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Trade globalization: 1827-2012

When did trade costs start to fall?

Michel Fouquin and Jules Hugot

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HIGHLIGHTS

- We demonstrate that the First globalization began c.1840
- We show that both the First and the Second globalization have been associated with an increasing regionalization of trade
- We provide a new bilateral trade dataset for 1827-2012, designed for gravity studies.

ABSTRACT

This article provides the first assessment of the early nineteenth century trade globalization based on a systematic collection of the available bilateral trade data. Drawing on a unique dataset of more than 1.3 million observations for the 1827-2012 period, we show that the nineteenth century trade globalization began roughly twenty years before the 1860s blooming age of trade liberalization. To do so, we use the Head and Ries (2001) index that measures for each country pair and year the implicit tariff-equivalent trade costs, relative to domestic trade costs. We develop a new method of aggregation to obtain two trade cost indices that reflect the trend for the entire sample. Our finding of an early start for the First globalization is consistent with the price convergence approach, but challenges the studies that suggest that the First globalization began c.1870. We then decompose trade costs into a border and a distance effect. We find a dramatic rise in the distance effect in the post-World War II era. For the nineteenth century, we show a similar rise in the trade response to distance until c.1890, followed by a period of stability until World War I and a fall during the interwar de-globalization. These results show that both periods of trade globalization have been primarily fueled by the intensification of short-haul trade.

JEL Classification: F14, F15, N70

Keywords: Globalization,Trade costs, Border effect, Distance effect

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POINTS CLEFS

- La Première mondialisation a débuté aux alentours de 1840
- La Première et la Seconde mondialisation ont été des périodes de régionalisation du commerce
- Nous fournissons une nouvelle base de données de commerce pour la période 1827-2012

RÉSUMÉ

Cet article est le premier à évaluer l'ampleur et la chronologie de la mondialisation du dix-neuvième siècle en s'appuyant sur des données de commerce bilatérale collectées de manière systématique. En utilisant une base de données de plus de 1,3 millions d'observations pour la période 1827-2012, nous démontrons que la Première mondialisation commerciale a débuté une vingtaine d'années avant 1860 et le début de l'âge d'or de libéralisation commerciale. Nous utilisons l'indice de Head et Ries (2001), qui mesure pour chaque année et chaque paire de pays le coût de commerce relatif au coût de commerce interne, sous la forme d'un équivalent tariffaire. Nous développons une nouvelle méthode d'aggrégation qui nous permet d'obtenir deux indices synthétiques des coûts de commerce mondiaux. Ces indices montrent que la Première Mondialisation a débuté aux alentours de 1840, ce qui conforte les conclusions de l'approche consistant à examiner la convergence des prix, mais va a l'encontre des conclusions des études qui suggèrent que la Première Mondialisation a débuté aux alentours de 1870. Nous séparons ensuite les coûts de commerce en un effet frontière et un effet distance. Nous montrons que l'effet distance a massivement augmenté depuis la Seconde Guerre mondiale. Pour le dix-neuvième siècle, nous trouvons une augmentation jusqu'aux années 1890, suivie par une période de stabilité jusqu'à la Première Guerre mondiale, puis par une réduction dans l'entre-deux guerres. Ces résultats montrent que les deux périodes de mondialisations ont été principalement stimulées par le commerce de courte distance.

Classification JEL : F14, F15, N70

Mots clés : Mondialisation, Coûts de commerce, Effet frontière, Effet distance

TRADE GLOBALIZATION: 1827-2012
WHEN DID TRADE COSTS START TO FALL?[1]

Michel Fouquin[*] and Jules Hugot[†]

1. INTRODUCTION

Globalization is the process by which local markets around the world become more and more integrated. In that sense, two countries are perfectly integrated when the economic conditions that prevail in one local market influence the domestic and the foreign market in the same way. In that sense, we adopt a relativist definition of globalization, which shall be measured in comparison to the degree of domestic integration; not in absolute terms. A sufficient condition for such perfect economic integration is therefore that bilateral trade costs are equal to domestic trade costs. Hence, measuring the evolution of relative trade costs across years provides a satisfactory assessment of the extent of trade globalization.

Globalization has gone through booms and busts (Jacks et al., 2008). The existence of two distinct periods of trade surges in the modern era – the First Globalization of the nineteenth century and the post-World War II Second Globalization – has been extensively documented (Baldwin and Martin, 1999, Estevadeordal et al., 2003, Jacks et al., 2008). Looking at a simple index of trade openness shows that these two periods were comparable in terms of the increase of trade openness. Figure 1 plots ratios of the sum of countries' exports, divided by the sum of their GDP. In order to avoid capturing some changing characteristics of the countries included in our

[1]We are grateful to Thierry Mayer, Kevin O'Rourke, Guillaume Daudin, David S. Jacks, Christopher Meissner and Denis Novy for helpful comments. We thank Guillaume Daudin and Béatrice Dédinger for letting us use the data they collected in the RICardo project and to Zachary Weiss for his (future) meticulous proofreading. We are deeply thankful to Sylvie Leduc for outstanding assistance with the input of the data. This research was improved by the comments from the participants at the 2012 EHS conference in Oxford, the EEA conference in Malaga, the EHA meeting in Vancouver, the 2013 FRESH meeting in Edinburgh, the EGIT workshop in Berlin, the EHES conference in London, the macro seminar at UQAM, the 2014 EBES in Istanbul and the CIE in Salamanca. This research has received funding from the European Research Council under the European Community's Seventh Framework Programme (FP7/2007-2013) Grant Agreement no. 313522.
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dataset, we provide aggregate figures for six country-samples that remain constant overtime[2]. The legend reports the initial year of each sample and, in parenthesis, the number of countries included in the sample.

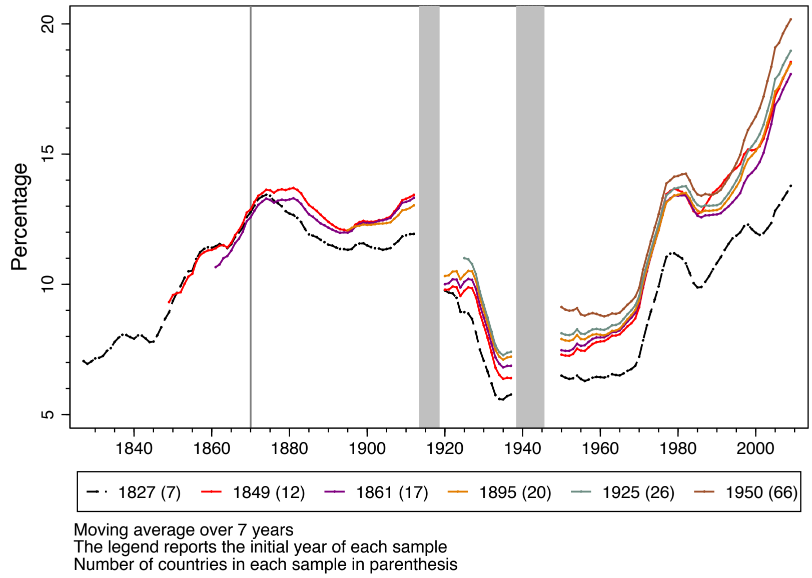

Figure 1 – Aggregate export openness computed on constant country samples

The economic literature on the history of trade has adopted two distinct approaches to assess the extent of trade globalization: the price-convergence (indirect) approach and the trade-based (direct) approach.

The indirect approach relies on the classical economic theory that states that if markets are integrating, then prices should converge to a world equilibrium. Empirically, this prediction has been tested by comparing price data for the same commodity, across different regions of the world. This approach is particularly helpful when trade data is scarce, i.e. for most early periods. Indeed, the first comprehensive imports and exports customs reports were drafted in the early eighteenth century, and only for a handful of countries[3]. On the other hand, scattered price data has been obtained through various sources, including the records of the Dutch East

[2]The 1827 sample covers Australia, France, the United Kingdom, the Netherlands, Norway, Sweden, and the USA. On top of the countries covered by the 1827 sample, the 1849 sample covers Chile, Belgium, Germany (or the future territory of Germany before 1871), Denmark and Greece. The 1861 sample adds Brazil, Finland, Italy, Japan and Portugal. For details on subsequent samples, contact the authors

[3]We found bilateral trade data series beginning in 1703 and 1720, respectively for the United Kingdom and France. These data will be analyzed in another article

India Company (Bulbeck et al., 1998, Chaudhuri, 1978), the accounts of monasteries, hospitals and municipalities (Hamilton, 1934) and even Babylonian tablets (Földvári and van Leeuwen, 2000).

Using the price-convergence approach, O'Rourke and Williamson (2002) find no evidence that trade globalization took off in the aftermath of Christopher Columbus' and Vasco da Gamma's discoveries (respectively in 1492 and 1498). Using data on various homogeneous commodities including cloves, pepper, coffee, indigo and silk, they do not observe any major price convergence before the early nineteenth century. These commodities, however, share a particular feature: they have a high cost-to-weight ratio, which makes them relatively worth trading across continents. The major limitation of this method is therefore its reliance on a subset of all the products that are traded. In turn, the conclusions from such studies are very dependent on the goods that are chosen: using the same approach as O'Rourke and Williamson (2002), Federico and Persson (2006) show that the transatlantic wheat price convergence did not occur before the last quarter of the nineteenth century.

Our research builds upon the direct approach. Head and Ries (2001) introduce a measure of the inverse "freeness of trade". Jacks et al. (2006) use this measure to compare the First Globalization (which they define as 1870-1913) to the Second Globalization (1950-2000) Jacks et al. (2008). This article borrows their methodology to provide an assessment of trade costs over the 1827-2012 period. This method presents several advantages. First, the Head and Ried index is bilateral-specific, which allows to differentiate patterns along trade routes. Second, trade costs are measured in tariff-equivalent, which makes it directly comparable to the level of actual tariffs.

The triggers of the First Globalization remain unclear. Some argue that rising trade is due to the limitation of protectionist policies, following the 1846 repeal of the British Corn laws and the trade treaties signed in Europe following the 1860 Cobden-Chevalier pioneering trade agreement (**?**). Two studies have questioned this common belief. Accominotti and Flandreau (2006) find that the Cobden-Chevalier network of bilateral trade treaties did not contribute to expand trade. They argue that those treaties merely substituted to the previous unilateral liberalizations. Similarly, Lampe (2009) finds no significant effect of the Cobden-Chevalier network of treaties on overall trade. Using commodity-level data, however, he finds some evidence of a trade-enhancing effect for some particular commodities.

Others authors pinpoint the introduction of more efficient transportation technologies, including railways, steamships, and inter-oceanic canals. In a seminal paper, North (1958) constructs ocean freight rates indices. For the 1750-1815 period, he finds that freight rates fluctuated at the whim of the recurring wars that affected Europe. In particular, freight rates reached their peak from 1793 to 1815, during the French and Napoleonic Wars. Freight rates then fell during the nineteenth century, with a first phase from 1815 to the 1850s and a second phase beginning in the 1870s. In a recent paper that concentrates on the 1870-1913 period, Pascali (2014) identifies the effect of steam power on trade by taking advantage of the asymmetric impact of steamships on reducing transit time. Indeed, the speed of steamships is roughly constant, whereas sailing ships are very dependent on wind patterns. He argues that the adoption of the steamship was the leading cause of the First Globalization. Easier communications may also have had an important stimulating impact on trade. In a recent paper, Steinwender (2014) finds that the dramatic reduction of information frictions following the 1866 introduction of the transatlantic telegraph had a significant impact on trade, equivalent to a 6 percent reduction of ad valorem tariffs.

All the studies that rely on bilateral trade data to compare the nineteenth and the twentieth century define the First Globalization as the 1870-1913 period (Estevadeordal et al., 2003, Jacks et al., 2006). This project is the first to our knowledge that has involved a systematic collection of bilateral as well as aggregate trade data before 1870. We chose 1827 as a starting point for this article, due to the limited amount of available data for the previous years[4]. Our analysis provides insights on the timing of the First Globalization, which we believe constitutes the first step toward a proper causal evaluation. Indeed, we find that the initial trade expansion took place in the 1840s, before the onset of the golden age of European bilateral trade liberalization, before steamships got the upper hand and also before the introduction of the telegraph. This article therefore raises more questions in terms of the causes of the First Globalization than we are able to answer.

Section 2 provides a derivation of the Head and Ries (2001) measure of trade costs, which is the central tool of our analysis. In section 3, we introduce our new aggregation method of trade costs across country pairs and comment on the resulting indices. Section 4 provides a decomposition of trade costs in two elements: a border effect and a distance effect. In section 5, we derive our measure of border thickness and comment on the results. Finally, section 6 provides concluding remarks.

[4]We collected data covering the eighteenth century for France and Britain. These data will be used in a future research project

2. TRADE COSTS

Based on Novy (2009), we derive a micro-founded measure of trade costs from the Anderson and van Wincoop (2003) model. This aggregate measure of trade costs was introduced by Head and Ries (2001)[5]. Aggregate trade costs are *ex-post* measures of the cost of trading with a foreign partner, relative to the cost of trading with a domestic partner. This measure takes internal trade costs as a benchmark for evaluating the frictions that specifically hamper international trade. In other words, aggregate trade costs capture the export premium that encompasses transport costs, restrictive commercial policies, but also any other factors that impede international trade: currency instability, communication barriers, lack of trust, etc. The following section provides a derivation of the multi-sector version of the model.

From utility to demand: the consumer's program

We provide the standard derivation of the Anderson and van Wincoop (2003) version of the gravity equation. We choose the version based on a continuum of varieties, hence the integrals; but using a discrete number of varieties yields the same final equation. The first step leading to the aggregate measure of trade costs consists in maximizing a constant elasticity of substitution utility function subject to a budget constraint, as in any Dixit and Stiglitz (1977), Krugman (1980).

$$\text{Maximize utility:} \qquad U_i = \sum_{k=i}^{K} \left[\int_v \left(x_i^k(v) \right)^{1-\frac{1}{\sigma_k}} \, dv \right]^{\frac{1}{1-\frac{1}{\sigma_k}}} \tag{1}$$

Where $x_i^k(v)$ is the quantity of variety v of industry k consumed in country i and σ_k is the elasticity of substitution across the varieties of sector k.

$$\text{Under the constraint:} \qquad E_i \equiv \sum_{k=i}^{K} E_i^k = \sum_{k=i}^{K} \left[\int_v p_i^k(v)\, x_i^k(v)\, dv \right] \tag{2}$$

Where E_i denotes total expenditures in country i and p_i^k is the price of one unit of good $x_i^k(v)$. The consumer therefore wants to choose the $x_i^k(v)$ that will maximize her utility, within the boundaries imposed by the budget constraint. The maximization leads to a demand function:

$$x_i^k(v) = E_i^k \frac{\left[p_i^k(v)\right]^{-\sigma_k}}{\int_v \left[p_i^k(v)\right]^{1-\sigma_k} \, dv} \tag{3}$$

[5]Equations 8 and 9, p.863

Introducing an "ideal" price index defined as: $P_i^k = \left[\int_v \left[p_i^k(v)\right]^{-\sigma_k} dv\right]^{\frac{1}{1-\sigma_k}}$ leads to a second version of the demand function:

$$x_i^k(v) = \left[\frac{p_i^k(v)}{P_i^k}\right]^{-\sigma} \frac{E_i^k}{P_i^k} \tag{4}$$

From profit to supply: the producer's program

As consumers maximize their utility, producers maximize their profit. Given that firms face an infinite number of competitors, they cannot adopt strategic behaviors and prices are given by a constant mark-up over marginal cost. Finally, labor is the only factor of production, hence the only production cost being wages (w). The firm's profit function writes:

$$\pi_i^k(v) = p_i^k(v)\, x_i^k(v) - wa_i^k\, x_i^k(v) - wf_i^k \tag{5}$$

Where $p_i^k(v)\, x_i^k(v)$ is the revenue, $wa_i^k\, x_i^k(v)$ the marginal cost and wf_i^k denotes the fixed cost. Assuming that firms play Bertrand (price) competition, their goal is therefore to choose the price that will maximize their profit. This maximization yields:

$$p_i^k(v) = wa_i^k - \frac{x_i^k(v)}{\frac{\partial x_i^k(v)}{\partial p_i^k(v)}} \tag{6}$$

In order to solve for $p_i^k(v)$, we need an expression of the derivative of quantities with respect to prices. To do so, we differentiate equation 4 with respect to prices. Given the continuum assumption, we consider that $\frac{\partial P_i^k}{\partial p_i^k(v)} = 0$. Similarly, we assume that $\frac{\partial E_i^k}{\partial p_i^k(v)} = 0$, which leads us to : $\frac{\partial x_i^k(v)}{p_i^k(v)} = -\sigma_k \frac{x_i^k(v)}{p_i^k(v)}$. The price for which profit is maximized can therefore be re-written as a constant mark-up over marginal cost:

$$p_i^k(v) = \left(\frac{\sigma_k}{\sigma_k - 1}\right) wa_i^k \tag{7}$$

Trade frictions

So far, we have considered a world without trade costs. We now introduce frictions that hamper cross-country exchanges. Therefore, the marginal cost is no longer $wa_i^k(v)$ but rather $\tau_{ij}\, wa_i^k(v)$, where τ_{ij} is an iceberg international trade cost. The price equation can be rewritten as:

$$p_j^k(v) \equiv \tau_{ij}^k\, p_i^k(v) = \left(\frac{\sigma_k}{\sigma_k - 1}\right) \tau_{ij}^k\, w a_i^k \tag{8}$$

Introducing trade costs in the price index yields:

$$P_j^k = \left[\int_v \left[\tau_{ij}^k\, p_i^k(v)\right]^{-\sigma_k} dv\right]^{\frac{1}{1-\sigma_k}} \tag{9}$$

Equilibrium and gravity

Combining the demand equation (4) with the price equation (8) yields an expression of the bilateral exports of varieties v of industry k from country i to country j:

$$x_{ij}^k(v) = p_{ij}^k(v)\, x_j^k(v) = \tau_{ij}^k\, p_i^k(v) \left[\frac{\tau_{ij}^k\, p_i^k(v)}{P_j^k}\right]^{-\sigma_k} \frac{E_j^k}{P_j^k} = \left[\frac{\tau_{ij}^k\, p_i^k(v)}{P_j^k}\right]^{1-\sigma_k} E_j^k \tag{10}$$

Given that the data we have collected is aggregated across sectors, we need to aggregate the model across sectors. To do that, we simply consider that all firms in country i are identical. The aggregate exports from i to j are therefore:

$$X_{ij}^k = N_i\, x_{ij}^k(v) = N_i \left[\frac{\tau_{ij}^k\, p_i^k(v)}{P_j^k}\right]^{1-\sigma_k} E_j^k \tag{11}$$

We then introduce a general equilibrium accounting identity, namely that sector income in any country (Y_i^k) equals the total sales of all domestically-produced varieties in that sector:

$$Y_i^k = \sum_{j=1}^{J} X_{ij}^k = N_i[p_i^k(v)]^{1-\sigma_k} \sum_{j=1}^{J} \left[\frac{\tau_{ij}^k}{P_j^k}\right]^{1-\sigma_k} E_j^k \tag{12}$$

We can therefore replace $N_i[p_i^k(v)]^{1-\sigma_k}$ in the above equation by its expression in the aggregate export equation (11):

$$X_{ij}^k = \frac{Y_i^k\, E_j^k}{\sum_{j=1}^{J} \left(\frac{\tau_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k} \left[\frac{\tau_{ij}^k}{P_j^k}\right]^{1-\sigma_k} \tag{13}$$

Dividing the previous equation by the total world production of sector k (Y_k) and introducing $\left[\Pi_i^k\right]^{1-\sigma_k} = \sum_{j=1}^{J} \left(\frac{\tau_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y_k}$ yields the gravity equation proposed by Anderson and van Wincoop (2003):

$$X_{ij}^k = \frac{Y_i^k \, E_j^k}{Y^k} \left[\frac{\tau_{ij}^k}{\Pi_i^k \, P_j^k}\right]^{1-\sigma_k} \tag{14}$$

Let us assume that total expenditures (E_i) equal total production (Y_i). Given that our historical data are not disaggregated by sector, the gravity equation 14 can be simplified as:

$$X_{ij} = \frac{Y_i \, Y_j}{Y} \left[\frac{\tau_{ij}}{\Pi_i \, P_j}\right]^{1-\sigma} \tag{15}$$

From gravity to aggregate trade costs

Multiplying equation 15 by the equation giving the inverse flow (from j to i) yields:

$$X_{ij} \, X_{ji} = \left(\frac{Y_i \, Y_j}{Y}\right)^2 \left(\frac{\tau_{ij} \, \tau_{ji}}{\Pi_i \, \Pi_j \, P_i \, P_j}\right)^{1-\sigma} \tag{16}$$

We now want to get rid of the denominator of the second term of the previous equation, for which data is not available. Given that we haven't ruled out the possibility that i and j denote the same country, we can also write:

$$X_{ii} = \frac{Y_i \, Y_i}{Y} \left[\frac{\tau_{ii}}{\Pi_i \, P_i}\right]^{1-\sigma} \tag{17}$$

From there, we can obtain an expression of $\Pi_i \, P_i$ and $\Pi_j \, P_j$:

$$\Pi_i \, P_i = \tau_{ii} \left(\frac{X_{ii} \, Y}{Y_i^2}\right)^{\frac{1}{\sigma-1}} \quad \text{and} \quad \Pi_j \, P_j = \tau_{jj} \left(\frac{X_{jj} \, Y}{Y_j^2}\right)^{\frac{1}{\sigma-1}} \tag{18}$$

Plugging back the two previous equations in equation 16, we obtain:

$$X_{ij} \, X_{ji} = X_{ii} \, X_{jj} \left(\frac{\tau_{ii} \, \tau_{jj}}{\tau_{ij} \, \tau_{ji}}\right)^{\sigma-1} \tag{19}$$

Rearranging leads to:

$$\frac{X_{ij}\,X_{ji}}{X_{ii}\,X_{jj}} = \left(\frac{\tau_{ii}\;\tau_{jj}}{\tau_{ij}\;\tau_{ji}}\right)^{\sigma-1} \quad \Leftrightarrow \quad \frac{\tau_{ij}\;\tau_{ji}}{\tau_{ii}\;\tau_{jj}} = \left(\frac{X_{ii}\,X_{jj}}{X_{ij}\,X_{ji}}\right)^{\frac{1}{\sigma-1}} \tag{20}$$

The right-hand side of the previous equation is the product of two ratios of bilateral trade costs relative to domestic trade costs. Each of these ratios accounts for the extra cost to be paid to export, relative to the cost to be paid to sell on the domestic market. These are the aggregate trade costs we are ultimately interested in. We take the square root of the expression above to obtain the geometric average of both those trade costs. Finally, we subtract 1 in order to obtain a tariff equivalent measure of trade costs:

$$TC_{ij} \equiv \left(\frac{\tau_{ij}\;\tau_{ji}}{\tau_{ii}\;\tau_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{X_{ii}\,X_{jj}}{X_{ij}\,X_{ji}}\right)^{\frac{1}{2(\sigma-1)}} - 1 \tag{21}$$

With:
X_{ii} = i's internal trade
X_{ij} = Trade flow from i to j
σ = Elasticity of substitution

In the above equation, σ represents the degree of substituability across varieties. The more differentiated the varieties (low σ), the larger will be the trade cost, all other things being equal. Intuitively, it means that when the potential gains of trade are higher (low σ), the same level of observed trade reveals higher trade barriers.

The bilateral trade cost expressed in equation 21 measures the export premium associated with internationally-traded goods relative to the goods that are trading within countries' borders. In other words, they provide an *ex-post* assessment of the extent to which barriers to international trade are uneasy to overcome. Indeed, they measure for each pair of countries the extent to which they trade more internally than with each other. As an example, let us consider a pair of countries across which there are no trade frictions at all. For this country pair, the tariff equivalent trade cost (TC_{ij}) must be equal to zero. If this is true, then $\left(\frac{X_{ii}\,X_{jj}}{X_{ij}\,X_{ji}}\right)$ must be equal to one. In other words, the frictionless situation is the situation in which the product of two countries' internal trade flows is strictly equal to the product of the two bilateral flows that relate them.

These tariff-equivalent trade costs should *a priori* not be assumed to be symmetric – they may depend on the direction of the flow –, but we can only identify the geometric average of both directional trade costs for each country pair. An important caveat is that this measure of trade costs solely relies on trade data that is aggregated across sectors. Thus, it does not take into account the types of goods traded. A reduction of observed trade costs could therefore possibly be attributed to a composition effect in the same way as it could be attributed to a change in shipping technology or tariffs.

Derivation from Eaton and Kortum (2002)

Novy (2009) provides derivations of equation 15 based on two other trade models of reference: the Ricardian model of Eaton and Kortum (2002) and the Heterogeneous trade model of Chaney (2008) and Melitz and Ottaviano (2008). In the Ricardian framework, the trade cost formula writes:

$$TC_{ij} \equiv \left(\frac{\tau_{ij}\,\tau_{ji}}{\tau_{ii}\,\tau_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{X_{ii}\,X_{jj}}{X_{ij}\,X_{ji}}\right)^{\frac{1}{2\theta}} - 1 \tag{22}$$

With:
θ = The variation of productivity distribution parameter

In this framework, other things being equal, trade costs are higher when there is not much productivity differences across countries (low θ). Intuitively, if means that when the gains of trade are potentially high, a same ratio of bilateral to internal trade reveals higher trade costs.

Derivation from Chaney (2008), Melitz and Ottaviano (2008)

In the Heterogeneous firms framework developed by Chaney (2008) and Melitz and Ottaviano (2008), the trade cost formula writes:

$$TC_{ij} \equiv \left(\frac{\tau_{ij}\,\tau_{ji}}{\tau_{ii}\,\tau_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{X_{ii}\,X_{jj}}{X_{ij}\,X_{ji}}\right)^{\frac{1}{2\gamma}} - 1 \tag{23}$$

With:
γ = The shape parameter of the Pareto distribution from which firms' levels of productivity are drawn

In this framework, other things being equal, trade costs are higher when varieties are not much differentiated (low γ). The interpretation is therefore similar to the equation resulting from the Anderson and van Wincoop (2003) framework: the more differentiated the varieties, the more potential gains to trade, and therefore, the larger trade costs associated to equivalent observed trade. An interesting feature of the aggregate measure of trade costs derived by Novy (2009) is that its scope is not limited to one particular trade model. One can therefore remain agnostic as to which model best describes the reasons for countries to trade.

3. Trade cost indices

Data

One major feature of our research has been to systematically collect bilateral and aggregate trade data, as well as GDP and exchange rates. A detailed description of the dataset can be found in Fouquin and Hugot (2014). Here, we simply provide insights on the key features of that dataset. The dataset has been constructed using current price information. Values have been converted to the British pound in order to make data internationally comparable and suitable for gravity analysis[6]. The trade data relies on various first-hand national sources, as well as pre-existing data extracted from other sources. The GDP data comes mostly from the various studies that gravitate around the Angus Maddison project, which aim has been to reconstruct historical national accounts. We provide different measures of distances, including population-weighted great-circle distance and actual maritime distance. We also provide some dummy variables that are commonly used in the gravity literature. Overall, we report 1,315,760 bilateral trade observations and distances for 34,533 country pairs. We also provide 39,768 aggregate imports and exports observations for 235 countries, 12,876 observations on GDP for 211 countries and 12,585 exchange rates for 143 countries.

Bilateral trade costs

We compute the Head and Ries (2001) index for all the country pairs available in our dataset. The usage of bilateral trade data in current prices in the denominator is straightforward, but the results depend on the measure of internal trade that is chosen.

Trade is a gross notion, in the sense that intermediary consumption is not subtracted. Internal trade should thus in principle be equal to internal gross production, minus total exports. Unfortunately, historical research has concentrated on reconstructing GDP series that are, in fact, net of intermediary consumption. There are, however, cross-country gross production datasets available for recent years. Using the average ratio of production to GDP, we reconstruct an approximation of production based on the available GDP data. The results of this sensitivity analysis are presented in appendix D.

Another caveat lies in the fact that our trade data only records trade in goods. For most of our period of interest, trade in services is a priori very limited, but this is not true for most recent years. Whenever data is available, we also provide in appendix D alternative results using the tradable component of GDP, minus exports as a measure of internal trade.

Finally, the measure of trade costs is sensitive to the elasticity of substitution across varieties (σ). Appendix A shows the results obtained when adding a decreasing or increasing trend for sigma. Head and Mayer (2013) provide a meta-analysis of the elasticity of trade with respect to

[6] In this respect, see comments on the "Bronze medal mistake" in Baldwin and Taglioni (2006)

trade costs[7]. In the Anderson and van Wincoop (2003) framework, this elasticity corresponds to $1-\sigma$. We choose the median estimate they find, based on structural estimations: -3.78 as our benchmark, hence we set sigma to 4.78. A change of this elasticity over the years could thus affect the validity of our results. We discuss this point in section 4.

In the end, following Jacks et al. (2008) and due to data availability, our benchmark results use GDP minus exports as a measure of internal trade and a fixed elasticity of substitution across country pairs and years set to 4.78.

Trade costs aggregation across country pairs

The trade costs we compute are country-pair-year specific. Since we are interested in shedding light on the timing of the First and the Second Globalizations, we need to aggregate those trade costs over country pairs to let us consider the time dimension only. This aggregation is not trivial given that the composition of the sample varies over the years (Figure 2).

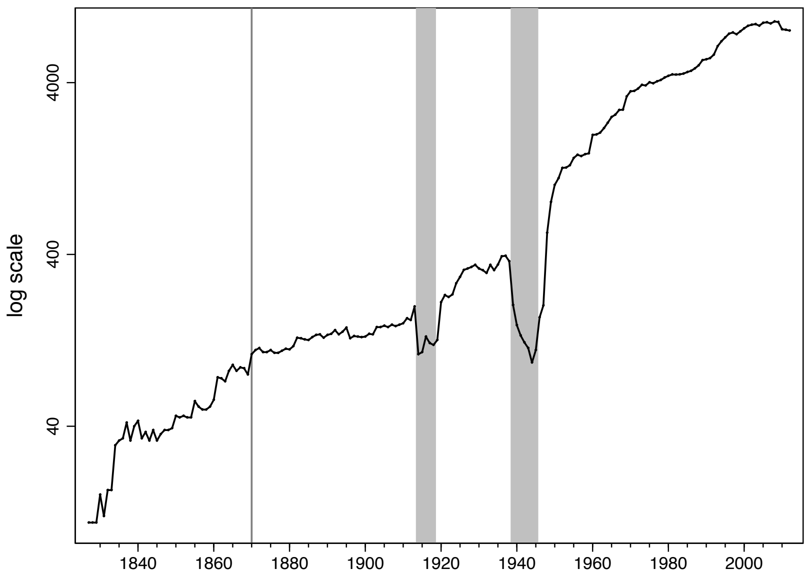

Figure 2 – Number of computed bilateral trade costs: 1827-2012

We overcome this shortcoming by regressing trade costs on a set of country-pair dummies and country-specific dummies:

- Time trend with country fixed effects: $\ln(TC_{ijt}) = FE_i + FE_j + \boxed{FE_t}$
- Time trend with country-pair fixed effects: $\ln(TC_{ijt}) = FE_{ij} + \boxed{FE_t}$

[7] p.33

The fixed effects of the first trade cost index capture the factors that are country-specific (e.g. countries' economic sizes, geographic location, etc.). In the second trade cost index, the fixed effects capture the factors that are country-pair-specific (e.g. distance, trust, etc.). In both indices, the time fixed effects reveal the overall evolution of trade costs. Our preferred index is the one based on country-pair fixed effects. Indeed, this index neutralizes all the characteristics of the country pairs that appear in the sample year after year, and not only the characteristics of the individual countries that appear in the dataset.

The resulting indices show a dramatic fall of trade costs in the last years of the 1840s, in other words, immediately following the British unilateral decision to resort to free-trade (Figure 3). More surprising, trade costs were reduced during the 1850 decade by the same magnitude as they were during the entire 53 years from 1860 to 1913. In this respect, the massive effort of trade liberalization launched by the 1860 Cobden-Chevalier Franco-British treaty can therefore appear as a consequence rather than a cause for the fall of trade barriers. If tariff reductions are indeed a second order factor that stimulated the trade barrier reductions of the nineteenth century, then our guess is that the First Globalization was primarily fueled by a reduction of transportation costs and/or by the post-1815 (Congress of Vienna) peaceful international relationships.

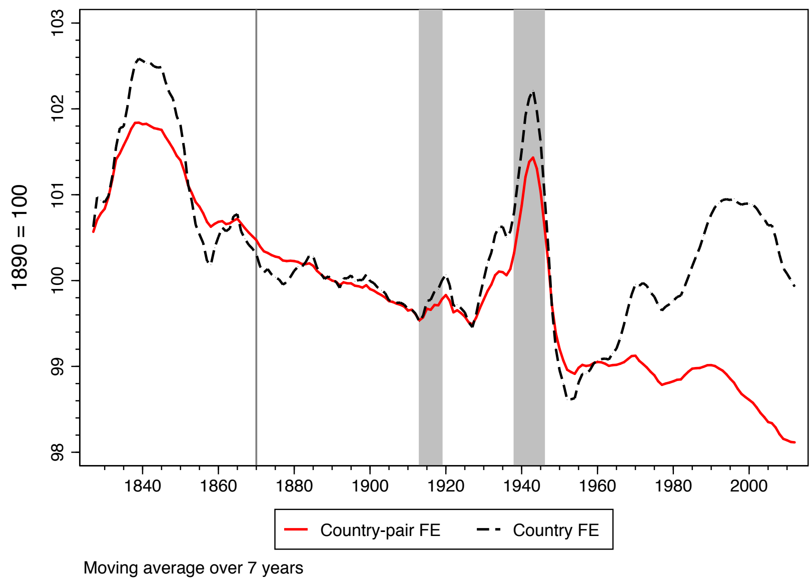

Figure 3 – Trade cost indices: 1827-2012

One should remain cautious while examining the trade costs we obtain. Indeed, they are computed using an elasticity of substitution (σ) that is set to 4.78 and does not vary over time. The larger σ, the smaller the resulting trade costs. Thus, the falling trade costs we observe in the different eras of globalization could very well be attributed to a rise of the elasticity of substitution. In appendix A, we provide a sensitivity analysis that replicates our preferred trade cost index, but imposing a trend for the elasticity of substitution.

Trade route-specific results

Figure 4 plots region-specific indices[8]. The time effect is extracted after imposing country pair fixed effects, as for the index represented by the bold line in Figure 3. Looking at the graph, it is clear that the American Civil War had a dramatic impact on trade, freezing the reduction of trade costs until the eve of the twentieth century. On the contrary, trade costs affecting European economies fell steadily from the 1840s to the First World War. The reduction of trade costs was even more severe for the Asian countries included in the sample.

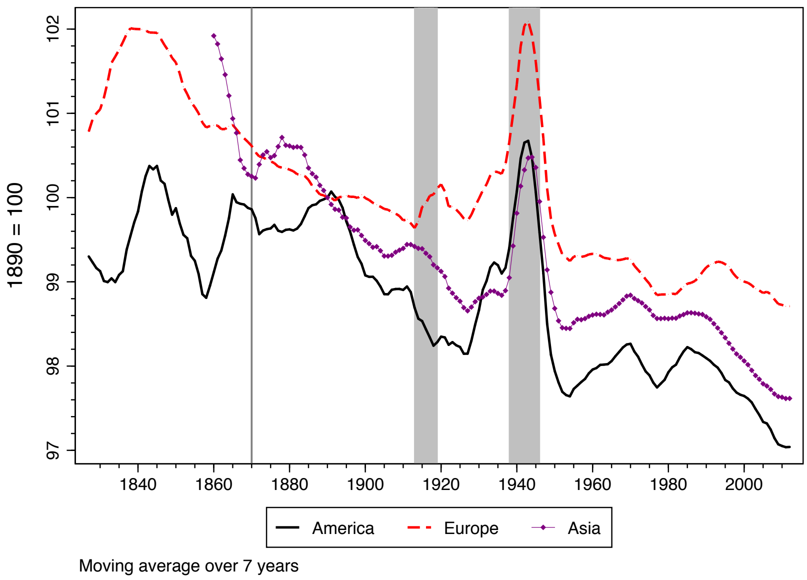

Figure 4 – Trade cost indices for three groups of countries: 1827-2012

Similarly, Figure 5 plots trade costs indices for the intra-regional trade relationships of three European regions. The graph shows that trade cost reductions were of similar magnitudes within Scandinavia and within Northwestern Europe until the end of the nineteenth century and the protectionist backlash. In turn the rise of trade costs that began for most countries right after World War I had already began among Northwestern European countries before the War.

Figure 6 plots trade costs indices along three trade routes. The graph shows that the reduction of transatlantic trade costs was also put to an end by the American Civil War, before resuming in the early twentieth century, at the time when intra-European trade costs started themselves

[8]see: Fouquin and Hugot (2014) for the composition of each group.

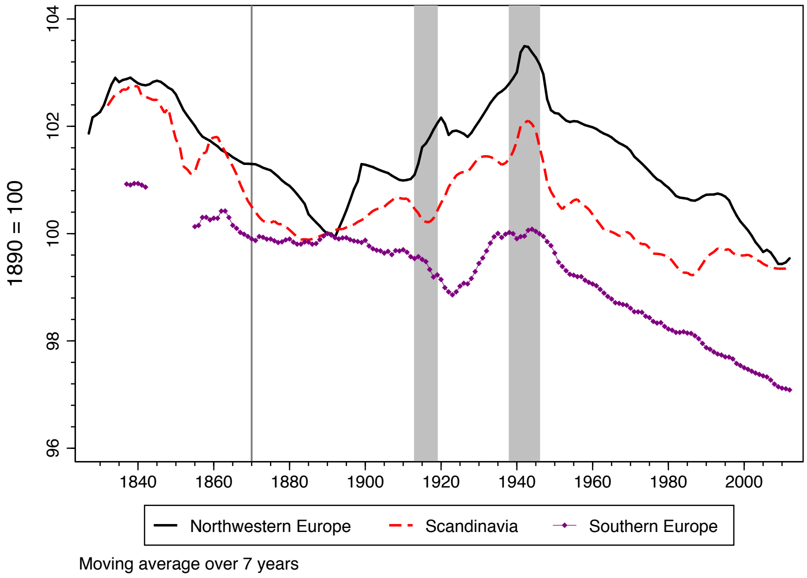

Figure 5 – Trade cost indices for trade within three groups of European countries: 1827-2012

to rise. The second half of the twentieth century is characterized by a continuous fall of intra-European trade costs, that even amplifies after 1990. On the other hand, transatlantic trade costs appear to have been slightly rising.

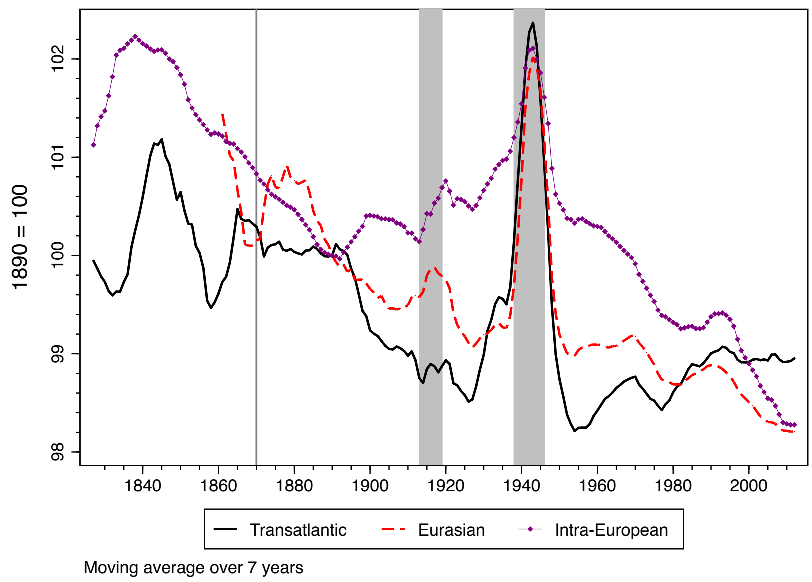

Figure 6 – Trade cost indices along three trade routes: 1827-2012

4. Trade costs decomposition

Once we are aware of the general timing of trade globalization, as well as trade route-specific patterns, one question that naturally comes to mind is about the internal dynamics of those intensifying trade flows. Notably, did distance play a role in structuring the pace of trade cost reduction?

We provide a decomposition of overall trade costs into a cost that is independent of the distance between the trading partners – the border effect – and a distance effect. Building upon the AvW version of the gravity equation, we impose more structure on the model and specify the bilateral directional trade cost τ_{ij} from gravity equation 15 as follows:

$$\tau_{ij} = Distance_{ij}^{a} * \exp(b Home_{ij}) \tag{24}$$

Plugging equation 24 into the gravity equation 15, taking logs and imposing origin and destination country fixed effects, we estimate the resulting equation in the cross-sectional dimension, for each year:

$$\ln(X_{ij}) = FE_i + FE_j + \boxed{\alpha} \ln(Distance_{ij}) + \boxed{\beta} Home_{ij} + \varepsilon_{ij} \tag{25}$$

With:
$X_{ij|i \neq j}$= Bilateral trade flow
$X_{ij|i=j}$= Internal trade flow (GDP-Exports)

$Distance_{ij}$ = Great-circle weighted distance from i to j
$D_{ij|i=j}$ = $.67\sqrt{area/\pi}$ (Mayer and Zignago, 2011)
$Home_{ij}$=1 if $i = j$
$\alpha = (1-\sigma)a$
$\beta = (1-\sigma)b$
$FE_{i(j)}$ = Set of origin (destination) country fixed effects

Border effect

The β coefficient can be interpreted as a border effect, as it reflects the trade-reducing effect of international borders. We convert the border effect into a tariff-equivalent measure, using the "pure price-shifter" property of tariffs. Indeed, prices on the destination market should in principle react one for one to a variation of the tariff. Therefore, a variable equal to one plus bilateral tariffs enters τ_{ij} with an exponent equal to one in the gravity equation. In turn, the elasticity of trade to bilateral tariffs should exactly reflect the elasticity of trade to trade costs, which is $1-\sigma$ in AvW. Assuming $\sigma = 4.78$, we therefore obtain a tariff-equivalent border effect using the following formula:

$$BE_t = \left[\exp\left(\frac{\beta_t}{1-\sigma}\right) - 1\right] * 100 \tag{26}$$

For both periods of globalization, the border effect confirms the trend highlighted by the trade cost indices (Figure 7).

We find a border effect c.1830 of approximately 50 percent. In other words, controlling for internal and international distances between trading partners, two partners of the same country traded 50 percent more that two partners located in different countries. The reduction of the border effect follows a steady path, down to 40 percent on the eve of World War I. Not surprisingly, the negative effect of borders on trade massively rises during the period of inter-war de-globalization, back to 50 percent in the late 1930s. Finally, the Second Globalization witnesses a fall of the border effect from 50 percent to 36 percent in the 2010s.

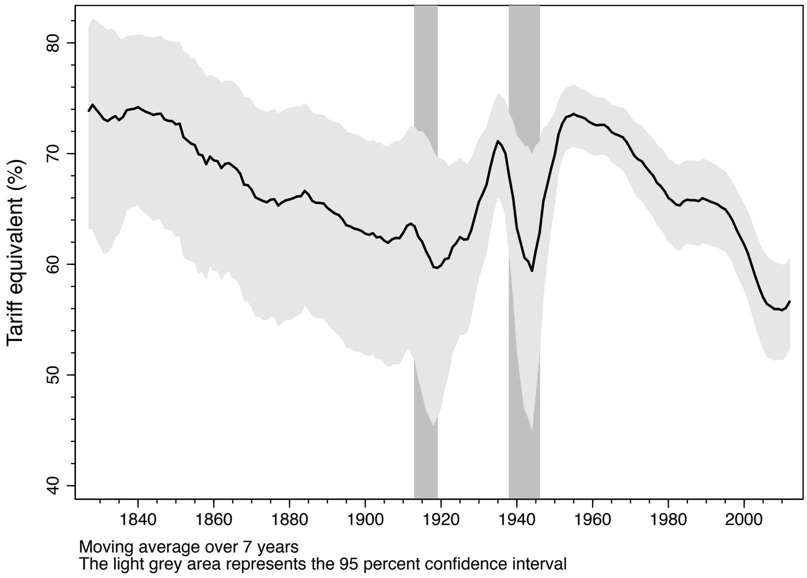

Figure 7 – Tariff-equivalent border effect: 1827-2012

Distance effect

The regressions based on equation 25 also provide yearly estimates of the distance elasticity (α). These estimates represent the response of trade to the distance that separates trading partners. Our results show that the distance elasticity increased in both periods of globalization: it quadrupled from c.1830 to c.1913 and doubled from c.1950 to c.2010 (Figure 8). The rise of the distance elasticity during the second half of the twentieth century is congruent with the gravity-based results found by Combes et al. (2006) and confirmed by the meta-analysis by Disdier and Head (2008). Nevertheless, this article is the first to our knowledge to document a massive rise of the distance elasticity for the nineteenth century.

Two lines of explanations can potentially explain these rising distance elasticities. First, trade liberalization has been massively biased toward neighboring countries. The Cobden-Chevalier network of trade treaties for the nineteenth century and the European Union for the post World War II period are probably the most striking examples. On the contrary, the fall of the distance elasticity during the interwar period can be linked to major European economies reallocating their trade toward their colonial empires. Another explanation could lie in a variation of the degree of substituability across varieties, represented in the model as σ. Indeed, if products were to become more substituable, this elasticity would rise. In turn, the elasticity of trade to trade costs $(1-\sigma)$ would increase. In other words, the same trade cost would have a larger reducing impact on trade. This is rather intuitive, since consumers are much less ready to pay an additional trade cost if the product they are importing can easily be replaced by another, produced in a closer market. Indeed, the distance elasticity in equation 25 is $\alpha = (1-\sigma)a$, where a represents the response of trade costs to distance, and $1-\sigma$ the response of trade to trade costs.

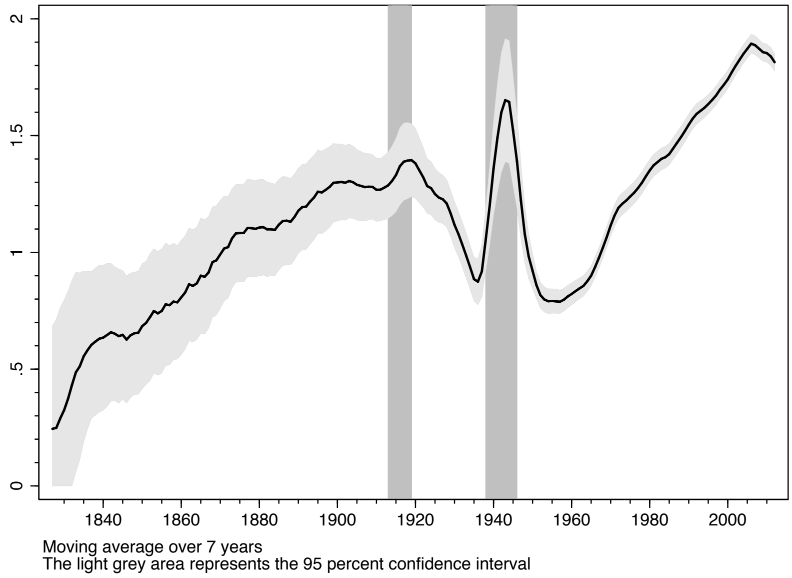

Figure 8 – Distance elasticity: 1827-2012

5. Border thickness

Finally, we combine the estimates of the border effect, the estimates of the distance effect, and the average bilateral distance in the sample to obtain a time-varying measure of "border thickness" (Figure 9). This estimate of "border thickness" reflects the distance that has the same trade-reducing effect as crossing a border. For each year, the measure of border thickness is equal to the following:

$$THICK_t = \frac{\exp(\beta_t) - 1}{\alpha_t} * \overline{Distance_t} \quad (27)$$

When borders are thin, it means that the partner-specific distance matters a lot compared to the overall decision of exporting or not. For example, c.1850 trading with a country 9,000 kilometers away cost roughly twice as much as trading with a country right across the border. For the first two decades of the twentieth century, our estimates are slightly below 5,000 kilometers. In other words, the relative cost of distance has risen. The Second Globalization is also characterized by the same pattern. We interpret this finding as revealing regionalization as a the major source of trade globalization, both during the nineteenth century and the second half of the twentieth century. In other words, over the course of both period of globalization the distance between partners has become more and more important in determining trading patterns.

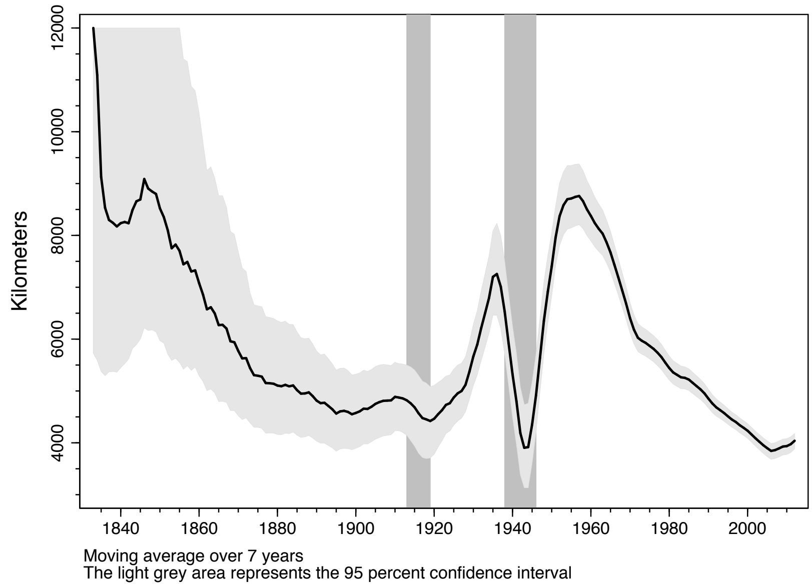

Figure 9 – International border thickness: 1833-2012

6. Conclusion

Using systematically-collected trade and GDP data for a 186-year period ranging from 1827 to 2012, we have shown that the trade globalization of the nineteenth century began c.1840. This early start of the First Globalization contradicts the theories that see the leading cause of this globalization in the series of trade treaties that bloomed after 1860. It also contradicts the research that pinpoints the role of technological breakthroughs such as the steamship and long-distance communications.

We are thus left with two potential explanations for the early rise of the First Globalization. First, the 1815 Treaty of Vienna marks the beginning of a period of peace in Europe that only comes to an end in 1914. This relatively long period of pacific relations likely had a positive impact on trade. Second, the period before 1860 witnessed a movement of unilateral trade liberalization, led by the 1846 British repeal of the Corn Laws. These non-coordinated movements toward freer trade paved the way for the wave of bilateral treaties that were signed by European countries in the late nineteenth century.

Decomposing trade costs into a border effect and a distance effect, we have shown that both the First and the Second Globalization have been characterized by a relative reduction of long-haul trade. In other words, both globalizations have been primarily fueled by an intensification of trade with proximate countries.

BIBLIOGRAPHY

Accominotti, Olivier and Marc Flandreau, "Does bilateralism promote trade? Nineteenth century liberalization revisited," working paper 5423, CEPR Jan 2006.

Anderson, James E. and Eric van Wincoop, "Gravity with gravitas: a solution to the border puzzle," *American Economic Review*, 2003, *93* (1), 170–192.

Baldwin, Richard and Daria Taglioni, "Gravity for dummies and dummies for gravity equations," CEPT working paper 5850, CEPR Sep 2006.

Baldwin, Richard E. and Philippe Martin, "Two waves of globalization: superficial similarities, fundamental differences," working paper 6904, NBER Jan 1999.

Barbieri, Katherine and Omar Keshk, "Correlates of war project trade data set," 2012, *version 3.0.* Available online: $http://correlatesofwar.org$.

Bulbeck, David, Anthony Reid, Lay Cheng Tan, and Yiqu Wu, *Southeast Asian Exports since the 14th Century: Cloves, Pepper, Coffee, and Sugar*, Leiden, The Netherlands: KITLV Press, 1998.

Chaney, Thomas, "Distorted gravity: the intensive and extensive margins of international trade," *American Economic Review*, Sep 2008, *98* (4), 1707–1721.

Chaudhuri, Kirti Narayan, *The Trading World of Asia and the English East India Company 1660-1760*, Cambridge, United Kingdom: Cambridge University Press, 1978.

Combes, Pierre-Philippe, Thierry Mayer, and Jacques-François Thisse, *Economie géographique*, Paris, France: Economica, 2006.

Disdier, Anne-Célia and Keith Head, "The puzzling persistence of the distance effect on bilateral trade," *Review of Economics and Statistics*, Feb 2008, *90* (1), 37–48.

Dixit, Avinash K. and Joseph E. Stiglitz, "Monopolistic competition and optimal product diversity," *American Economic Review*, Jun 1977, *67* (3), 297–308.

Eaton, Jonathan and Samuel Kortum, "Technology, Geograpy and Trade," *Econometrica*, Sep 2002, *70* (5), 1741–1779.

Estevadeordal, Antoni, Brian Frantz, and Alan M. Taylor, "The rise and fall of world trade: 1870-1939," *Quarterly Journal of Economics*, May 2003, *118* (2), 359–407.

Federico, Giovanni and Gunnar Persson, "Market integration and convergence in the world wheat market, 1800-2000," discussion paper 06-10, Department of Economics University of Copenhagen 2006.

Földvári, Péter and Bas van Leeuwen, "Markets in ancient societies? The structural analysis of Babylonian price data," working paper 2000.

Fouquin, Michel and Jules Hugot, "A historical database for gravity studies: 1827-2012," working paper, unpublished 2014.

Hamilton, Earl J., *American Treasure and the Price Revolution in Spain, 1501-1650*, Cambridge, M.A., USA: Harvard University Press, 1934.

Head, Keith and John Ries, "Increasing returns versus national product differentiation as an explanation for the pattern of U.S. Canada trade," *American Economic Review*, Sep 2001, *91* (4), 858–876.

_ **and Thierry Mayer**, "Gravity Equations: Workhorse, Toolkit and Cookbook," working paper 9322, NBER Jan 2013.

Jacks, David S., Christopher M. Meissner, and Dennis Novy, "Trade costs in the first wave of globalization," working paper 12602, NBER Oct 2006.

_ **,** _ **, and** _ , "Trade Costs: 1870-2000," *American Economic Review: Papers and Proceedings*, 2008, *98* (2), 529–534.

Krugman, Paul, "Scale economies, product differentiation, and the pattern of trade," *American Economic Review*, Dec 1980, *70* (5), 950–959.

Lampe, Markus, "Effects of bilateralism and the MFN clause on international trade: evidence for the Cobden-Chevalier network, 1860-1875," *Journal of Economic History*, 2009, *69* (4), 1012–1040.

Mayer, Thierry and Soledad Zignago, "Notes on CEPII's distances measures: the GeoDist database," CEPII working paper 25 Dec 2011.

Melitz, Marc J. and Gianmarco I. P. Ottaviano, "Market Size, Trade, and Productivity," *Review of Economic Studies*, 2008, *75* (1), 295–316.

North, Douglass C., "Ocean freight rates and economic development 1750-1913," *Journal of Economic History*, Dec 1958, *18* (4), 537–555.

Novy, Dennis, "Gravity redux: Measuring international trade costs with panel data," working paper 861, Warwick University Nov 2009.

O'Rourke, Kevin and Jeffrey G. Williamson, "When did globalisation begin?," *European Review of Economic History*, Feb 2002, *6*, 23–50.

Pascali, Luigi, "The Wind of Change: Maritime Technology, Trade and Economic Development," working paper 1049, Warwick economic research papers Jun 2014.

Steinwender, Claudia, "Information Frictions and the Law of One Price: "When the States and the Kingdom became United"," working paper, London School of Economics Apr 2014.

APPENDIX

8. ROBUSTNESS CHECKS

A. Elasticity of substitution

A larger elasticity of substitution results in a smaller trade cost. It also amplifies the variations of the trade costs (Figure A.1). The results are similar for all country pairs (appendix B, p.27 in Jacks et al. (2006) for more details).

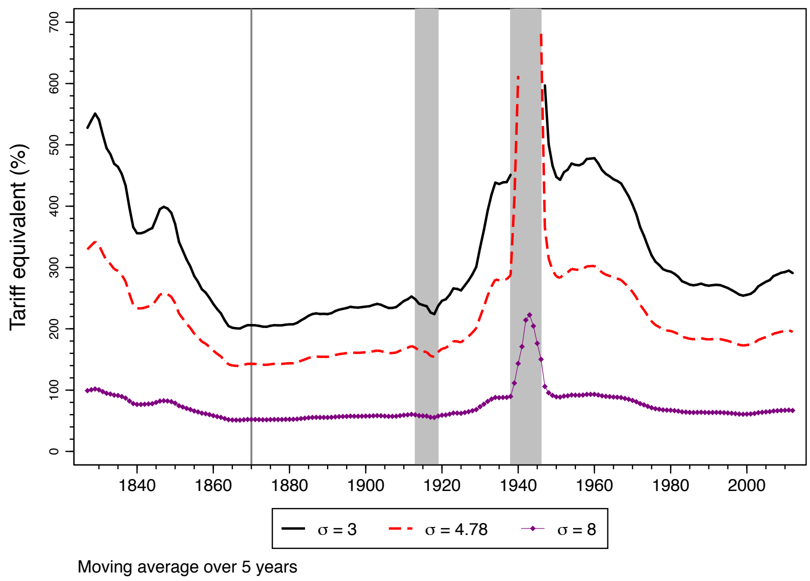

Figure A.1 – Franco-British trade costs for various values of σ

B. Distance elasticity estimated on our dataset vs. the Barbieri and Keshk (2012) dataset

Figure B.2 provides a comparison of the distance elasticity that we obtained using our dataset as well as the Correlates of War dataset (Barbieri and Keshk, 2012) that reports bilateral trade from 1870 to 2010. The estimates are obtained using equation **??**. For the second half of the twentieth century, the results using both datasets are very similar. However, the addition of the data we collected for the period before World War I significantly affects the results we find.

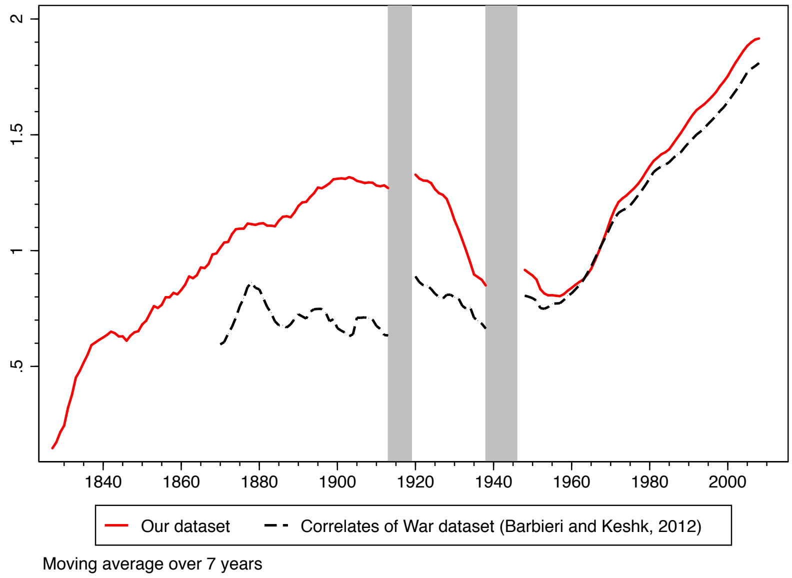

Figure B.2 – Distance elasticity estimated on our dataset and the Correlates of War dataset (Barbieri and Keshk, 2012)

C. Comparison with Jacks et al. (2008)

Using the underlying data of Jacks et al. (2008), we extracted the trade costs for several bilateral relationships that we compared with the results based on our dataset. Figure C.3 reports a comparison of the Franco-British trade cost computed on the dataset used in Jacks et al. (2008) and on our dataset. In the years for which our two studies overlap (1870-2000), we find very similar results.

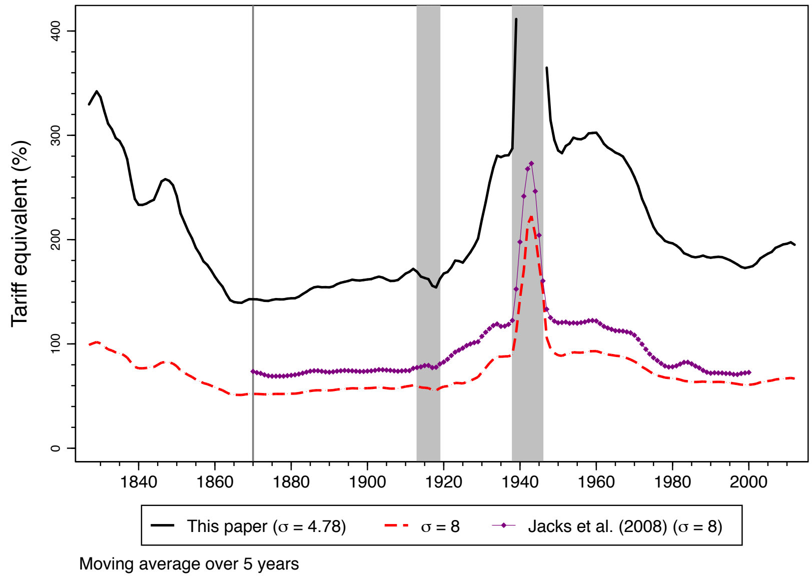

Figure C.3 – Bilateral trade cost: Britain-France

D. Sensitivity to the measure of internal trade

A proper measurement of the Head and Ries (2001) trade costs index requires a measure of internal trade. For the sake of data availability, Jacks et al. (2008) chose to approximate internal trade by subtracting countries' total exports from their GDP. This paper generally adopts their view, but we provide two alternative measures of internal trade. Specifically, Figure D.4 provides the trade costs index based on dyadic fixed effects using two alternative measures for internal trade. The three trade costs indices are computed on the same country sample, which is much more restricted than the one on which we draw our main conclusions. The legend reports different ways to measure trade costs. GDP means that internal trade is approximated by GDP only. GDP-minus-exports is the method we use broadly in this article. To obtain the index labeled "Tradable GDP minus exports", we simply multiplied GDP by a factor three in order to account, at least partially, for the fact that GDP is a valued-added concept, while trade data is reported without subtracting intermediary consumption. The multiplicator we choose is constant overtime. It reflects the mean of the gross production-to-GDP ratio computed on the 1963-2000 period on UNIDO data.

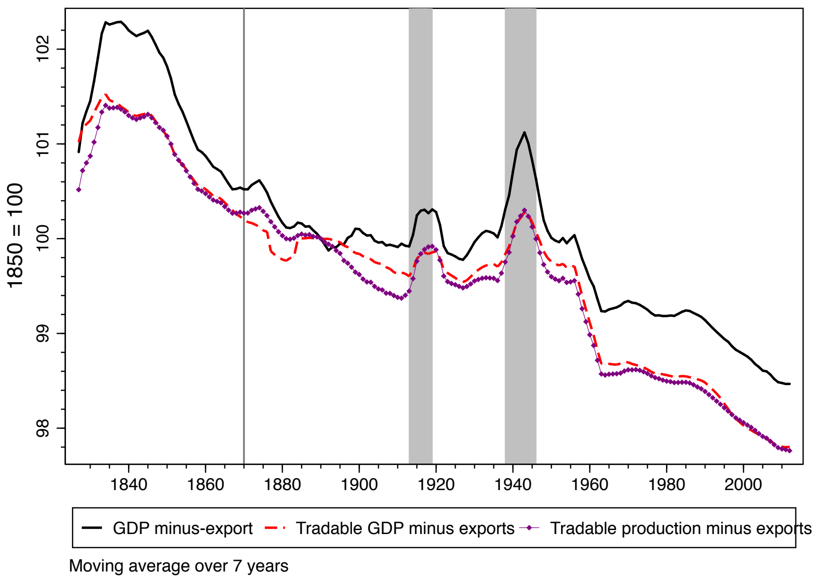

Figure D.4 – Trade cost index based on various measures of internal trade: 1827-2012