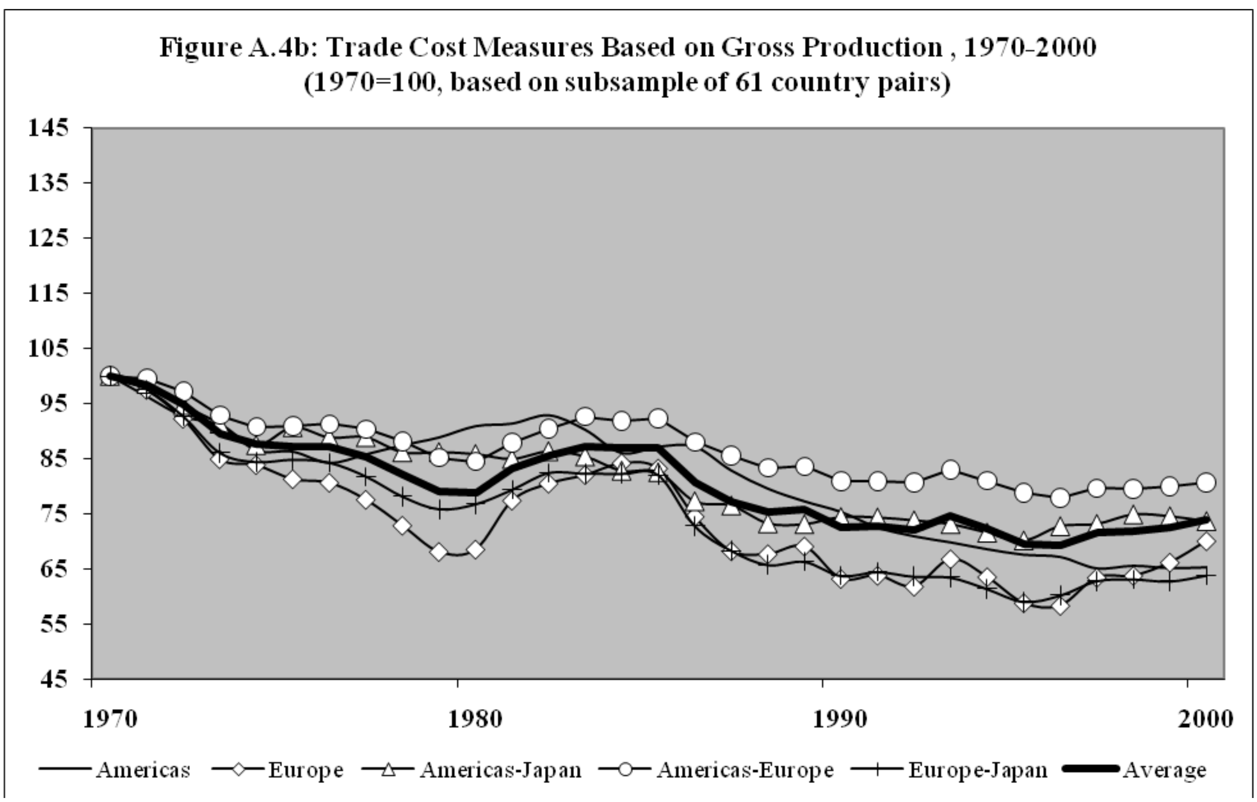


Figure A.4b: Trade Cost Measures Based on Gross Production , 1970-2000
(1970=100, based on subsample of 61 country pairs)
145
135
125
115
105
95
85
75
65
55
45
1970
1980
1990
2000
Americas
Europe
Americas-Japan
Americas-Europe
Europe-Japan
Average

Appendix C: Sensitivity to Parameter Assumptions

This appendix is intended to demonstrate that our results are not highly sensitive to the assumed value of the elasticity of substitution in our model—or alternatively, the Fréchet and Pareto parameters in the Eaton and Kortum (2002) and Chaney (2008) models. The ordering of the trade cost measure is stable across all dyads with respect to uniform changes of the elasticity of substitution. Our reported regression results are also strongly robust to shifts in this parameter.

To demonstrate this property, we recalculate our trade cost measure using three distinct values of the elasticity of substitution which roughly span the range suggested by Anderson and van Wincoop (2004), namely six, eight (our preferred value), and ten. In Figure A.5, the bilateral trade cost measures between Canada and the United States are plotted for the years from 1870 to 2000 with all values normalized to 1870=100. The three series are highly correlated. What is more, the proportional changes in the series are very similar: the cumulative drop from 1870 to 2000 is calculated at 53 percent when σ equals six versus 48 percent when σ equals ten.

Another concern may be that σ is changing over time. To explore that possibility, we consider two scenarios, one where σ is smoothly trending upwards over time and one where σ is smoothly trending downwards over time. Although differences in the level of the trade cost measures naturally emerge, the proportionate changes over time are once again very similar. Figure A.6 demonstrates this graphically by considering the annual change in logged bilateral trade cost measures for Canada and the United States for the years from 1870 to 2000.

Figure A.5: Bilateral Trade Cost Measures, Canada and the United States, 1870-2000 (1870=100)

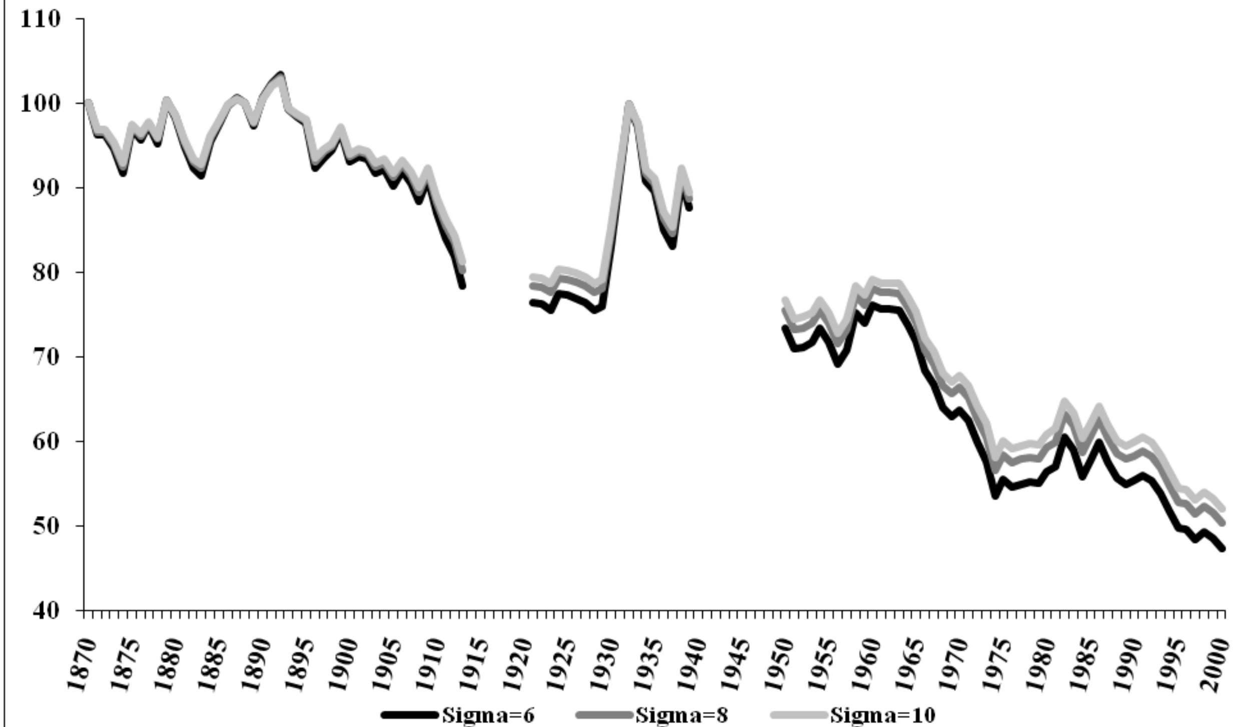


Figure A.6: Annual Change in Logged Bilateral Trade Cost Measures, Canada and the United States, 1870-2000

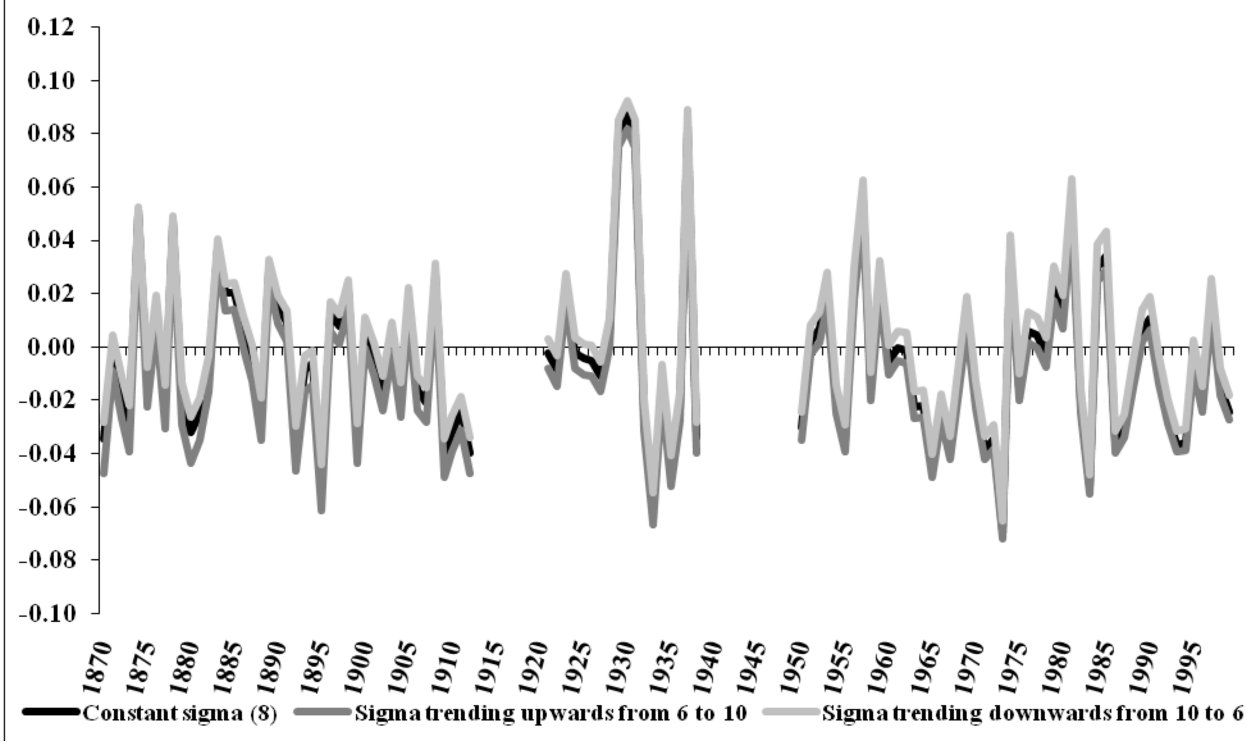


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Table 1: Bilateral Country Pairs

Americas (n = 6)

Argentina	United States
Brazil	Canada
Brazil	United States
Canada	United States
Mexico	United States
Uruguay	United States

Asia/Oceania (n = 7)

Australia	India
Australia	Indonesia
Australia	New Zealand
India	Indonesia
India	Japan
India	New Zealand
India	Sri Lanka

Europe (n = 56)

Austria-Hungary	Belgium
Austria-Hungary	France
Austria-Hungary	Italy
Austria-Hungary	United Kingdom
Belgium	Denmark
Belgium	France
Belgium	Germany
Belgium	Italy
Belgium	Netherlands
Belgium	Norway
Belgium	Portugal
Belgium	Spain
Belgium	Sweden
Belgium	Switzerland
Belgium	United Kingdom
Denmark	France
Denmark	Germany
Denmark	Netherlands
Denmark	Norway
Denmark	Sweden
Denmark	United Kingdom
France	Germany
France	Greece
France	Italy
France	Netherlands
France	Norway
France	Portugal
France	Spain
France	Sweden
France	Switzerland
France	United Kingdom
Germany	Netherlands
Germany	Norway
Germany	Portugal
Germany	Spain
Germany	Sweden
Germany	United Kingdom
Greece	Italy
Greece	United Kingdom
Italy	Germany
Italy	Norway
Italy	Spain
Italy	Switzerland
Italy	United Kingdom
Netherlands	Norway
Netherlands	Sweden
Netherlands	United Kingdom
Norway	Portugal
Norway	Spain
Norway	Sweden
Norway	United Kingdom
Portugal	Spain
Portugal	United Kingdom
Spain	Sweden
Spain	United Kingdom
Sweden	United Kingdom

Americas-Asia/Oceania (n = 6)

Australia	United States
Canada	India
India	United States
Indonesia	United States
Japan	United States
New Zealand	United States

Americas-Europe (n = 35)

Argentina	Belgium
Argentina	France
Argentina	United Kingdom
Austria-Hungary	United States
Belgium	Brazil
Belgium	Canada
Belgium	United States
Belgium	Uruguay
Brazil	France
Brazil	Norway
Brazil	Portugal
Brazil	Spain
Brazil	United Kingdom
Canada	France
Canada	Germany
Canada	Italy
Canada	Netherlands
Canada	Portugal
Canada	Spain
Canada	United Kingdom
Denmark	United States
France	Mexico
France	United States
France	Uruguay
Germany	United States
Greece	United States
Italy	United States
Mexico	United Kingdom
Netherlands	United States
Norway	United States
Portugal	United States
Spain	United States
Sweden	United States
United Kingdom	United States
United Kingdom	Uruguay

Asia/Oceania-Europe (n = 20)

Australia	France
Australia	United Kingdom
Belgium	India
Belgium	Indonesia
France	India
France	Indonesia
France	Japan
France	New Zealand
Germany	India
Germany	Japan
India	Italy
India	Netherlands
India	Spain
India	United Kingdom
Indonesia	Netherlands
Indonesia	United Kingdom
Japan	United Kingdom
New Zealand	United Kingdom
Philippines	United Kingdom
Sri Lanka	United Kingdom

Table 2: Largest Bilateral Trade Relationships by Year

1870		**Value (million 1990 USD)**	**Share of sample**
United Kingdom	United States	4135	0.1172
France	United Kingdom	2979	0.0845
Germany	United Kingdom	2173	0.0616
Netherlands	United Kingdom	1581	0.0448
India	United Kingdom	1359	0.0385
1913			
United Kingdom	United States	12154	0.0691
India	United Kingdom	7859	0.0447
Germany	United Kingdom	7382	0.0420
Canada	United States	7380	0.0420
Germany	Netherlands	7322	0.0417
1921			
United Kingdom	United States	8623	0.0891
Canada	United States	6784	0.0701
India	United Kingdom	4302	0.0444
Japan	United States	3554	0.0367
Germany	United States	3305	0.0341
1939			
Canada	United States	7801	0.0794
United Kingdom	United States	6162	0.0627
Canada	United Kingdom	4245	0.0432
Australia	United Kingdom	3909	0.0398
Japan	United States	3702	0.0377
1950			
Canada	United States	21472	0.1550
Australia	United Kingdom	6509	0.0470
Brazil	United States	5745	0.0415
United Kingdom	United States	4592	0.0331
Mexico	United States	4491	0.0324
2000			
Canada	United States	311023	0.1547
Mexico	United States	187682	0.0934
Japan	United States	160456	0.0798
France	Germany	74996	0.0373
Germany	United States	66763	0.0332

Table 3a: Gravity in Three Eras of Globalization (OLS)

Dependent variable: log of bilateral exports from i to j

Panel A: With importer/exporter fixed effects

	1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
GDP	0.36	0.17	***	1.21	0.33	***	1.23	0.14	***
Distance	-0.41	0.09	***	-0.28	0.08	***	-0.61	0.05	***
Fixed exchange rate regime	0.30	0.10	***	0.09	0.05	*	0.22	0.12	*
Common language	0.57	0.21	***	0.33	0.17	**	0.17	0.12	
Imperial membership	1.72	0.40	***	0.83	0.25	***	0.68	0.15	***
Shared border	0.98	0.22	***	0.91	0.15	***	0.66	0.09	***
Observations	11418			4940			13256		
R-squared	0.70			0.75			0.86		

Panel B: With annual importer/exporter fixed effects

	1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
GDP	-	-		-	-		-	-	
Distance	-0.38	0.09	***	-0.23	0.09	***	-0.61	0.05	***
Fixed exchange rate regime	0.27	0.23		0.17	0.14		0.40	0.15	***
Common language	0.57	0.24	*	0.22	0.19		0.15	0.14	
Imperial membership	1.67	0.46	***	0.70	0.30	*	0.67	0.17	***
Shared border	1.01	0.24	***	0.97	0.17	***	0.65	0.11	***
Observations	11418			4940			13256		
R-squared	0.79			0.81			0.93		

NB: Importer, exporter and year fixed effects not reported. Robust standard errors clustered at the country pair level.
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 3b: Gravity in Three Eras of Globalization (PPML)

Dependent variable: bilateral exports from i to j

With importer/exporter fixed effects

	1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
GDP	0.62	0.10	***	0.96	0.17	***	0.92	0.17	***
Distance	-0.26	0.07	***	-0.27	0.06	***	-0.73	0.05	***
Fixed exchange rate regime	0.18	0.06	***	0.20	0.04	***	0.13	0.08	*
Common language	0.34	0.14	***	0.17	0.15		0.13	0.09	
Imperial membership	1.71	0.26	***	1.15	0.20	***	1.07	0.14	***
Shared border	0.89	0.16	***	0.96	0.16	***	0.64	0.08	***
Observations	11418			4940			13256		

NB: Estimation is by Poisson pseudo-maximum likelihood (PPML).
Importer, exporter and year fixed effects not reported. Robust standard errors clustered at the country pair level.
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 4: Determinants of the Trade Cost Measure in Three Eras of Globalization

Dependent variable: log of the bilateral trade cost measure separating i and j

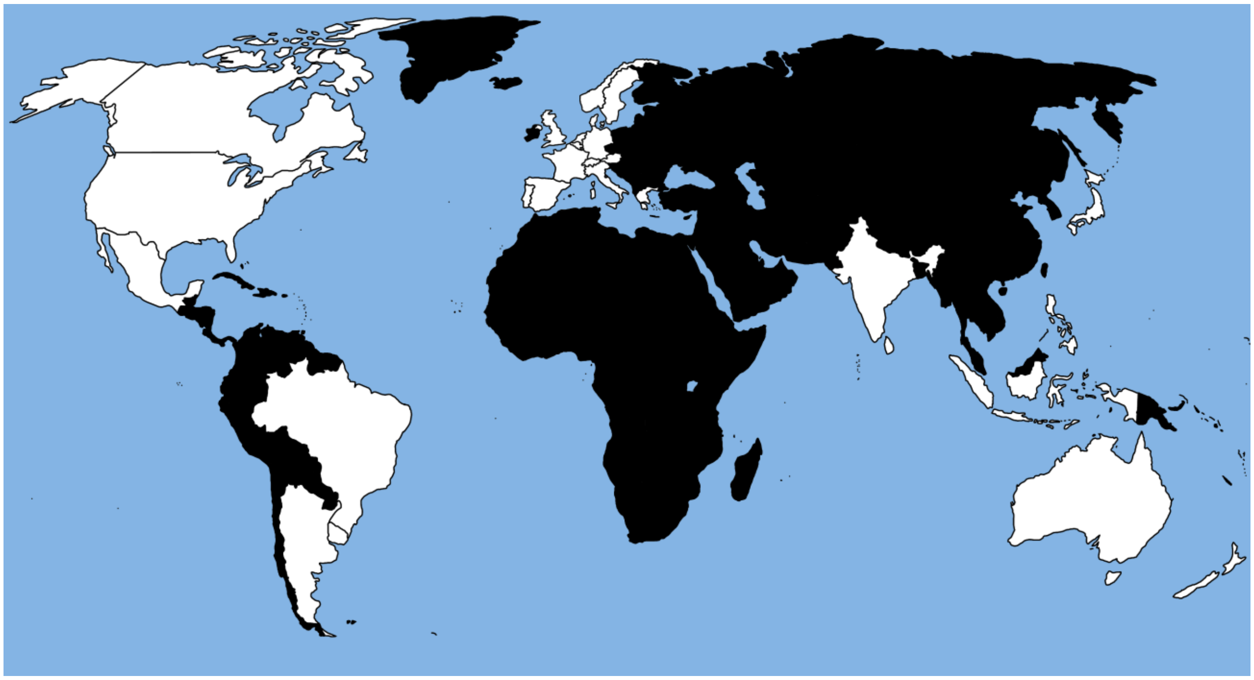
	Pooled			1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
Distance	0.13	0.00	***	0.11	0.01	***	0.06	0.01	***	0.17	0.00	***
Fixed exchange rate regime	-0.03	0.01	***	-0.08	0.01	***	-0.04	0.01	***	-0.09	0.01	***
Common language	-0.11	0.01	***	-0.14	0.01	***	-0.08	0.01	***	-0.08	0.01	***
Imperial membership	-0.28	0.01	***	-0.46	0.02	***	-0.20	0.02	***	-0.15	0.01	***
Shared border	-0.26	0.01	***	-0.29	0.01	***	-0.26	0.01	***	-0.22	0.01	***
Observations	14807			5709			2470			6628		
R-squared	0.65			0.72			0.69			0.82		

NB: Estimation is by OLS. Country and year fixed effects not reported. Robust standard errors clustered at the country pair level.
*** significant at the 1% level.

Table 5: Decomposition of Trade Booms and Busts, 1870-2000

			Contribution of growth in output (GDP weighted)		**Contribution of growth in income similarity** (GDP weighted)		**Contribution of change in trade cost measure** (GDP weighted)		**Contribution of change in multilateral factors** (GDP weighted)		**Average growth of international trade** (GDP weighted)
1870-2000	**Full sample**	**(n = 130)**	**744%**	**+**	**-16%**	**+**	**326%**	**+**	**-25%**	**=**	**1029%**
	Americas	(n = 6)	886	+	14	+	162	+	-1	=	1061
	Asia/Oceania	(n = 7)	610	+	51	+	436	+	-24	=	1074
	Europe	(n = 56)	590	+	23	+	330	+	-38	=	904
	Americas-Asia/Oceania	(n = 6)	832	+	-47	+	511	+	-28	=	1268
	Americas-Europe	(n = 35)	808	+	-56	+	281	+	-22	=	1011
	Asia/Oceania-Europe	(n = 20)	601	+	28	+	386	+	-30	=	985
1870-1913	**Full sample**	**(n = 130)**	**225%**	**+**	**-11%**	**+**	**290%**	**+**	**-18%**	**=**	**486%**
	Americas	(n = 6)	331	+	0	+	151	+	-19	=	463
	Asia/Oceania	(n = 7)	105	+	29	+	434	+	-11	=	557
	Europe	(n = 56)	177	+	-6	+	176	+	-23	=	324
	Americas-Asia/Oceania	(n = 6)	281	+	-48	+	339	+	-9	=	564
	Americas-Europe	(n = 35)	273	+	-26	+	297	+	-18	=	524
	Asia/Oceania-Europe	(n = 20)	146	+	20	+	497	+	-16	=	647
1921-1939	**Full sample**	**(n = 130)**	**88%**	**+**	**4%**	**+**	**-87%**	**+**	**-6%**	**=**	**0%**
	Americas	(n = 6)	82	+	14	+	-115	+	9	=	-10
	Asia/Oceania	(n = 7)	58	+	12	+	-36	+	0	=	34
	Europe	(n = 56)	103	+	-2	+	-65	+	-16	=	20
	Americas-Asia/Oceania	(n = 6)	78	+	6	+	-37	+	2	=	48
	Americas-Europe	(n = 35)	86	+	7	+	-132	+	-6	=	-45
	Asia/Oceania-Europe	(n = 20)	85	+	1	+	-50	+	-6	=	30
1950-2000	**Full sample**	**(n = 130)**	**353%**	**+**	**8%**	**+**	**148%**	**+**	**-25%**	**=**	**484%**
	Americas	(n = 6)	347	+	7	+	16	+	-7	=	363
	Asia	(n = 7)	448	+	-14	+	-27	+	-15	=	391
	Europe	(n = 56)	332	+	7	+	331	+	-38	=	633
	Americas-Asia/Oceania	(n = 6)	356	+	29	+	84	+	-25	=	444
	Americas-Europe	(n = 35)	343	+	5	+	125	+	-23	=	450
	Asia-Europe	(n = 20)	386	+	2	+	185	+	-28	=	544

Figure 1: Sample Countries (in white)



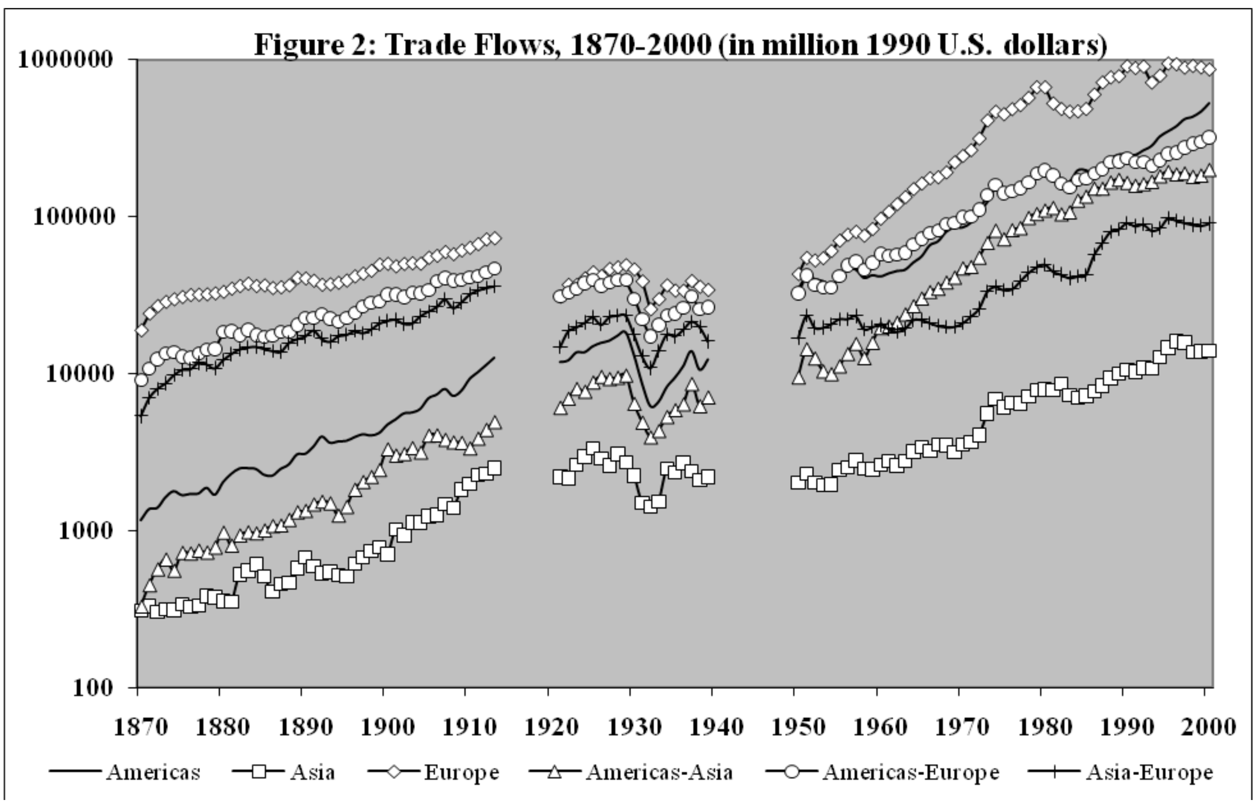


Figure 3: Trade Cost Measures, 1870-1913 (1870=100)

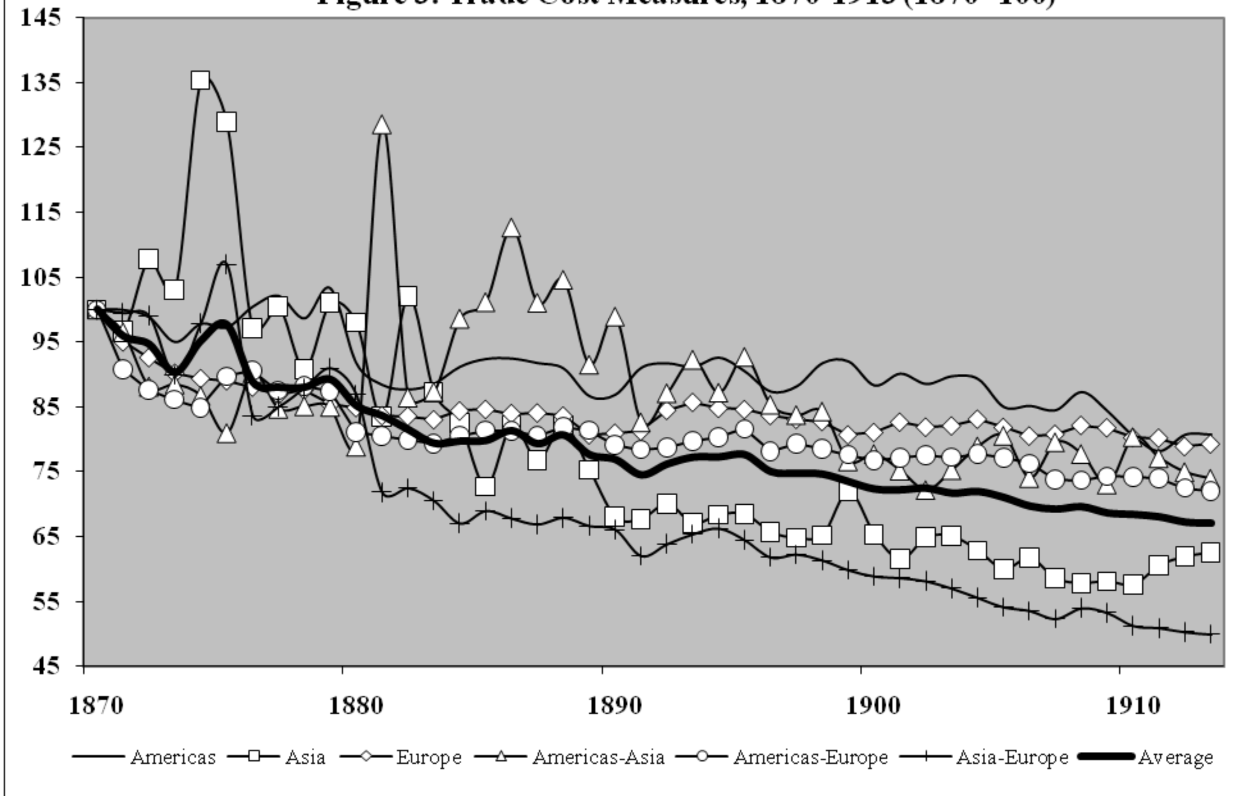
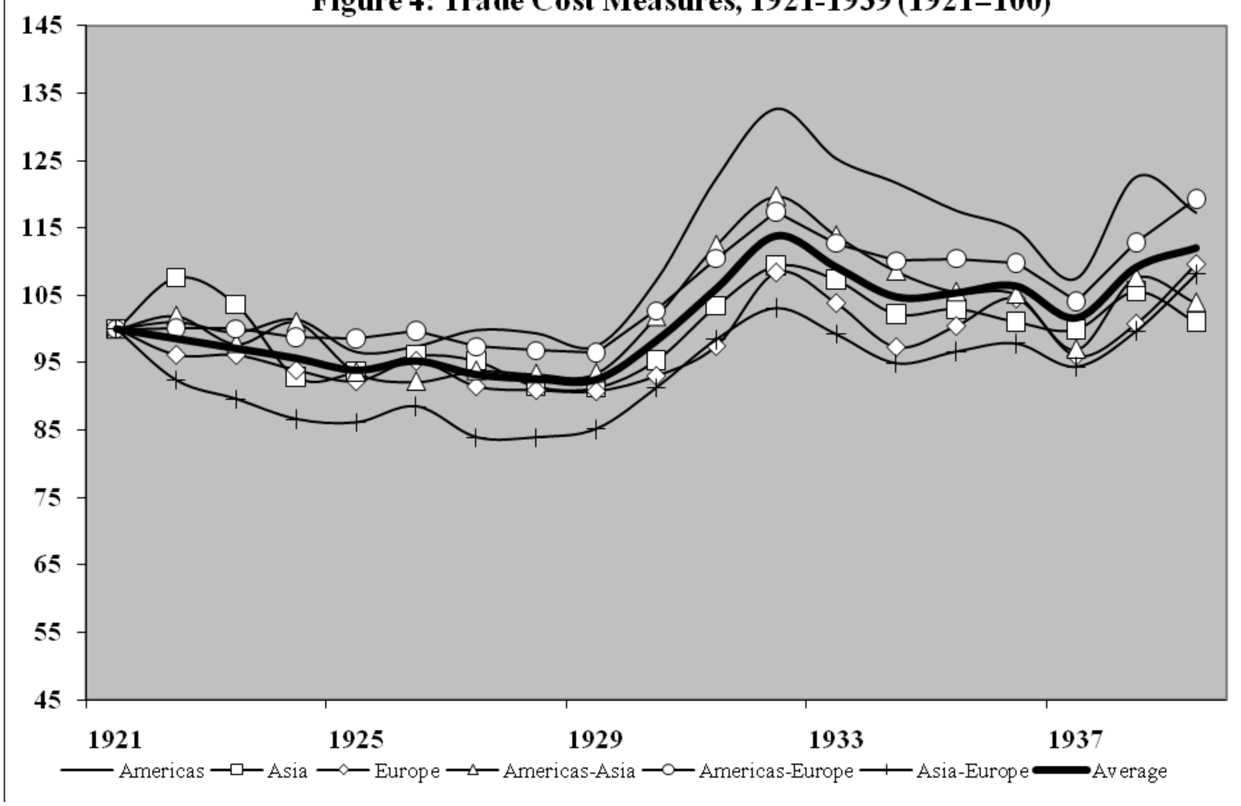


Figure 4: Trade Cost Measures, 1921-1939 (1921=100)



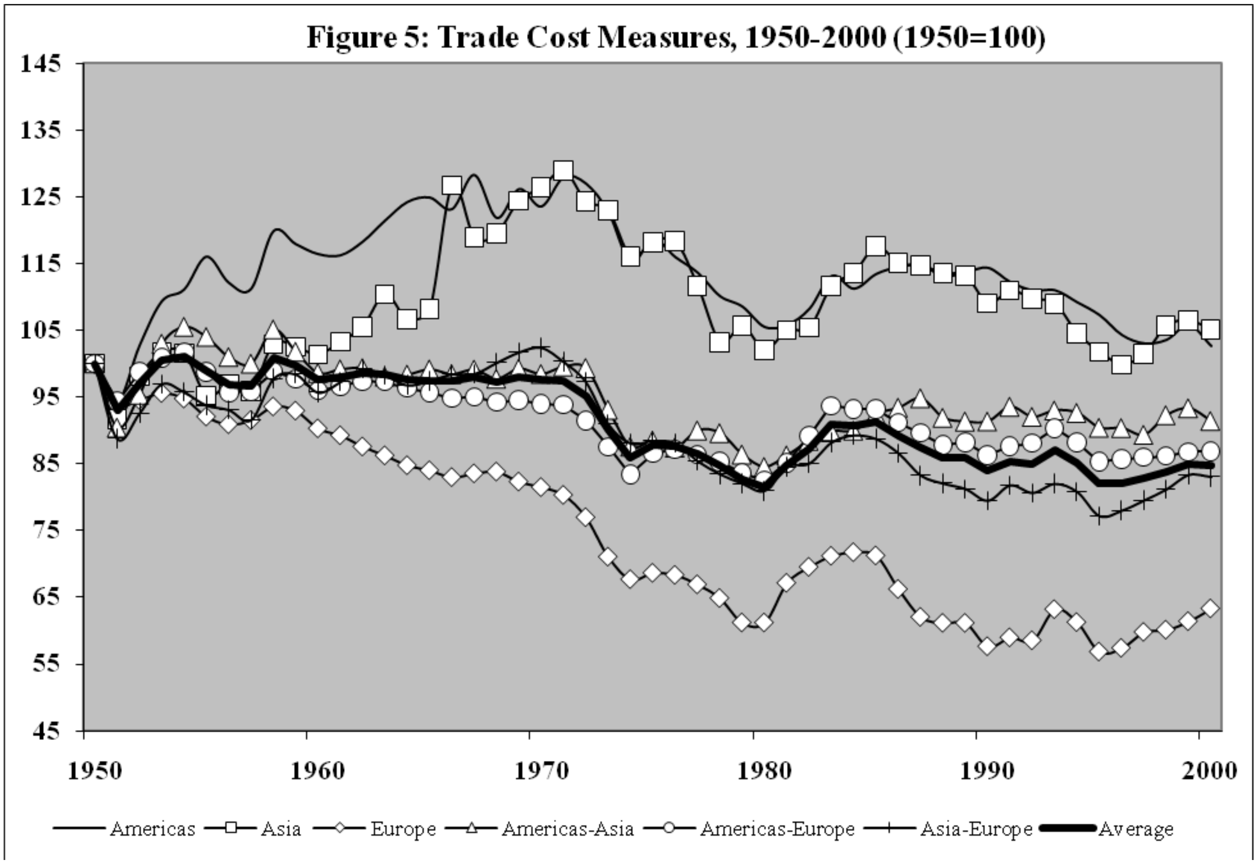


Figure 5: Trade Cost Measures, 1950-2000 (1950=100)

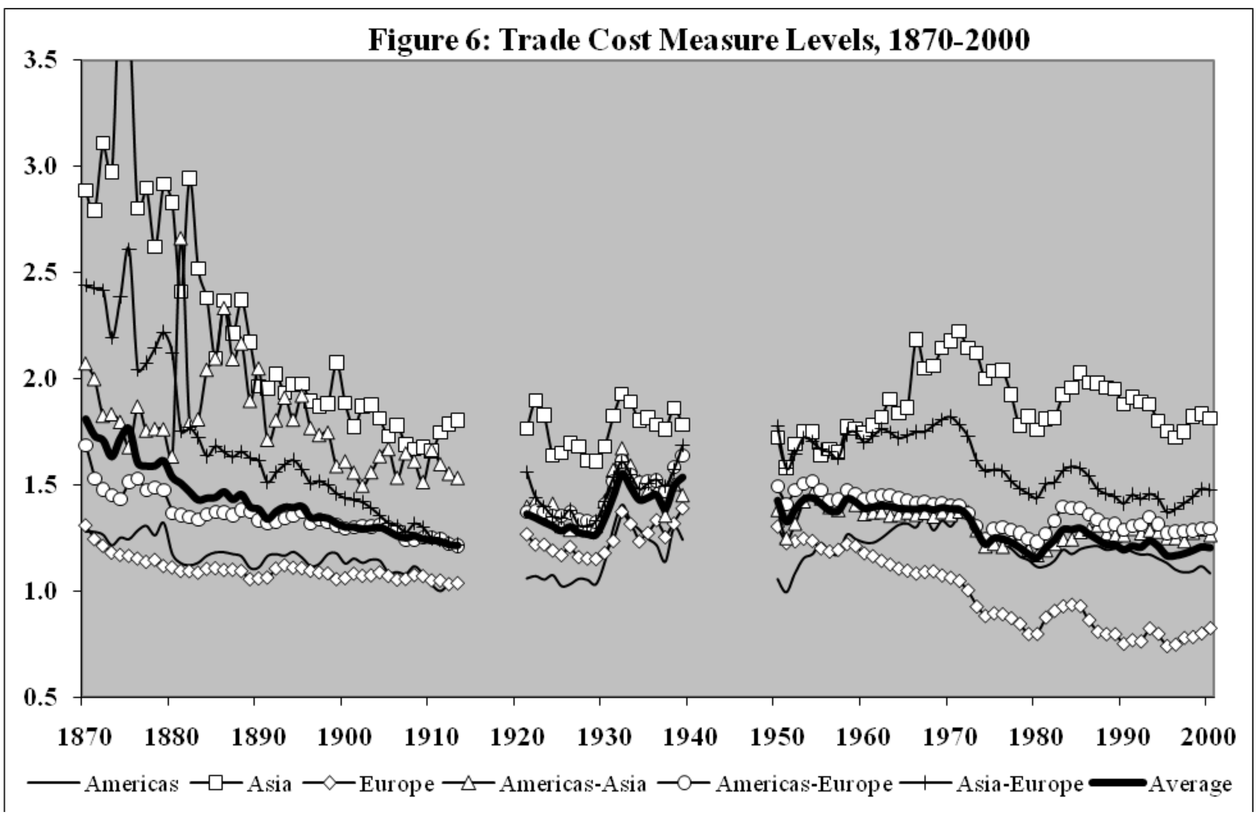


Figure 6: Trade Cost Measure Levels, 1870-2000

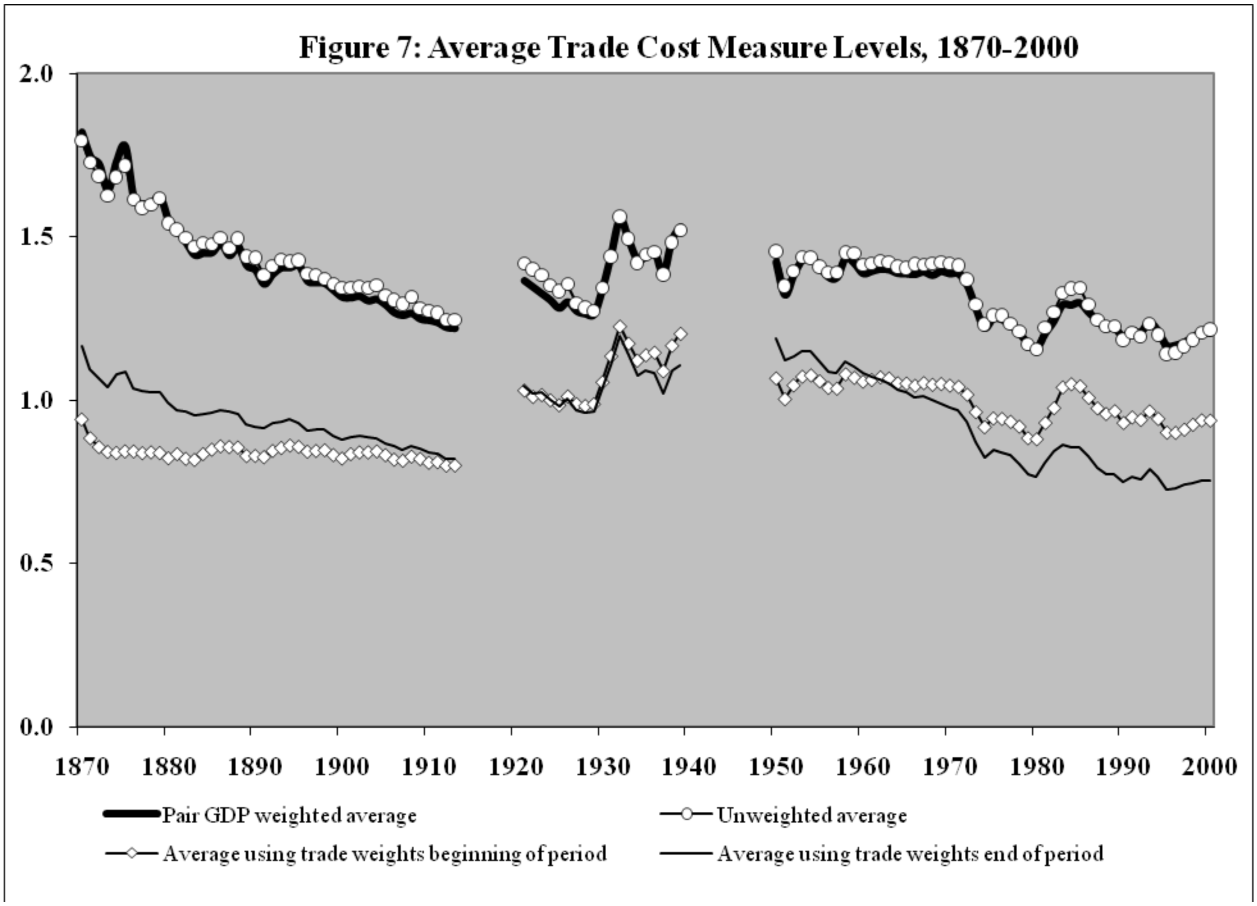


Figure 7: Average Trade Cost Measure Levels, 1870-2000
2.0
1.5
1.0
0.5
0.0
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Pair GDP weighted average
Unweighted average
Average using trade weights beginning of period
Average using trade weights end of period

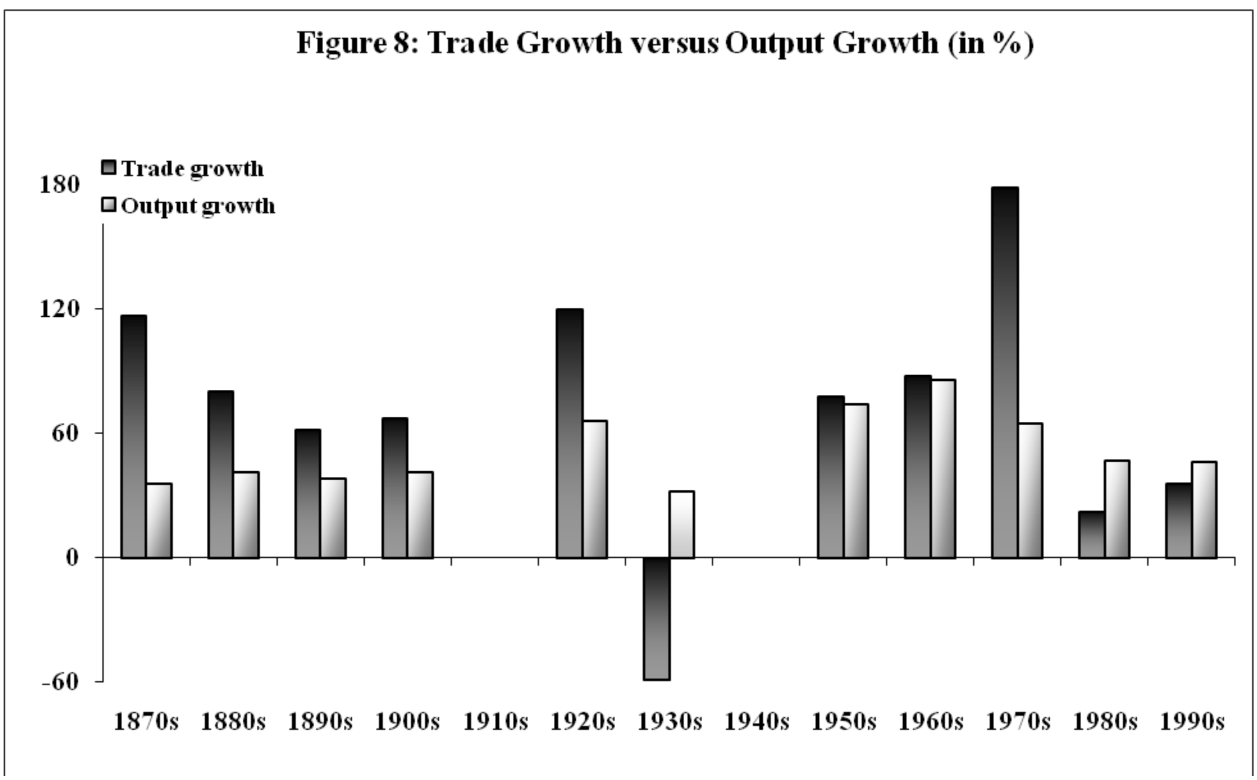


Figure 8: Trade Growth versus Output Growth (in %)
Trade growth
Output growth
180
120
60
0
-60
1870s
1880s
1890s
1900s
1910s
1920s
1930s
1940s
1950s
1960s
1970s
1980s
1990s