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OPENING THE BLACK BOX OF DISTANCE: EVIDENCE FROM ITALY, 1862-1938

Christopher Absell*, Andrea Incerpi**

Abstract

Historical studies of international trade have firmly established that distance was an important determinant of bilateral trade during the last two centuries. Despite the distance effect being one of the most robust results in trade history, we do not know much about how this effect changes over time, trade flows, across trading partners or traded goods. This paper examines the effect of distance on Italian bilateral trade comparing two periods: the first globalisation and the interwar years. Using a structural gravity model and data on Italian exports and imports by country and product and a new series of freights for the period 1862 to 1938, we find that the size and significance of the distance effect was highly contingent on the period and product composition of trade. While the trend in the effect of distance on trade during the first globalisation reflected the conventional story of the decline of transport costs during this period, the 1920s displays opposite trends for exports and imports. Further analysis of imports on the product-level reveals a similar heterogeneity of effect by product class. The distance elasticities of manufactured and industrial products reflected the overall trend, while those of raw materials and fuels did not seem to follow any clear pattern. We generate time series of trade to distance elasticities on the four-digit product category level and regress these on measures of trade costs and substitutability. We find that the distance effect at the product-level is explained by shifts in Italy's transport costs and the (γ) elasticity of substitution across products.

Keywords: gravity, distance, international trade, Italy, heterogeneity.

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1. INTRODUCTION

The theoretical foundations of gravity models have been the workhorse for analysing the dynamics of international trade for the last sixty years. Since its first formulation (Tinbergen, 1962), standard gravity models have consistently shown that bilateral trade flows increase with the economic size of the two trading economies and decrease according to the size of the natural or humanly devised barriers that separate them. This latter set of trade costs, broadly defined, accounts for a sizeable part of the trade dynamic. In particular, historical studies of trade using the gravity model have firmly established that distance, however measured, is an important determinant of bilateral trade. Despite the robustness of this result, we still do not have a complete picture of how the effect of distance on trade changes over time, trade flows, across trading partners or traded goods. What's more, while distance is conventionally equated with transport costs, which are commonly understood to be increasing with distance, the study of the determinants of the distance effect and the issue of product-level and temporal heterogeneity of effect are largely absent from empirical trade history.

Recent research on trade in applied economics has centred on attempts to solve the so-called "distance puzzle;" that is, the rising elasticity of trade flows to distance during the post-war period (Disdier and Head, 2008; Head and Mayer, 2013). Analogous work on the interwar period has highlighted an "interwar distance puzzle": the decreasing distance effect during a period of rising real transportation costs (Eichengreen and Irwin 1995; Albers 2018; Adam 2019). Explanations for the distance puzzle in both periods include misspecification (Disdier and Head 2008), composition effects (Carrère et al 2013), the omission of intranational trade (Yotov 2012; Albers 2018), additional transportation cost proxies (Brun et al. 2005), integration areas (Adam 2019) and country-pair heterogeneity (Bergstrand et al 2015). In the context of the second globalisation (from the 1970s or so onwards), Disdier and Head (2008: 41) underline the importance of "structural heterogeneity"; that is, that individual countries or groups within a given sample may have different distance effects. What's more, changes in distance sensitivity over time may have more to do with structural heterogeneity parameters (such as substitutability) than to changes in trade costs (Berthelon and Freund 2008).

This paper uses the case of Italy to study the degree and determinants of the heterogeneity of the distance effect in the long run. Italy is an interesting case for three reasons. First, thanks to the seminal work of Giovanni Federico, Giuseppe Tattara and Michelangelo Vasta (FTV-Bankit), we possess data on the country-product level for Italy's imports and exports over the period following the proclamation of the Kingdom of Italy (1862) to the eve of World War Two (1938). The FTV-Bankit database is unique in its detail and temporal coverage, and permits the identification of heterogeneity on the product-level over time. Second, Italy experienced a particularly intense process of structural change over this period, which provides a potentially rich source of heterogeneity with regard to the product composition of trade. Finally, despite the availability of finely grained data and the knowledge of Italy's industrial development, there remains an absence of gravity work on the country. Italy is usually lumped into key studies on the determinants of bilateral trade (Estevadeordal et. al, 2003). Indeed, the work on the gravity of Italian trade is limited to a study by Timini (2021), which covers the years from unification to 1913. There is no work that explicitly investigates the heterogeneity of the distance effect over time and by product. What's more, our historical and empirical knowledge of the black box of distance – the underlying mechanisms that generate the distance effect – remain limited.

Thus, the aim of the paper is to open this black box by exploiting the heterogeneity of the distance effect over time (during the First Globalisation and interwar years), trade flow (imports and exports) and product (at the SITC four-digit level), and to analyse the determinants of the distance effect across both dimensions using new and updated series on freights (reference removed for purposes of anonymity) and tariffs (Federico and Vasta, 2015), as well as new estimations of the elasticity of substitution across products and trading partners. To chart the trend in the distance effect over the period 1862-1938, we estimate a structural gravity model with distance-time interactions by trade flow and product. We then explore the determinants of the changes of the distance effect over time at the SITC four-digit level. Our specification includes proxies for trade costs and structural heterogeneity parameters. For the former, we include freight rates at the country-level and tariffs at the product-level. For the latter, we construct a time series of product-level elasticities of substitution across products (γ) for the full period and across trading partners (σ) for the interwar period (the data on unit values varies across products but not trading partners until 1921). We also categorise products as homogenous or differentiated according to a conservative interpretation of the Rauch (1999) classification scheme.

We highlight four main results of the study. To begin with, our structural gravity estimates show that the trend in the effect of distance on trade during the first globalisation reflected the conventional story of the decline of transport costs during this period. Second, the trend for imports during the 1920s highlights a puzzle: during a period of *declining* real transport costs (until the Crash of 1929), the effect of distance was *increasing*. This was an import-side phenomenon. The trend for exports is as expected. Third, on the product-level, manufactured and industrial products followed the general trend of the distance effect. We observe, however, a considerable degree of heterogeneity of effect across non-industrial categories. Fourth, we find that the distance effect at the product-level is explained by shifts in transport costs and the Armington elasticities of substitution across products (γ) and trading partners (σ). Concretely, the distance effect for non-industrial products over the period was associated with changes in both average freight rates and γ, while that for manufactured and industrial largely reflected the trend in transport costs.

The paper is organized as follows. Section 2 describes the conventional results of the gravity model in economics and its application to the Italian case; section 3 provides a descriptive narrative of Italian trade by focusing on the composition of exports and imports, the relevance of trading partners and a brief description of the data (trade flows and freights); section 4 examines the trends over time of the distance effect; section 5 explores the determinants of the distance effect; section 6 concludes.

2. GRAVITY AND THE DISTANCE EFFECT

Trade costs have been the subject of a wide set of studies on trade and market integration. From transportation costs to policy barriers, each category of costs has stimulated various avenues of research. The interest in transport costs fills a considerably large part of the trade literature. Due to the lack of observed transport costs by trade routes and products, most of these studies conventionally adopt distance as the standard proxy for transportation costs together with other geographical dummies (e.g., access to the sea). This is also one of the main assumptions of gravity-type models that are the common theoretical framework adopted to investigate the determinants of bilateral trade flows in both economics and economic history. This approach is undoubtedly useful as much as contradictory: it allows researchers to overcome the lack of data on transportation costs using a time-invariant element (distance) to study changes over time (Federico 2021). In their comprehensive study on the distance effect on bilateral trade, Disdier and Head (2008) show the effect of this counterintuitive approach. They collect 103 papers and the corresponding estimates of the distance coefficients, most of them covering the years from 1970 onwards and just 11 out of 103 going back to 1870. Their results depict a controversial trend: after a slight decrease of the distance effect until 1950, it starts to rise by the end of the century. Thus, the technological change that occurred in the world economy and the resulting decline of transport costs seems to have not smoothed the barrier of spatial separation.

Despite this controversial result, there is little work that attempts to incorporate observed transport costs. Among these, Jacks and Pendakur (2010) run a standard gravity model for the United Kingdom during the first globalisation (1870-1913). Their model uses a country-specific index of freight rates instead of distance, but the results are still puzzling: according to them, the fall in freights would cause a decline in trade over the entire period while trends in sea freights would depend on trade. Other authors try to solve the puzzle by attending to specification problems. For example, Standaert et al. (2016) interact distance with period-specific dummies in a Bayesian state-space model. Their bilateral index of trade integration allows the analysis of both waves of globalisation covering the years from 1870 to 2011. However, the main findings confirm an opposite trend: a decreasing effect of distance in the first globalisation and an increasing effect for the second wave, starting in the 1960s.

Following a different route, Pascali (2017) highlights the asymmetric changes in trade distance among countries driven by the introduction of the steamship in the shipping industry. According to Pascali (2017), the shift from wind to steam kept sea freight rates at low levels and this also represented the major determinant of the first globalisation. Unlike sea freights, overland transport costs depend on the differences in means of transport as well as on the competition between them and the evolution of technological change (Federico, 2021). This makes dummies for overland transportation a weak and potentially misleading instrument. Moreover, the impact of technological change on freights during the 18th and the 19th centuries appears modest according to other work (Harley, 1988; Klovland, 2009).

The same paucity of contributions holds true for the determinants of the heterogeneity of the distance effect highlighted by Disdier and Head (2008). Albers (2018) investigates the relationship between physical and political trade frictions on world trade, focusing on both tariffs and transport costs during the interwar period (1925-1936). The structural gravity model adopted confirms the distance puzzle and a decreasing role of distance for European trade in those years. Empirical results suggest that the relevance of the distance coefficient depends also on non-distance related costs: that is, as tariffs increase, transport costs count for less. These results are consistent with Yotov (2012): the measures of distance elasticity of trade and other trade costs are strictly related. Following a similar route, Adam (2019) examines the same interwar period (1928-1937) to find the causes of the collapse of world trade. His model includes transport costs, tariffs, and the payment system in the estimation of gravity equation, together with new data on the ocean freight-rates for cotton. The relevance of the gold standard and transport costs is marginal compared to tariffs and the border effect. Results indicate that distance, as a proxy for transport costs, does not explain the fall of world trade in the 1930s.

Looking to the second wave of globalisation, Berthelon and Freund (2008) examine the increasing trade elasticity to distance since 1980 by disaggregating bilateral trade data at the product-level and through the study of distance sensitivity within industries. According to them, distance became significant for 40 per cent of industries due to an increasing distance sensitiveness for bulky, homogeneous, and high tariffs goods. Mainly, changes in trade costs, both tariffs and transportation costs, had little effect on the distance sensitivity across industries while the relevance of distance over time is primarily related to the substitutability of goods and the initial level of trade costs.

Shifting attention to Italy, empirical studies on the gravity of Italian trade are almost entirely missing. The exception is Timini (2021), who analysed the drivers of Italian exports and product market entry and exit for the first globalisation period. According to his gravity model, distance and market size explain the dynamic of trade flows as well as differences in endowments. In addition, trade agreements are positively related to increases in bilateral exports, especially for agricultural goods, while emigration explains the increasing probability of market entry due to the reduction of trade costs. Despite Timini's (2021) seminal contribution, we are still no closer to understanding the changing role of distance over time, how this effect differed on the product-level, and what was driving changes in the distance effect.

3. ITALIAN TRADE PATTERNS FROM UNIFICATION TO 1938

The transition of Italy from a new-born country to one of the leading economies in the world was a gradual process that affected Italy from Unification until at least World War One. From a macroeconomic perspective, the framework of the first wave of globalisation in the second half of the 19th century stimulated the demand for foreign goods and the openness to trade for those countries, such as Italy, experiencing a catching-up process towards the leading industrial economies (Federico and Tena-Junguito, 1998; Federico and Wolfe, 2013; Felice and Vecchi, 2015; Federico and Vasta, 2015).

Figure 1 shows the value of imports, exports, and total trade in constant 1913 US dollars for the period of the study. Overall, total trade grew by around two per cent per annum, with export growth (at 2.3 per cent) being marginally quicker than import growth (at 2.1 per cent). Most of this growth occurred, however, during the first globalisation. Growth slowed dramatically with the onset of the War. The pattern during the interwar period (1920-38) was one of stagnation, with overall trade growing by zero percent, imports contacting by 0.3 per cent, and exports growing by a mere 0.4 per cent. As Figure 1 clearly indicates, trade contacted following the Wall Street Crash of 1929, by around 0.4 per cent per annum from 1930 to 1938.

The industrialization process after Unification is clearly reflected in the descriptive statistics of the commodity composition of trade. Table 1 depicts the evolution of imports and exports for the period 1862 to 1938. In 1862 primary commodities dominated both for exports (mainly silk) and imports, proving the paucity of raw materials such as wheat, coal, cotton, and wood and confirming Italy as a predominantly agricultural country at the time of Unification. At the beginning of the 20th century, the composition of trade changed. The share of raw materials in total exports decreased by more than

20%, occupying only half of the total share by the end of the 1930s. In 1929, for the first time, Italy's share of world manufacturing exports reached 3%. This was also confirmed in the following years by the conquest of Ethiopia in 1936. On the import side, raw materials were still predominant before WWII: coal, cotton, wheat, and wool accounted for almost 30% of total imports. However, in the first decade of 20th century, the significant decrease of textile products imports confirmed the growth of domestic production capacity (Federico et al., 2012).

Table 2 shows the evolution of the shares of Italy's top 10 trading partners in total imports and exports. Around the time of Unification, there was a large degree of concentration of the geographical distribution of trade, with the top ten trading partners accounting for 90 and 94 per cent of imports and exports, respectively. France accounted for one third of trade, followed by the United Kingdom and Switzerland, which both counted for a sixth (Federico and Wolfe, 2013). This level of concentration would decline over the period, reaching 55 and 46 per cent of imports and exports in 1937.[1] There was a not subtle shift in the composition of trading partners as well. The period witnessed the substitution of relatively proximate trading partners (Austria-Hungary, France, Great Britain and Switzerland) with relatively distance ones (Germany, Argentina, the United States, and other countries). Increasing trade with the Americas reflected increasing Italian overseas migration flows (Federico et al., 2012).

Finally, freight data (reference removed for purposes of anonymity) complete the descriptive picture of Italian trade in the period. Figure 3 shows the average inbound and outbound freight that includes: port handling costs and fees, insurance, transport costs and duties. The overall trend is marked by the impact of WWI. Before 1914, freights decreased for both inbound and outbound routes, although inbound freights showed a little jump in 1871 and during the 1870s. On average, outbound freights

[1] We use 1937 as our final benchmark as data for Austria-Hungary is missing in 1938.

were lower than inbound freights. The impact of WWI radically changed the picture. During the 1920s, outbound freights recovered the trend of pre-war years, reaching the same level only during the 1930s. On the other hand, inbound freights remained consistently higher than outbound freights until WWII, without ever returning to globalisation levels before WWI.

4. OPENING THE BLACK BOX OF DISTANCE

To estimate the trend of the effect of distance on Italian bilateral trade over time, we run a structural gravity model on both country-level and country-product-level data that takes the form:

$$X_{ijpt} = \exp\left[\beta_0 + \beta_1 \mathrm{Dist}_{ij} * \mathrm{Year}_t + \pi_{ipt} + \gamma_{jpt} + \mu_{ij}\right] * \varepsilon_{ijpt} \quad [1]$$

where X is bilateral trade between Italy (i) and partner j of product p at time t in current US dollars, Dist is the log of distance in nautical miles between Italy and partner j, π_{jpt} and γ_{jpt} exporter-product-year and importer-product-year fixed effects and μ_{ij} dyad fixed effects. The former (exporter- and importer-product-year) account for any time-varying unobserved characteristics (including multilateral trade resistances), while the latter capture unobserved time-invariant characteristics. As these fixed effects are collinear with time invariant variables such as distance, we interact distance with year dummies to generate a time series of distance elasticities (β_1). Robust standard errors are clustered at the dyad level. As is standard in the gravity literature, [1] is estimated with pseudo-Poisson maximum likelihood (PPML) (Santos Silva and Tenreyro 2006).[2]

[2] The estimation is performed with Stata using the user-written command ppmlhdfe, designed for high dimensions of fixed effects. See Correia et al 2020.

We run [1] on two different sets of data. The first, which come from the RICardo database, includes annual observations of bilateral trade for both exports and imports for the period 1864 to 1938. The sample of countries included constitutes the complete universe of Italy's trading partners, according to official statistics (Dedinger and Girard 2017). The second, derived from the FTV-Bankit database, contains country-product-level data for both exports and imports for the period 1862-1939 (Federico et al. 2012). However, the latter only covers Italy's ten principal trading partners, which may generate serious problems of sampling bias.[3] This is not such a problem for the period of the first globalisation, when these trading partners accounted for around 80 per cent of Italy's total trade.[4] During the interwar period, this coverage drops to just under half of total trade (48 per cent in 1938, see Table 2). As we wish to exploit the product-level data of the FTV-Bankit database, we compare results from both databases to gauge the seriousness of the possible sample bias derived from reduced coverage. We also address the limited coverage of this period by returning to the primary sources (*Movimento Commerciale del Regno d'Italia*) and digitising the complete universe of Italy's trade partners on the product-country level for three benchmarks: 1913, 1929 and 1938.

Figure 3 graphs the results for the first globalisation and interwar periods with the country-level data (RICardo, panel A) and country-product level data (FTV-Bankit, panel B). Our reference year is 1913; the values on the y axis are interpreted as the change in elasticity relative to this year. We use 1913 as our reference year as it marks the lowest point of the distance elasticity during the first globalisation period for total trade. Values under zero indicate that the effect of distance was higher than the 1913 level, while values over zero the opposite. For the period of the first globalisation, the overall trends of the series derived from both databases are quite similar: sharp fluctuations before a dramatic fall in the 1880s that slows in the 1890s and first decade of the twentieth century. The size

[3] This includes Austria, Argentina, Belgium, France, Germany, Netherlands, Russia, Switzerland, United Kingdom, and United States. Before the War, Austria represents Austria-Hungary. After the War, Hungary is separated and not included in the ten-country sample. We do, however, include it in our robustness check.
[4] Concretely, the coverage drops from 89% in 1865, to 80% in 1900, and to 68% in 1913.

of the coefficients, however, differs considerably; in panel A, the distance elasticity for total trade in 1864 was 221 per cent lower than that of 1913, while that of panel B was 89 per cent lower.[5] The decline in the final quarter of the century is particularly dramatic for the elasticities estimated using the country-level data, declining from 210 per cent in 1883 to 31 fifteen year later. With some small differences, it was the same story for both exports and imports. Despite these important differences in the size of the elasticities, the results from both series tell the same story: the Italian experience reflected well the conventional narrative of the falling effect of distance during the last quarter of the nineteenth century.

Our findings for total trade during the interwar period also partially reflect the conventional narrative of deglobalisation. At its nadir, in 1935, the effect of distance was 13 per cent below the 1913 level (in Panel A). By 1938, this had risen to 10 per cent. This is in line with Jacks et al. (2011), who found that average trade costs increased by around 13 per cent during the period from 1921 to 1938. Despite this decline, our results show that gains made during the first globalisation far exceeded the losses during the interwar period of deglobalisation. When disaggregated by trade flow, however, the story becomes more complicated. While the distance effect declined during the 1920s for exports, the opposite was true for imports. This had much to do with the impact of the War.[6] The case of exports is as expected: a sharp decline to reach 1880s levels in 1918, before an equally rapid recovery until 1929. The immediate post-war recovery was particularly impressive. In 1919, the distance elasticity (in Panel A) for exports stood at 40 per cent below that of 1913. Only four years later, this gap had been reduced to zero, and the elasticity finally exceeded 1913 levels in 1926. Imports, however, showed a contradictory trend; following the outbreak of the War, the elasticity rose rapidly above the 1913 level, indicating that the effect of distance was reduced during wartime.[7] From the end of the

[5] The economic effect is calculated as $100*e^{\beta 1-1}$

[6] We drop the war years from our results, as we are unsure with regard to the quality of the data during this period. Both Austria and Belgium disappear from the composition of imports for several years and we do no tknow whether this reflects zero or missing trade values.

[7] In both cases, however, the coefficients on distance during the War and post-war periods are generally insignificant.

War to 1929, the effect of distance gradually increased, reaching 1913 levels in the year following the Crash.

From 1929 onwards there is divergence between the two sources: the effect of distance, as expected, generally declines for the country-level data, while the product-level data shows a rapid increase. This is perhaps due to the sampling bias inherent in the latter and highlights the need for caution when interpreting the estimations using the Bankit database for the 1930s. To provide a check of these results, in Table 3 we provide benchmark estimates of the distance coefficient for 1929 and 1938 (relative to 1913) using the complete distribution of Italy's trading partners. Again, this is presented for total trade as well as exports and imports. Note that the standard errors are marginally lower for the estimates using the full series. The coefficients on the full and Bankit series for total trade in 1929 show a similar tendency, lying at 14 and eight per cent above the 1913 level, respectively. A comparison of the coefficients between 1929 and 1938, however, reveals opposite trends: a small decline for the full series (from 14 to 11 per cent) and a considerable increase for the Bankit series (from eight to 24). The coefficients for exports and imports show that the Bankit results are reliable for the former but not for the latter. Thus, the estimates for the period following 1929 should be interpreted with an extreme degree of caution.

Just as the trend in the distance effect for total trade disguises considerable differences in the trends of exports and imports during the interwar period, so the trend of total imports disguises important compositional changes at the product-level. To examine heterogeneity at the product-level, we run [1] again but only for imports and at the SITC one-digit product category level. Figure 4 displays the results. In Panel A we display the distance elasticities for non-industrial (categories zero through four) and in Panel B those for manufactured and industrial (categories five through eight) products. The overall trend during the period of the first globalisation is comparable for both non-industrial and industrial products. The former declined from a peak of 122 per cent in 1866. This declining trend, however, concealed a considerable amount of variation across product categories. Like that of non-industrial products, the average for industrial products also declined from 116 per cent in 1864, largely mirroring the tendency of manufactures (category six). However, unlike the considerable level of variation observed for non-industrial products, all categories displayed a pronounced decline over the period.

The interwar period displays a wide degree of variation between the distance elasticities of the two groups. The elasticities for manufactured and industrial products do not decline as dramatically as those for nonindustrial products, hovering around 10 per cent lower than the 1913 level during the 1920s. The decline for certain non-industrial categories is markedly higher. The distance elasticity for beverages and tobacco (category one) declined from 37 per cent higher in 1919 to 86 per cent lower than 1913 on the eve of the Crash. Animal and vegetable oils (category four) evinced an even more dramatic trend, declining from 57 to 99 per cent over the same period. Crude materials (category two), which included raw cotton, on the other hand, experienced marginal declines (from 36 to 15 per cent higher than 1913 level). Thus, the level and trend of the effect of distance was highly contingent not only on the period, but also on the product composition of imports.

5. EXPLAINING THE BLACK BOX

Discussions of the distance puzzle in the post-war period have underlined the importance of heterogeneity. As Disdier and Head (2008: 41) (also: Archanskaia and Daudin 2017) argue, the distance coefficient does not merely represent the impact of trade costs on bilateral trade, it also captures the elasticity of trade flows to trade costs. The so-called trade elasticity is inversely linked to measures of heterogeneity. Increases in heterogeneity that arise during the process of globalisation may serve to offset trade costs, effectively generating distance coefficients that are less sensitive to cost reductions. Sampling and methodological heterogeneity aside, heterogeneity may derive from three conditions: a) varying degrees of substitution across products, (Anderson and van Wincoop 2003), b) varying levels of productivity across trading partners (Chaney 2008), and c) varying degrees of productivity within countries between industries, widely interpreted as the strength of comparative advantage (Eaton and Kortum 2002). In all cases, increased heterogeneity reduces the elasticity of trade flows to trade costs.

While these explanations of the heterogeneity of the distance effect possess a solid theoretical foundation, they are very hard to test empirically. Estimates of the elasticity of substitution (σ) require country-product level price or unit value data. In the Italian context, unfortunately, the official sources before 1921 only give quantities, and not values. Cross-country productivity estimates are absent for the great majority of Italy's trading partners over the period in question. The freight series presented varies at the country-level, not the product-level. We are evidently constrained by the availability of information on the product-level. Thus, to gain an intuition of the forces driving the changes in the distance effect for Italy's imports over time and across products, we are forced to make a series of simplifying assumptions.

Here, we examine the importance of both trade costs and heterogeneity for distance. For observed trade costs, we include freight rates and tariffs. As the clearest proxy of transport costs, the relationship between the distance coefficient and freights is purportedly negative. Tariffs, however, are a different story. The effect of a tariff increase on the distance coefficient is ambiguous and depends on whether tariff changes are applied to all trading partners, or whether preferential rates are given. A specific tariff applied to the same product from different countries would decrease relative transport costs and increase demand for the product from the distant country, leading to a decline in the effect of distance (Berthelon and Freund 2008: 317; Albers 2018: 321 and Adam 2019 for the interwar case). On the other hand, if preferential access is given to proximate trading partners, a tariff rate hike will increase the effect of distance. The historical experience of Italy includes both contexts.

During the period of the first globalisation to the eve of the War, except for the trade war with France, bilateral treaties were established with the most-favoured nation clause. During the interwar period, however, tariffs were regulated by individual treaties, allowing for preferential treatment. The data for tariffs come from Federico and Vasta (2015), and represent the receipts derived from import taxation (*riscossioni*), which we divide by the total value of imports of each product to obtain the ad valorem equivalent tariff. However, the latter is only available for benchmark years and until 1929. This unavailability of tariff data, together with the issue of sampling bias discussed in the previous section, forces us to delimit the end point of our analysis to 1929. The availability of the tariff data also delimits our sample of products. 55,882 observations, including products from all ten SITC single-digit product categories, are missing data on revenue, so these are dropped. Data on freights are taken from the most recent reconstruction of the Italian balance of payments (Incerpi 2018). These estimates include yearly inbound and outbound freights for different maritime routes and a partial estimate of overland trade freights. The series provide a partial differentiation by product for inbound freights while referring only to coal for outbound freights. Furthermore, the data collects an overall transport costs per tonne using an accurate reconstruction of the weight of each commodity (checked by looking at auctions website). Given that the freight series does not vary at the product-level, the estimated coefficient cannot be interpreted as a product-specific mean effect.

We include three proxies for structural heterogeneity. The first is the Armington (σ) elasticity of substitution between different varieties of a product, and, by extension, the type of good imported. The original Armington (1969) formulation explored the elasticity of substitution of domestic goods with respect to imports. In our context, we are interested in the degree of substitutability across foreign suppliers: the “lower-tier” (Archanskaia and Daudin 2017: 13) or “micro” (Bazjik et al. 2019: 7) elasticity. The second is the (γ) elasticity of substitution between different imported products. The third is an indicator of the degree of homogeneity of a product, following a looser and simplified version of the Rauch (1999) classification. In our historical context, the Rauch classification scheme is anachronistic. For this reason, we use the scheme to classify products into homogenous or differentiated categories. We use Rauch's "conservative" approach and include goods traded on an organised exchange in the homogenous category, and the reference priced and differentiated products in the latter category.[8] Together, these three variables capture different dimensions of substitutability. In Berthelon and Freund's (2008: 16) formulation, increases in substitutability incentive importers to switch to suppliers with relatively lower transport costs. Thus, increased elasticities of substitution driven by greater degrees of homogeneity imply increased distance effects. We should expect to observe a negative relationship between these three proxies of structural heterogeneity and the distance coefficient over time.

We calculate the σ's as:

$$\left(\frac{Q_{p,j,t}}{Q_{p,i,t}}\right) = \exp\left[\beta_0 + \sigma_1 \log\left(\frac{P_{p,i,t}}{P_{p,j,t}}\right) + \mu_{p,i,j} + \gamma_t\right] + \varepsilon_{p,t} \text{ [2]},$$

that is, the ratio of the quantities (Q) imported of product p from countries j and i at time t is related to the corresponding price ratio of the product from each country. To control for unobserved heterogeneity between country-pairs and over time, we include dyad (μ) and year (γ) fixed effects. The elasticities are estimated using PPML to control for heteroscedasticity of the dependent variable in levels. Robust standard errors are clustered at the dyad level. We run [2] using the unit value and quantity data from FTV-Bankit and generate a series of σ for each product at the four-digit level. As mentioned, unit values are equal across countries but vary across products for the period before 1921, so we estimate the elasticities for the benchmark years 1923, 1925 and 1929 only.

The elasticity of substitution between imported products, γ, is calculated as:

[8] Data on the Rauch classification scheme can be found here: https://econweb.ucsd.edu/~jrauch/rauch_classification.html.

$$Q_{pt} = \exp\left[\beta_0 + \gamma_1 \log\left(\frac{P_{p,t}}{P_t}\right) + \alpha_p + \gamma_t\right] + \varepsilon_{p,t} \; [3],$$

where Pt is the unweighted average price of Italy's import products, α is a product fixed effect, and the estimation method is the same as [2]. Unlike σ (which is characterised by observations on the country-product level), the dimensions of the panel restrict us from calculating γ's on the four-digit level. We are thus limited to estimating these elasticities at the single-digit (category) level, which assumes that the elasticity of substitution is constant across products within categories.[9] Unlike σ, however, we include a complete series of γ´s for every benchmark from 1862 to 1929.

Table 4 displays descriptive statistics of γ and σ. As Broda and Weinstein (2006: 567) observe for levels of σ during the period of the second globalisation, one would expect less differentiated goods to have higher σ's. Presumably, the characteristics of non-industrial goods would result in them being more substitutable than manufactures and industrial goods. Our σ's generally confirm this for the interwar period. Panel A shows that non-industrial products on average were characterised by a considerably higher σ. Panel B shows that the same is true for homogenous goods, using the Rauch classification. In the case of the γ's, the opposite is true. Substitution between import products was higher for industrial than nonindustrial products. The γ's indicate that, within categories of non-industrial products, there was a higher degree of differentiation (e.g., tea versus coffee, cotton versus woollen textiles). On the other hand, the σ's suggest that there was a higher degree of substitutability between varieties of non-industrial products (wheat from France versus USA, cotton fabrics from Germany versus Great Britain). Of course, each of these categories is characterised by a large degree of heterogeneity. This is shown in Panel C, which gives the elasticities for Italy's top product

[9] This assumption is also taken by Bromhead et al. 2019 when estimating σ, although they use the elasticity of trade to trade costs derived from a gravity model as their proxy for the elastcity of substitution between varieties. What's more, their estimation of γ differed somewhat in that they use the quantity and price nests for each product generated from the gravity equation.

categories at the two-digit level. The σ was higher for cereal, but the category zero γ virtually dropped to zero during the 1920s. The adverse is true for category two γ's, while the σ was comparable to industrial products. In terms of the import composition, category six γ's were the most important and they also exhibited the highest elasticities values.

We estimate [1] on the four-digit level and store the time series elasticities for distance, β_1. This generates a series for 209 products. However, as mentioned, several of these do not possess corresponding tariff data, which reduces our number of observations to just under 3,500. Our estimation takes the form:

$$\mathrm{Dist}_{pt/1929} = \beta_0 + \gamma_{pt} + \mu_{pcat} + \beta_1 \log(1 + \tau_{pt}) + \beta_2 \log f_t + \beta_3 \sigma_{pt} + \beta_4 \gamma_{ct} + \varphi_1 H_p + \varepsilon_{p,t} \quad [4]$$

where Dist is the distance elasticity of product p at time t relative to 1929, τ the log of the ad valorem equivalent tariff of product p at time t, f the log of the average freight at time t, σ the Armington elasticity of substitution between varieties of product p at time t, σ the elasticity of substitution between import products of category c in time t , and H a dummy that equals one if a commodity belongs to the homogenous category. We include year (γ) and product (μ) fixed effects and robust standard errors are clustered at the category level. One concern is that the overrepresentation of products marginal to Italy's overall import composition may bias our results. This concern arises for two reasons. Firstly, a regression of the standard errors on import shares, including year and product fixed effects, shows a strongly negative and significant relationship. Thus, distance coefficients of products with lower shares are measured with relatively higher degrees of error. Furthermore, due to scale effects, it is likely that products with larger shares in the import composition could be more sensitive to our explanatory variables. We thus weight our estimates by each product's share in the total value of imports. A comparison of the results for ordinary and weighted least squares (in appendix Table A1) shows that in most cases weighting increases both the explanatory power and point estimates of the specification while reducing standard errors, importantly for non-industrial during the first globalisation and industrial products for the 1920s.

The results are displayed in Table 5. Panel A displays the results for all products for the two periods, while Panels B and C shows the results of non-industrial (categories zero to four) and industrial (categories five to eight) products, respectively. Overall, our specification explains a fair amount of variation within the sample (R-squared of 0.74 and 0.65 for the first globalisation and interwar periods, respectively). With several exceptions to be discussed below, the signs of the coefficients accord with the hypothesised relationship between the distance coefficients and the explanatory variables. The results for all products (Panel A) for the first globalisation period indicate that both trade costs and structural heterogeneity parameters were important determinants of the observed changes in the distance effect. Tariffs, while negative, are insignificant. As expected, transport costs evince a large, negative, and statistically significant effect on the distance sensitivity; a one-percentage point decrease in freights corresponds with a four-percentage point decrease in the distance coefficient relative to 1929. The results for this period suggest, however, that declines in transport costs were offset by structural heterogeneity. The homogenous dummy suggests that products that are less differentiated were less distance sensitive over the period, the first of several counterintuitive results. The coefficient of γ is negative and significant, although the size of the effect is smaller than that of freights; a one percentage point increase in the elasticity of substitution between different import products is associated with a 0.04 decrease in the distance coefficient. Thus, overall, transport costs seemed to exert a stronger influence on the distance coefficient during the first globalisation. Results for the same period for non-industrial products (Panel B) and manufacturing and industrial products (Panel C) reflect these patterns. Both freights and the γ elasticities were important drivers of the distance effect, the former being larger for non-industrial products and the latter for industrial products (although only significant at the 10 per cent level). The homogenous dummy is significant only for non-industrial products.

The interwar period presents a more complicated picture. Results in Panel A show that our specification fails to elucidate statistically significant correlations for the whole panel, indicating a considerable degree of heterogeneity of effect at the category-level. Panels B and C highlight why this is. The distance effect for non-industrial products was not associated with transport costs, but rather with shifts in structural heterogeneity parameters. Concretely, the homogenous dummy and γ elasticity are negative and statistically significant, and the size of the effect is decidedly larger than that of the first globalisation. For manufacturing and industrial products, transport costs were still associated with declines in distance sensitivity, although the size of the effect is considerably lower in the interwar period. The σ elasticity is also significant but, again counterintuitively, positive.

Together, these results suggest the following story. The decline of transport costs during the first globalisation was associated with a generalised decline in the effect of distance. However, the strength of this effect was offset by increases in substitutability across products. Given the direction of the distance effect over this period, transport cost declines evidently won this tug of war. This dynamic was distorted during the interwar period. While manufacturing and industrial products remained sensitive to transport costs, shifts in the substitutability of non-industrial products were the defining forces governing changes in the distance effect. While the elasticity of substitution generally declined, the effect of substitutability on distance increased, being particularly important for relatively less differentiated products. Evidently, the decline in transport costs during the 1920s was not enough to offset this process. Thus, the trend of the distance effect for non-industrial products is largely associated with shifts in the composition of Italy's trading partners. As Figure A1 in the appendix shows, non-industrial imports were increasingly sourced outside of the principal trading partners, especially after the War. Italy's main trading partners suffered a marked decline that began prior to the shock of WW1 and accelerated thereafter. On the other hand, the effect was weaker for industrial products, and most likely offset by falling transport costs. This was because Italy's trading space for manufacturing and industrial products contained fewer suppliers. Italy's principal trading partners, which were also its most proximate, maintained their trade shares over the entire period, although there were important changes between them – especially between France and Germany following the trade war.

6. CONCLUSIONS

While the literature on the gravity model, and particularly on the distance puzzle of the inter- and post-war years, has recognised the importance of the heterogeneity of the distance effect, this issue remains unexplored in applied trade history. This paper shows that heterogeneity matters for our understanding of the distance effect. Indeed, our results show that the size and significance of the distance effect was highly contingent on the period and product composition of trade.

This paper contributes to both the economic historiography of Italy and the literature on historical applications of the gravity model. On the Italian side, we have provided the first sketch of the trend of the distance effect for Italian trade across two defining moments in the country's history (the first globalisation and interwar periods). We have shown that this trend reflected the conventional story of falling transport costs during the former period, but that things got complicated during the latter. While the reduction of transport costs was important for Italian trade, shifts in the geographical distribution of trade due to the impact of the First World War were also important for understanding the high degree of heterogeneity of the distance effect during the interwar period. We know that trade got especially political during the 1920s and 1930s (James and O'Rourke 2011), thus an interesting avenue of research might focus on the political economy narrative underlying our results for the structural heterogeneity parameters.

More widely, this paper has shown that the distance effect contains an immense amount of heterogeneity at the product-level. Thus, researchers should be careful when reading distance coefficients on aggregated measures of trade. Furthermore, we demonstrate that care must be taken when interpreting the distance effect. While our results show that it is closely correlated with the trend in transport costs – at least, for the case of Italy – the strength, significance and direction of this correlation can change over time as other factors come into play. In this paper, we have underlined the particular importance of structural heterogeneity parameters, specifically substitutability across products and between trading partners, which is an important part of the elasticity of trade flows to trade costs (the trade elasticity). Applied work using the gravity model in trade history should thus take these issues into account when drawing inferences from the results of distance coefficients.

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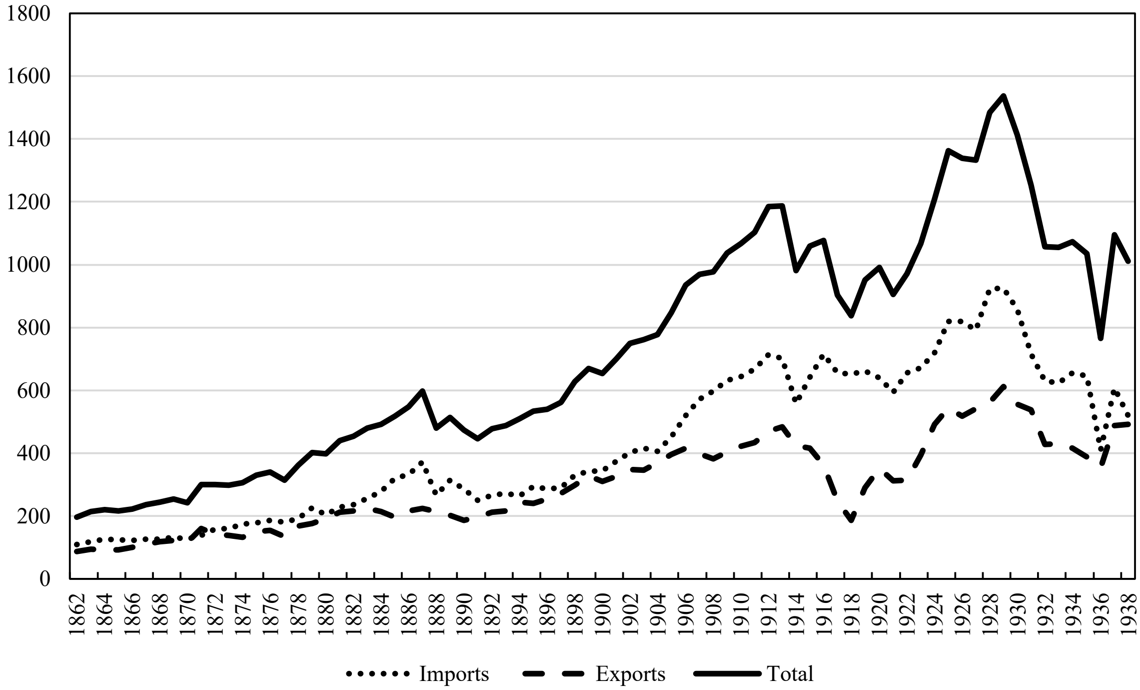


Figure 1: Import, exports, and total trade value, in constant prices (millions 1913 USD), 1913

Source: Federico and Tena-Junguito 2019.

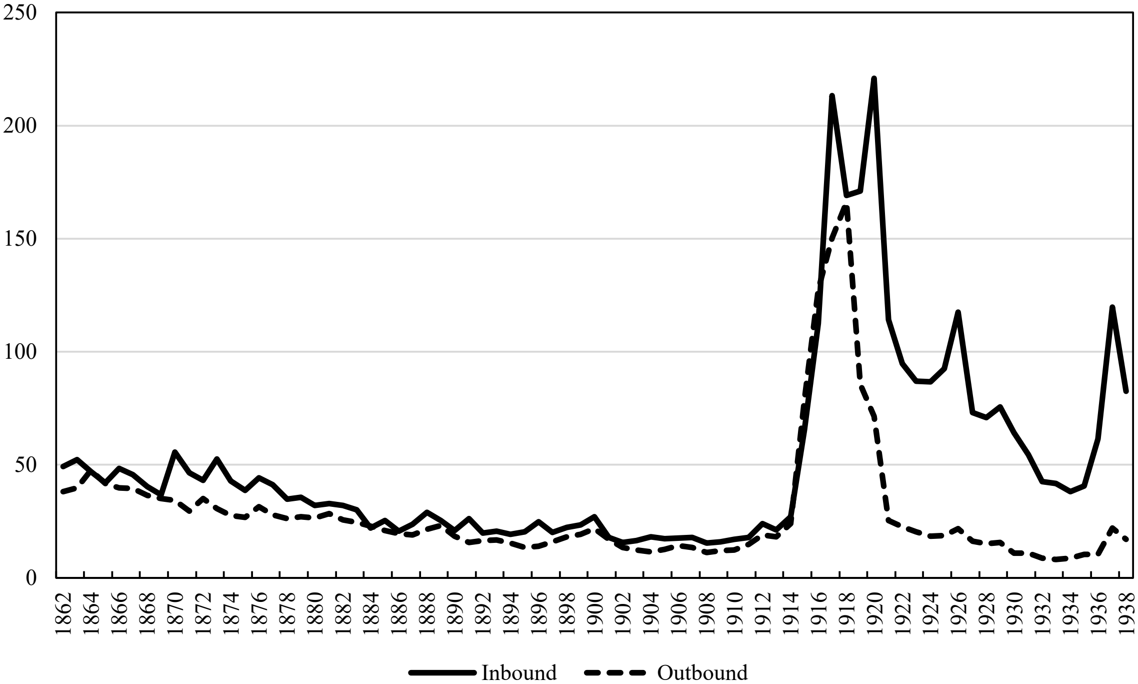
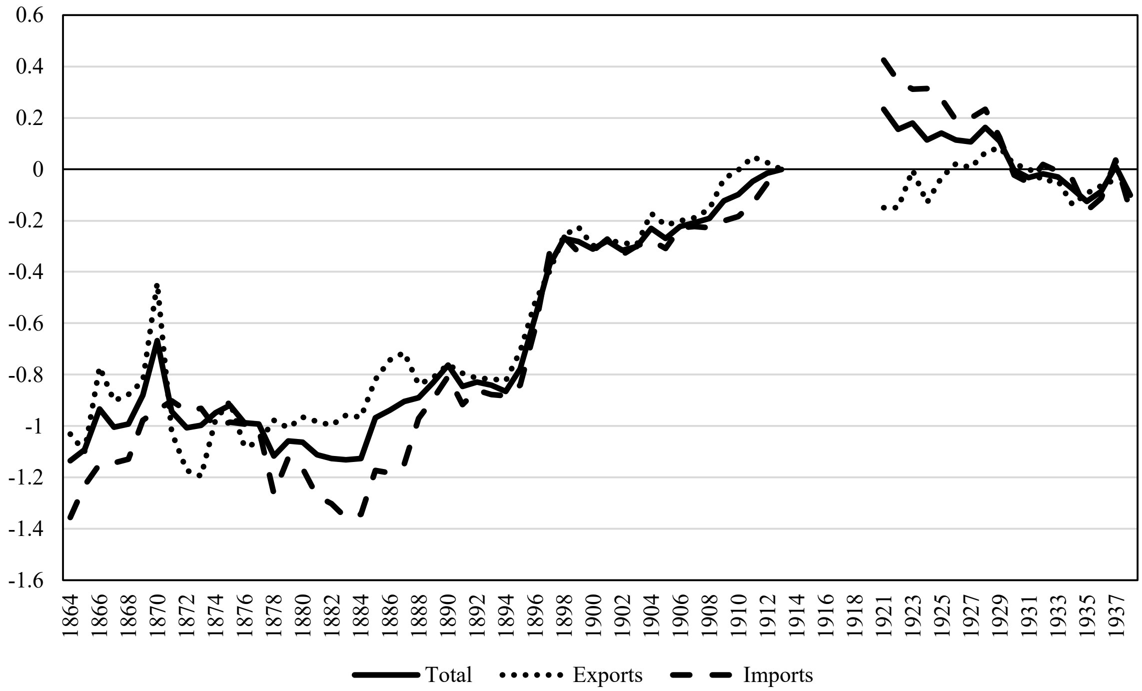


Figure 2: Average freight (lire 1911), 1862-1939.

Source: Incerpi 2018.



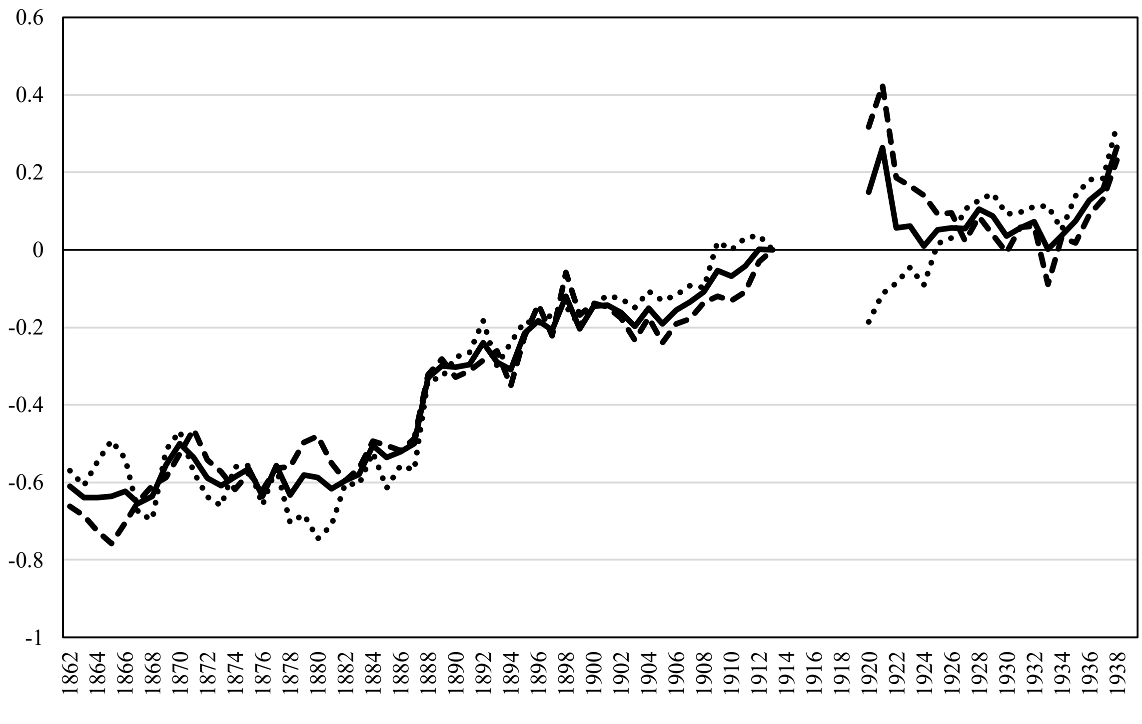


Figure 3: Average annual elasticity of distance with respect to trade (base year=1913), Italy, [A] country-level, [B] country-product-level.

Sources: Panel A: RICardo, Dedinger and Gerard 2017. Panel B: FTV-Bankit, Federico et al. 2012.

Notes: Observations: RICardo: 6,956; FTV-Bankit: 518,841; Full: 903,077.

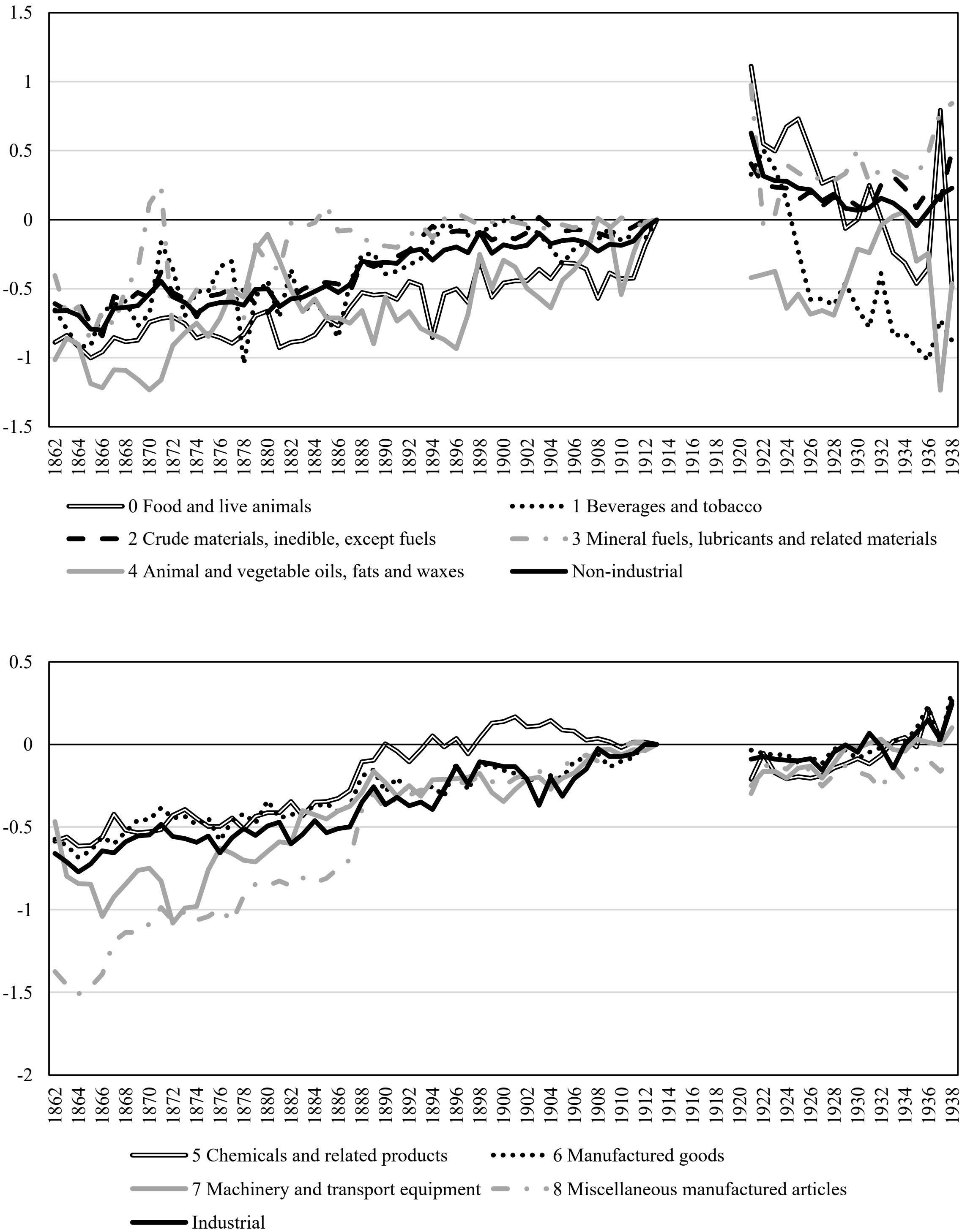


Figure 4: Average annual elasticity of distance with respect to trade for imports by SITC Rev. 1 product category (base year=1913), Italy, [A] non-industrial, [B] industrial products.

Source: FTV-Bankit, Federico et al. 2012.

Table 1: Share of top 10 products in trade by trade-flow and period.

Imports					
1862-67	%	1909-13	%	1935-39	%
Wheat	12.3	Raw cotton	9.1	Coal	13.2
Silk	9.3	Coal	8.7	Raw cotton	7.2
Woollen textiles	5.8	Wheat	5.6	Wheat	4.5
Cotton textiles	5.2	Hard wheat	4.2	Wool	3.1
Sugar	4.9	Wood	4.0	Copper	2.9
Silkworms	3.1	Silk	3.9	Oil	2.5
Cotton yarns	3.0	Cocoons	2.2	Wood	2.5
Wood	2.7	Maize	1.7	Mineral oils	2.0
Coffee	2.3	Leather	1.7	Scrap iron	2.0
Leather	2.2	Fish	1.5	Machine tools	1.8
Total	50.7	Total	42.6	Total	41.8

Exports					
1862-67	%	1909-13	%	1935-39	%
Silk	29.9	Silk	9.1	Cotton textiles	13.2
Olive oil	11.9	Silk textiles	8.7	Almonds	7.2
Sulphur	5.3	Cotton textiles	5.6	Artificial fibres	4.5
Citrus fruits	4.6	Cheeses	4.2	Citrus fruits	3.1
Natural colours	3.2	Cocoons	4.0	Fresh fruits	2.9
Hemp and linen	2.9	Raw hemp	3.9	Raw hemp	2.5
Cocoons	2.7	Olive oil	2.2	Cheeses	2.5
Wheat	2.2	Almonds	1.9	Wine	2.0
Wine	2.2	Other textiles	1.9	Wool textiles	2.0
Rice	2.1	Wine	1.5	Silk	1.8
Total	67.1	Total	41.9	Total	31.0

Source: FTV-Bankit, Federico et al. 2012.

Table 2: Share (%) of top 10 trading partners in trade by trade-flow, benchmark years.

	AUST	BEL	FRA	GER	GB	NET	RUS	SWI	ARG	USA	OTH
					Imports						
1862	17	1	28	0	23	3	4	10	1	2	10
1880	14	1	24	7	20	1	7	3	0	6	18
1913	7	2	8	17	16	1	6	3	4	14	22
1928	2	3	9	10	8	1	1	2	8	18	39
1937	5	1	4	19	4	1	1	3	8	11	45
					Exports						
1862	10	1	33	1	16	2	3	24	2	3	6
1880	13	0	40	6	7	1	1	8	0	1	23
1913	9	2	9	14	10	1	2	11	7	10	24
1928	3	2	9	12	9	1	0	7	8	11	37
1937	3	1	4	14	6	1	0	5	4	7	54

Source: FTV-Bankit, Federico et al. 2012

Table 3: Coefficients on distance relative to 1913 reference year

	1929	1938
	Total	
Full	0.15	0.12
	(0.09)	(0.10)
Bankit	0.09	0.27
	(0.12)	(0.15)
	Exports	
Full	0.14	0.25
	(0.08)	(0.12)
Bankit	0.15	0.32
	(0.09)	(0.13)
	Imports	
Full	0.15	0.06
	(0.11)	(0.12)
Bankit	0.04	0.23
	(0.14)	(0.18)

Source: Full: *Movimento Commerciale del Regno d'Italia*, various years; Bankit: FTV-Bankit, Federico et al. 2012.

Notes: Robust standard errors clustered at the dyad level in parenthesis. Observations: FTV-Bankit: 518,841; Full: 903,077.

Table 4: Average γ and σ elasticities according to product category, 1862-1929.

	1862-1913	1920-29
	A: Industrial vs. non-industrial	
	γ	
Industrial	-4.53	-2.72
Non-industrial	-1.27	-0.49
	σ	
Industrial	-	2.39
Non-industrial	-	4.35
	B: Differentiated vs. homogenous	
	γ	
Differentiated	-3.07	-1.92
Homogenous	-3.29	-1.64
	σ	
Differentiated	-	2.57
Homogenous	-	3.69
	C. Top products by import share	
	γ/ σ (%)	
Cereal and cereal preparations (04)	-3.26 (11%)	0.02/5.51 (18%)
Textile fibres, not manufactured, and waste (26)	0.13 (13%)	-1.99/2.67 (17%)
Textile yarn, fabrics, made up articles, etc. (65)	-7.80 (17%)	-4.00/2.42 (5%)
Electrical machinery, apparatus and appliances (72)	-2.59 (3%)	-4.19/2.74 (2%)

Source: FTV-Bankit, Federico et al. 2012.

Note: figures in parenthesis are SITC Rev. 1 codes and import shares.

Table 5: The determinants of the distance effect.

	1862-1913	1920-29
A: All products		
Tariff	-.42	1.15
	(.52)	(9.16)
Freight	-3.67***	-1.50
	(.87)	(2.43)
Homogenous	1.89***	5.45
	(.25)	(4.34)
γ	-.04***	-.20
	(.01)	(.19)
σ	-	-.03
		(.20)
Obs.	2,997	493
R^2	0.74	0.65
B: Nonindustrial products		
Tariff	-.27	-6.14
	(.33)	(17.00)
Freight	-4.74***	1.23
	(.24)	(.88)
Homogenous	1.63***	-10.61**
	(.09)	(2.38)
γ	-.03***	-.48***
	(.01)	(.09)
σ	-	-.09
		(.17)
Obs.	972	166
R^2	0.78	0.74
C: Manufacturing and Industrial products		
Tariff	-.14	2.45
	(1.64)	(2.38)
Freight	-2.97*	-.86***
	(1.12)	(.16)
Homogenous	.52	-.28
	(.55)	(.17)
γ	-.07	-.01
	(.03)*	(.01)
σ	-	.17**
		(.06)
Obs.	2,025	327
R^2	0.53	0.61

Source: FTV-Bankit, Federico et al. 2012; Federico and Vasta 2015; Incerpi 2018.

Notes: the coefficient is the (product share in total imports) weighted average effect, robust standard errors clustered at the Category-level, in parenthesis. Regressions include product and year fixed effects.

Appendix

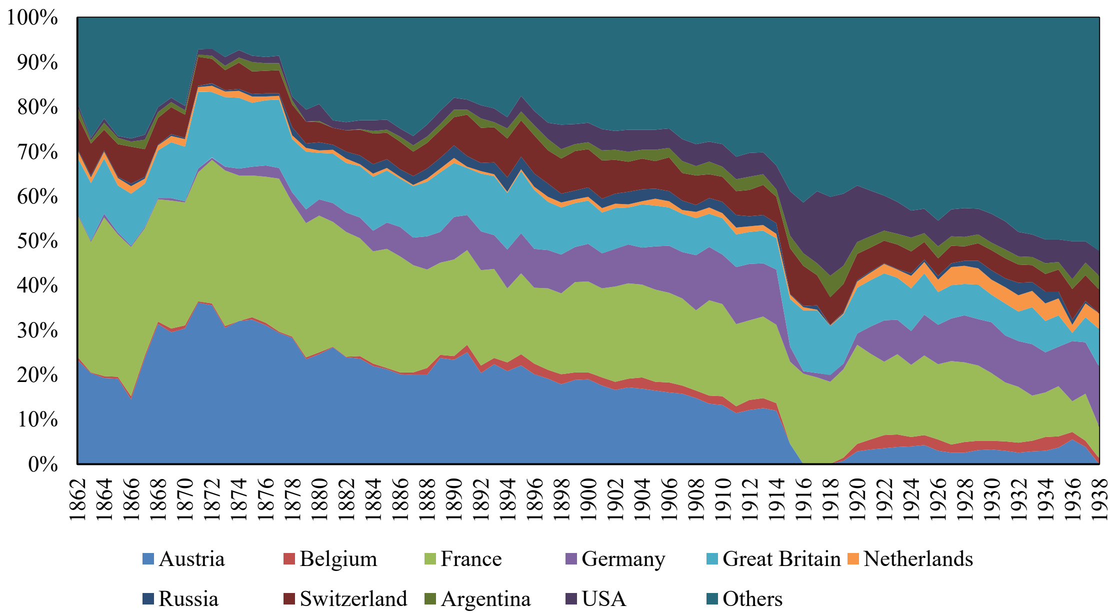
Table A1: Results of distance elasticity regressions with ordinary and weighted least squares.

	OLS	WLS
All	1862-1913	
ln_tariff	-.20	-.42
	(.61)	(.52)
ln_freight	-3.28***	-3.67***
	(.77)	(.87)
Homogenous	1.31***	1.89***
	(.20)	(.25)
γ	-.01	-.04***
	(.01)	(.01)
Obs.	3,041	2,997
R^2	0.61	0.74
	1920-29	
ln_tariff	-1.08	1.15
	(4.11)	(9.16)
ln_freight	.83	-1.50
	(1.43)	(2.43)
Homogenous	2.06	5.45
	(1.22)	(4.34)
γ	-.06	-.20
	(.06)	(.19)
σ	-.10	-.03
	(.17)	(.20)
Obs.	500	493
R^2	0.48	0.65
Non-industrial	1862-1913	
ln_tariff	.59	-.27
	(.50)	(.33)
ln_freight	-3.72*	-4.74***
	(1.44)	(.24)
Homogenous	2.31***	1.63***
	(.12)	(.09)
γ	.010	-.03***
	(.01)	(.01)
Obs.	996	972
R^2	0.74	0.78
	1920-29	
ln_tariff	1.01	-6.14
	(6.46)	(17.00)
ln_freight	2.47	1.23
	(2.61)	(.88)
Homogenous	-2.71	-10.61**
	(2.14)	(2.38)

γ	-.16	-.48***
	(.09)	(.09)
σ	-.20	-.09
	(.25)	(.17)
Obs.	169	166
R^2	0.51	0.74

Industrial	1862-1913	
ln_tariff	-.90	-.14
	(.75)	(1.64)
ln_freight	-3.36***	-2.97*
	(.78)	(1.12)
Homogenous	-.26	.52
	(.23)	(.55)
γ	-.02	-.07
	(.02)	(.03)*
Obs.	2,045	2,025
R^2	0.36	0.53
	1920-29	
ln_tariff	-5.94	2.45
	(3.83)	(2.38)
ln_freight	-.82*	-.86***
	(.37)	(.16)
Homogenous	-.53	-.28
	(.49)	(.17)
γ	-.01	-.01
	(.02)	(.01)
σ	.08*	.17**
	(.04)	(.06)
Obs.	331	327
R^2	0.51	0.61

A



B

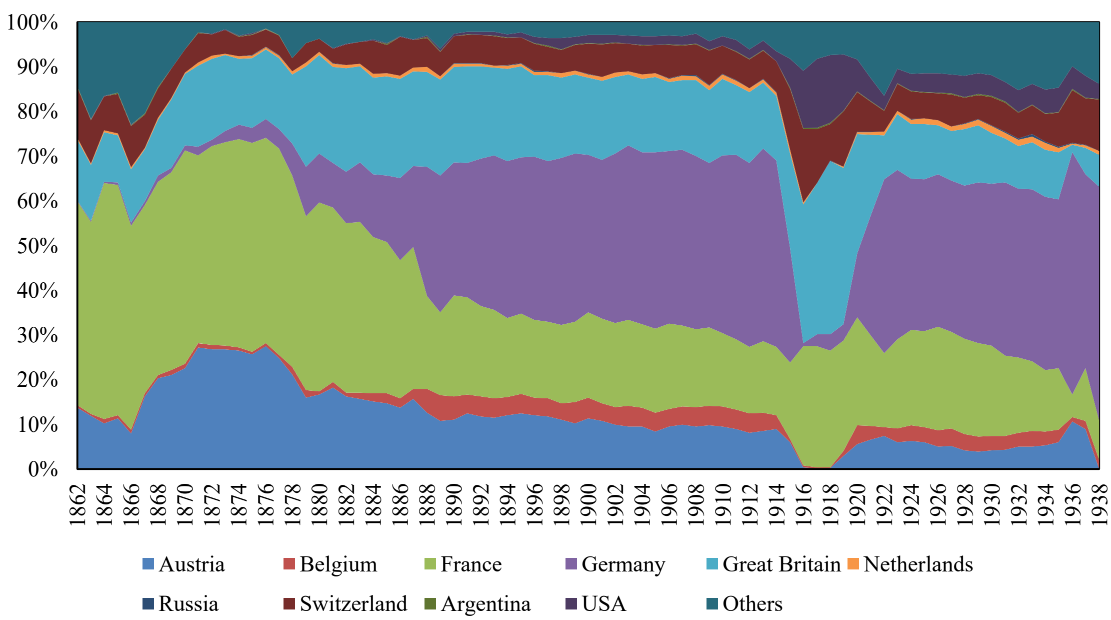


Figure A1: Country composition of Italy's imports, 1862-1938: [A] Nonindustrial and [B] industrial products.

Source: FTV-Bankit, Federico et al. 2012.