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Abstract

When did Germany become economically integrated? Within the framework of a gravity model, based on a new data set of about 40,000 observations on trade flows within and across the borders of Germany over the period 1885 – 1933, I explore the geography of trade costs across Central Europe. There are three key results. First, the German Empire before 1914 was a poorly integrated economy, both relative to integration across the borders of the German state and in absolute terms. Second, this internal fragmentation resulted from cultural heterogeneity, from administrative borders within Germany, and from geographical barriers that divided Germany along natural trade routes into eastern and western parts. Third, internal integration improved, while external integration worsened after World War I and again with the Great Depression, in part because of border changes along the lines of ethno-linguistic heterogeneity. By the end of the Weimar Republic in 1933, Germany was reasonably well integrated.

Keywords: Germany, Economic Integration, Aggregation Bias, Border Effects

JEL: F15, N13, N14, N90.

Introduction

Was Germany ever united? Or for that matter the Habsburg Empire, Italy, Spain, the Soviet Union? Germany was certainly unified politically, from the day Wilhelm I was proclaimed German Emperor in January 1871. But it is much less obvious whether Germany was then or thereafter a social and economic entity. The German state of 1871 had several strong regional centres besides the capital of Berlin. It was also divided culturally between Catholics and Protestants and between Germans and ethnic minorities (especially Poles in the east and French in the south-west), and the economy was fragmented by the geography of resource endowments and natural trade routes. Indeed, modern historiography have often argued that the quest for internal "unity" to complete the political unity achieved in 1871 was a driving force of German politics.[2] It is in fact far from obvious to what extent Germany was ever united within her external political borders. In this paper I explore the more specific question, whether there ever existed an integrated German economy within these external political borders.

Put into a broader perspective, the paper shows that aggregation bias involved in taking states as units of analysis can be large. It also sheds light on the question of why and how borders matter. Much empirical research in economics does of course take the political state as its basic unit of analysis, and treats it as an exogenously given entity. While statistics designed and collected by states often leave us little choice, this choice of units introduces aggregation bias into economic analysis.[3] For example, international comparisons of GDP per capita based on state level GDP and population data can be seriously misleading when there are large differences in GDP or population density within a state (see the recent debate on the

[2] Kehr, *Der Primat*, Fischer, *Griff*, Wehler, *Das Deutsche*.

[3] For an early theoretical exposition see Theil, *Linear Aggregation*.

"great divergence"). Similarly, empirical research on the exchange in goods and factors can be heavily biased when we neglect economic barriers within states. Any mis-measurement of intrastate frictions implies a bias of our estimates of cross-state frictions.[4] And any mis-specification of frictions in turn affects our measures of market access and "local" comparative advantage, and thus affects our explanations of the geography of production and trade.[5] The question is, whether such aggregation bias is large or negligible: how misleading would it be to assume that Germany was united in 1914 or in 1939? This is obviously related to several recent contributions that have looked into Germany's "division" and "re-unification" as a natural experiment based on exogenous changes in political borders and market access.[6] In this paper I provide a benchmark for economic integration prior to division, and determine whether it is reasonable to assume (as all these studies have) that the border changes are exogenous.[7]

Related to the question of aggregation bias is the recent but already quite large literature on borders or "border effects". Political borders have long been acknowledged to be a major source of trade costs that limit an efficient division of labour. "Border effects" are detectable both in large deviations from the law of one price (LOP) and in estimates of

[4] See Hillberry and Hummels, "Intranational Home Bias", Anderson and van Wincoop, Gravity with Gravitas".

[5] For the aspect of comparative advantage see Deardorff, "Local Comparative Advantage", for explanations of economic geography see Rossi-Hansberg, "A Spatial Theory".

[6] See for example Buch and Toubal, "Openess and Growth", Redding and Sturm "The Costs", also Alesina and Fuchs-Schuendeln, "Good Bye".

[7] This is related to Sleifer, "Planning Ahead", who estimated levels of industrial productivity in 1936 for the future German Democratic Republic and Federal Republic of Germany as a benchmark for post-war developments.

border-related trade costs from a gravity model.[8] But their origins and dynamics over time are not well understood. We still do not know why borders continue to matter in periods of increasing economic integration. Even in the careful specification of Anderson and van Wincoop (2003) the US-Canadian border is estimated to have reduced cross-border trade by roughly 40% in 1993, four years after the free-trade agreement. Moreover, recent studies on the cases of Poland's (1918) and Germany's (1990) political re-unifications indicate that the old borders that once divided these countries continued to have a quite large effect on trade even 15-20 years after unification.[9] It is thus not surprising that borders matter for trade, but it is startling that they matter so much and that their effects persist so long. That is puzzling to economists, who typically model "borders" in terms of tariffs, currency areas or similar economic barriers. The empirical evidence so far suggests that these factors fail to capture how borders matter for trade and this paper explores the dynamics of border effects over time – in particular how the dramatic changes in Germany's external borders affected trade flows *within and across* these borders. The fundamental question is when did the external border of Germany start to matter? But in order to answer this question, we must take other causes of fragmentation into account that may have also affected trade flows.

My empirical strategy is to consider trade costs defined as broadly as possible, including not just natural geographic barriers, but also all man-made (political, technical, religious or other) obstacles to trade. I analyse the pattern of regional trade flows within and across various lines of fragmentation, following the large empirical literature, which estimates trade costs from the identifying assumptions a gravity model. Specifically I employ the micro founded gravity model of Anderson and van Wincoop (2003), estimated in the empirical

[8] For border effects measured as deviations from the LOP see Engel and Rogers, "How Wide", for border effects measured in a gravity framework see McCallum, "National Borders".

[9] On Poland see Wolf, "Path Dependent", on Germany see Nitsch and Wolf, "Tear Down".

framework of Santos Silva and Tenreyro (2006), which can be seen as the new standard in the literature. This allows me to derive measures of fragmentation expressed in terms of "tariff equivalents", which are comparable both in the cross-section and over time. I will analyse basically three types of fragmentation for reasons that are spelled out below: external and internal administrative borders, geographical barriers including distance, and lines of fragmentation related to cultural heterogeneity. Economic integration of a specific area can then be defined as a situation where trade costs within the boundaries of that area, for example Germany in the borders of 1913, are significantly below trade costs across the area's boundaries.[10] This follows the argument by McCloskey (1998) that measures of economic integration need a plausible benchmark to be meaningful.

My data-set covers four points in time - 1885, 1913, 1925 and 1933 - and thus starts shortly after the foundation of the German Empire and ends with the Weimar Republic in 1933. Most important, the data comprises not only Germany in the borders of 1871 but also all adjacent European regions. Trade flows are disaggregated into 34 trade districts of which 21 are districts within the German Empire and the remaining 13 cover all European

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[10] An alternative approach to the analysis of economic integration between regions follows Cournot who defined an integrated market as "an entire territory of which the parts are so united by the relations of unrestricted commerce that prices take the same level throughout with ease and rapidity" (quoted by Spiller and Huang, "On the extent", p.131). Hence, in an integrated market the equilibrium level of prices must be equal (the famous law of one price) *and* prices must return quickly to their equilibrium level after any shock. A market should not be called integrated if equilibrium prices differ and/or if deviations from equilibrium last for long, see Federico, "Testing Market Integration". However, price data with sufficient geographical coverage and at a sufficiently high frequency to estimate half-lives of deviations is rarely available, in an historical context typically only for grain. This implies that all studies on "economic integration" either focus on grain markets alone, a questionable approach for Germany in the late 19th century, or generalise their results under some strong assumptions.

neighbours of Germany. The districts are defined in a way that allows me to distinguish the impact of three sorts of borders: administrative borders between districts inside the federal states of Germany (for example districts within Prussia), state borders within the Empire (for example between Bavaria and Prussia), and finally the borders of the Empire itself.[11] I completed this data with information on various geographical features of Germany and her neighbours, and data on population and on Central Europe's ethnic and religious composition over the period 1885 to 1933 to track the impact of geographical and cultural heterogeneity on trade.

The rest of the paper is organised as follows. I first lay out the main hypotheses on possible lines of fragmentation. I then present my theoretical and empirical framework for estimating trade costs. After briefly describing the data on trade flows the paper moves on to the empirical analysis and several robustness checks, and finally to the implications of my findings.

The roots of fragmentation: historical borders, geography, and culture

Let us begin by generating some testable hypotheses about lines of fragmentation that may have limited the "economic unity" of Germany 1885-1933. Three potential barriers come to mind: political and administrative borders, geographical features, and cultural differences between regions.

[11] The districts in my data are the "Verkehrsbezirke" from the German statistic on trade on railways and waterways. These "Verkehrsbezirke" in turn follow closely internal administrative borders of the federal states of Germany and state borders of Germany's neighbours. For example, "Verkehrsbezirke" in Prussia are congruent to "Regierungsbezirke" and can be aggregated into the larger Prussian "Provinzen", while the various Thuringian states are aggregated into one "Verkehrsbezirk". See maps 1 and 2 for details.

We can start with the external borders of the German Empire. There is every reason to believe that they imposed a barrier to trade flows in absolute terms and relative to other barriers, because of tariffs and differences in terms of law and administrative procedures. While the German Empire in 1871 was still committed to free trade, its trade policy started to change around 1878 with the adoption of the "iron and rye tariffs" in 1879, which triggered a wave of protectionism across Europe that continued until 1914.[12] After the war, Germany returned to the protectionist pre-war tariff levels when it regained commercial freedom in January 1925, as did her major trading partners.[13] These tariff levels were raised to previously unseen levels during the Great Depression 1929-1933, when governments tried to isolate their countries from the deflationary pressures of the world market. In addition, Germany and her eastern neighbours imposed quotas and exchange controls from 1931 onwards and hence created barriers along their borders that probably far exceeded the tariffs.[14] My first hypothesis is that external borders imposed a strong barrier to trade already prior to 1914, but increasingly so between 1925 and 1933.

We can assume that administrative borders within Germany mattered as well. The German Empire in 1871 was constitutionally a federal state based on a compromise between Prussian dominance and the attempt of other, medium-sized states to keep their autonomy. Many important policy tools remained in the hands of individual states such as large parts of the law, infrastructure policies (railways, canals, streets) and nearly all direct taxes. After World War I, the federal states retained most elements of their political independence in the Weimar Republic up to mid-1933. One can thus hypothesize that the old, historically inherited

[12] See Rogowski, *Commerce*.

[13] This is discussed in Liepmann, *Tariff Levels*, p. 60.

[14] See Liepmann, *Tariff Levels*, and also Ellis, *Exchange Control*.

state borders (such as the border between Prussia and Saxony) continued to play a role at least until 1933. Beyond this, internal administrative borders within these states (especially between the provinces within the huge territory of Prussia), may also have affected the pattern of domestic economic relations. Did other internal political or administrative structures matter? An older historiography in the tradition of Treitschke (1879) argued that the political unification of 1871 was the result of a long preparatory process and point to early attempts to create a body of German law or the German customs union (Zollverein) of 1834.[15] As shown by Shiue (2005) the Zollverein did contribute to economic integration of its members at least in the case of grain markets. Moreover, the Zollverein involved not just customs policy but also early monetary integration and infrastructure policies.[16] Given the typically high persistence of borders and institutions on trade, we can ask whether states that joined the Zollverein early were better integrated with each other than with late-comers in the 1880s and beyond.

A factor that runs counter to this intuition is Germany's geography. Most of the latecomers to the Zollverein were states in the north with direct access to sea-ports. These states were reluctant to join the Zollverein (and in the case of Hamburg and Bremen did so only in the 1880s), because they feared this would force them to adopt higher tariff-levels. While they joined the Zollverein much later, there is reason to assume that these states attracted large trade flows because of their geographical position. The main geographical features here are distance, resource endowments, the course of natural trade routes, and the pattern of lowlands in the north and uplands in the south.

[15] See Getz, *Die deutsche Rechtseinheit*.

[16] See Holtfrerich, "The monetary" for an analysis of monetary integration and Voigt, *Verkehr*, for a detailed description of infrastructure developments.

To start with, the location of trade districts relative to each other (matrix of distances between them) will have affected the pattern of trade flows between them. Most empirical studies that employed the gravity model have found that a 10% increase in distance reduces the volume of trade between two districts by about 9%, under the assumption that trade is log-linear in distance.[17] However, the assumption of a log-linear impact of distance on trade is very restrictive and should at least be tested. Several recent studies suggest that distance might affect trade in a non-linear way, for example when the cost-structure of different transport modes changes with distance or when small distance actually captures positive effects of agglomeration that decrease over distance.[18] My data-set will allow me to test for a non-linear effect of distance on trade flows and for differences between modes of transportation, especially waterways and railways. Next, we can explore whether the distinction between the northern lowlands and the central and southern uplands in terms of altitude mattered for trade, as recently argued by Puga and Nunn (2007) on the role of "ruggedness" for economic geography

Most navigable rivers and canals in Germany are part of two large systems.[19] In the west there is the Rhine with its tributaries Moselle, Neckar and Main but also the Ems (connected by the Dortmund-Ems canal in 1899) and Weser (connected by the Ems-Jade canal in 1888), which lead to the large north-sea ports of Rotterdam, Emden, Wilhelmshaven and Bremerhaven. In the east there is the large river system of Elbe and Oder with their main tributaries Spree, Netze, Warthe, and Neisse, which is connected to the Baltic ports Stettin, Lübeck and the north-sea port of Hamburg via various canals that were partly build already in

[17] Disdier and Head, "The puzzling persistence" provide an extensive survey over studies that use the gravity model to estimate the effect of distance on trade.

[18] See Hummles, "Towards a Geography" and Crafts, "The Death".

[19] De Martonne, *Europe Centrale*, is an early study on the effects of natural geography on Germany's economy.

the 17th century. The Danube and its tributaries form a third river system that essentially remained isolated from the big two until 1992 (!), because the Ludwigkanal that connected Main and Danube between Bamberg and Kehlheim in 1843 could not be used by larger ships. There was no waterway connection between the western and the eastern system prior to 1938, when the "Mittellandkanal" was extended to Magdeburg.[20]

Second, this geography of waterways is closely related to the geography of mineral resources in Germany and in Central Europe. The western river system connects to both the Ruhr and the Saar coal fields which produced more than three quarters of Imperial Germanys hard coal output, to the lower Rhineland, which yielded about 1/3 of Germany's brown coal, and to Lorraine which was the main source of Iron ores. Similarly, the east river system was linked to producers of non-ferrous metals in Upper Silesia, to sources of lignite around Leipzig and Halle, and to the rich salt resources in the Harz area are all linked to the eastern river system.[21]

My hypothesis is that this geographical structure gave rise to the emergence of broadly two economic areas in Germany that were not very well integrated with each other. Given the layout of waterways and resources, Thuringia, Saxony, Lübeck, Schleswig-Holstein and

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[20] The plan to build a waterway-connection that would link Rhine and North-Sea in the west to the Elbe and its tributaries in the east was object of an extremely heated debate in the German parliament, known as the debate about the "Kanalbauvorlage" (the government bill on a new canal). While the agrarian lobby fought against such an east-west canal, both to protect the east against cheap grain imports and to protect the Prussian railways against competition from waterways, the industrial lobby in the west was interested in gaining better access to the eastern parts of Germany. The canal was finally build and its first part up to Hannover completed in 1916. However, the canal was not completed before 1938, with the connection to the Elbe at Rothensee near Magdeburg.

[21] See Dickinson, *The Regions*.

Hamburg in the north should have been part of the "eastern" area, while Bavaria, Hesse, Hanover, and Bremen should have been part of the "western" area. It is of course possible that railways helped to connect east and west.[22] From 1847 onwards there existed a railway connection between Gleiwitz (Silesia) and Zwickau (Saxony), and also some indirect connection to the west. By 1885, when my data-set starts, the German railway network was nearly complete and not significantly improved afterwards.[23] However, it was still costly and cumbersome to transport bulky commodities such as coal, iron, and wheat over larger distances on railways. According to freight data by rail for around 1885 given by August Köttgen (1890, p. 64), the cost of shipping 1 ton of wheat by rail from Posen (238 km east of Berlin) to Cologne in the west, located about 706 km in the west of Posen, would have been about 33 Mark. By contrast, shipping the same ton of wheat first to the Baltic port of Stettin (190 km) and then by boat to Rotterdam would have come to only 21 Mark. Therefore, the arrival of railway connections between east and west did probably not fundamentally change this east-west pattern of the German economy for grain or other bulky commodities, particularly since grain shipped west had to compete with farm output from Westfalia, the Palatinate, Alsace, and Bavaria, which could be shipped there cheaply via both rail and waterways. The same holds for trade from west to east. In 1911, for example only 7.9 % of all coal consumed in Berlin came from the Ruhr, 24.4% from Britain, while the remaining two thirds originated either from Saxony or Silesia.[24]

One final barrier to trade was cultural heterogeneity of ethnic groups and more so heterogeneity in terms of religion. The German Empire of 1871 comprised territories with

[22] A recent study on the effect of railways on price dynamics in German grain markets before 1914 is Keller and Shiue, "Tariffs".

[23] See Fremdling, Federspiel, Kunz, *Statistik*.

[24] See the results in Fremdling, "Regionale Interdependenzen", table 9.

large population majorities with strong affiliations to France, respectively the remaining parts of Poland. The large literature on the effects of ethno-linguistic networks on trade suggests that both Alsace-Lorraine and the Polish East may have been less integrated into the Empire than other regions.[25] Similarly, Germany of 1871 was deeply divided between Catholic and Protestant regions, which followed in turn closely old political divisions within Germany. This was rooted in the specific character of the Holy Roman Empire of the German Nation (the "Old Empire") which existed from the Middle Ages through its dissolution in 1806.[26] Hence, in striking contrast to her European neighbours, a predominantly Catholic Bavaria coexisted with a Lutheran Saxony and a Calvinist Palatinate within the German Empire. Due to a serious conflict between the central power and the Protestants on the one hand side and the Catholic church on the other during the late 1870s and 1887 ("Kulturkampf") this internal border may well have been more visible in the 1880s than afterwards. How then did these three types of potential barriers, borders, geographical features and cultural differences affect the integration of German regions relative to their integration across the German state borders?

A theoretical and empirical framework to measuring fragmentation

Since the 1990s it has become a common approach to analyse the course of economic integration across political borders within the framework of a gravity model. Such a model relates trade flows between two economic areas (regions, countries) to the demand of the importer, the supply of the exporter, and to the geographical distance between them. It is a

[25] See Greif, "Contract Enforceability", Rauch, "Business and Social", Combes, Lafourcade and Mayer, "The Trade-creating Effects" on networks in trade relations and specifically Heinemeyer, Schulze and Wolf, "Endogeneous Borders", on the role of networks in Central European trade

[26] Von Aretin, *Das Alte Reich...*

helpful tool for explorative purposes because it usually fits the data very well while imposing only weak restrictions on the underlying economic structures. Several authors, including Redding and Venables (2004), Eaton and Kortum (2002), and Anderson and van Wincoop (2003) have shown that it is possible to derive a gravity formulation from competing models of trade with equally tight microfoundations. Here I will follow Anderson and van Wincoop (2004), since their model has by now become the standard in the literature. Define X_{ij}^{k} as the value of exports from area i to j in product k. Let Y_{i}^{k} be the value of production and E_{i}^{k} the value of expenditure in area i for product k. Y^k is the total output in sector k and trade costs are assumed to be symmetric ($t_{ij} = t_{ji}$). At any point in time, the basic gravity equation can be formulated as:[27]

(1) $$X_{ij}^{k} = \frac{E_{j}^{k} Y_{i}^{k}}{Y^{k}} \left(\frac{t_{ij}^{k}}{P_{j}^{k} P_{i}^{k}}\right)^{1-\sigma k},$$

where the price indices P^k_j and P^k_i can be solved as a function of the set $\{Y_{i}^{k}, E_{i}^{k}\}$, σ denotes the elasticity of substitution between varieties of product k, and t^k_{ij} is the markup associated with trade costs. The latter is one plus the tariff equivalent of trade barriers. Hence, given that we observe trade flows and given that we can control for production and consumption patterns, this structure allows us to make inference about all kind of trade barriers. For example, when two regions are separated by a political border involving direct (tariffs) or indirect (for example red-tape, waiting times, constraints imposed by exchange control) costs to cross that border, the model allows us to estimate the effect of all these costs on the volume of bilateral shipments. The approach is especially suited for applications to historical evidence, because it is not very demanding in terms of data. The model can be

[27] See Anderson and van Wincoop, “Trade Costs”, for details.

easily adjusted to account for data that is given in *metric tons instead of values*, which is often the case with historical sources on domestic trade.[28] In this case we are dealing with

(2a) $$X_{ij}^{k} = p_{i}^{k} t_{ij}^{k} Z_{ij}^{k}, \text{ and}$$

(2b) $$Z_{ij}^{k} = \frac{E_j^k Y_i^k}{Y^k} (t_{ij}^{k})^{-\sigma} (\frac{1}{P_j^k P_i^k})^{1-\sigma k} (p_i^k)^{-1},$$

where p^k_i is the f.o.b. price of product k at the origin, t^k_{ij} is again one plus the tariff equivalent of trade barriers between the exporting area i and the importer j and Z^k_{ij} is the volume of exports in metric quantities (tons). Note that when figures for values are lacking it is important to have data which is highly disaggregated in terms of commodity groups.

We also need to make some assumptions about the functional form of "trade costs". As usual in the literature, let us assume that trade costs are a function of transport costs that increase in distance between locations by some exponent (which is to be estimated), and the costs of crossing a border (dropping the product index k for simplicity):

(3) $$t_{ij} = dist_{ij}^{\gamma dist} border^{\gamma bordij}{}_{ij},$$

Where $border_{ij}$ is one plus the tariff equivalent of crossing a border and $\gamma_{bord,ij}$ is a dummy variable defined as

(4) $$\gamma bord_{ij} = \begin{cases} 1 \text{ if areas i, j are separated by at least one internal border,} \\ 0 \text{ else.} \end{cases}$$

[28] See Andersn and van Wincoop, "Trade Costs".

A negative and significant coefficient on such a dummy would give evidence of significant trade costs associated with crossing this internal border.

Below I will explore the effects of the three types of internal "borders" on trade flows as developed in the second section. Besides geographical distance, most of them can be constructed as simple dummies according to (4). The definition of administrative borders and early Zollverein membership (that is membership in 1834) is straightforward. Differences in altitude are calculated based on the main economic centers between any two pairs of trade districts. The natural geographic divide is simply modeled as a dummy that is one for all trade districts crossed by or situated east of the Elbe, Oder or one of their tributaries. This simple approach captures the fact that the Elbe linked one set of trade districts with each other and with the sea-ports of the Baltic and Hamburg, while all other trade districts were linked via the Rhine and tributaries to the North sea and the ports of Rotterdam, Emden and Bremen. It also reflects the two distinct big clusters of industry with supporting agricultural hinterland in Germany, which were divided along the same lines: the Ruhr area, with agricultural hinterlands in Westphalia, Bavaria and elsewhere on the one hand side; and Berlin, Saxony and Silesia, with the agricultural regions of Brandenburg, Mecklenburg, Posen, and Prussia on the other.

Finally, I measure ethno-linguistic and religious differences between any pair of trade districts via an index that varies between 0 and 1 based on language and religion statistics in 1885, 1910, 1925 and 1933. Denote by a_i^k the share of people in region i who declare that language k is their mother tongue. Similar to a Herfindahl-index we can then construct an index of *pair-wise* ethno-linguistic heterogeneity based on the (n=12) most commonly spoken languages in all of Central Europe:

(5a) $$Language_{ij} = \frac{1}{2}\sum_{k=1}^{n}\left(a_i^k - a_j^k\right)^2,$$

The index takes on values between 0 and 1. An index value of 0 would reflect a pair of regions that have identical shares in each language group; an index value close to 1 would reflect a pair of regions with no overlap in languages spoken.

In an identical way I constructed an index for religious heterogeneity, based on the (m=4) most common religious denominations, namely Roman Catholic, Protestant (lumping together all various protestant denominations), Russian Orthodox, and Jewish.

(5b) $$\mathrm{Re}ligion_{ij} = \frac{1}{2}\sum_{k=1}^{m}\left(b_i^k - b_j^k\right)^2.$$

Here, b_i^k denotes the share of people in region i who declare that religion k (Roman Catholic or Protestant, or Russian-orthodox or Jewish) is their faith.

There are several ways to estimate the theoretical gravity equation (2b). First, one can use non-linear least squares to estimate the structural equation under the restrictions imposed by the functional forms of the price-indices as suggested by Anderson and van Wincoop (2003). Alternatively, one can use data on price-levels, production, and consumption and estimate with OLS. However, this kind of data is often unavailable, and even more so in a historical context. Therefore, I have chosen a third approach that delivers unbiased estimates of trade costs with minimal data requirements. This approach is to replace the unobservable price-indices and production and consumption variables with a set of area- and time-specific dummies and then estimate the system with a Poisson pseudo-maximum-likelihood (PPML) estimator as suggested by Santos Silva and Tenreyro (2006). The equation to be estimated is then (dropping again the time index for simplicity):

(6) $$Z_{ij}^{k} = A_i^k A_j^k (t_{ij}^{k})^{-\sigma} \text{ where}$$

$$A_i^k = \frac{Y_i^k}{Y^k}(\frac{1}{P_i^k})^{1-\sigma k} (p_i^k)^{-1} \quad \textit{and} \quad A_j^k = E_j^k(\frac{1}{P_j^k})^{1-\sigma k}.$$

I thus include a set of time-varying importer and exporter dummies, one for each area and specific for each class of products k and different for every point in time. These dummies take into acount not only differences in local purchasing power and production into account but all variation that is specific to a particular location and time but not to a bilateral pairing of locations. Such differences can include the endowment in local minerals or other resources, a locality's productivity advantage, and a change in the size of a location due to shifting borders. In principle, equation (6) could be estimated with simple OLS by taking logs of both sides. However, Santos Silva and Tenreyro (2006) caution such an approach leads to biased estimates (unless very specific assumptions are met) due to two basic problems. First, the expected value of a log-transformed random variable does not only depend on the mean of the random variable but also on its higher moments. Given this, heteroskedasticity of the error term in the stochastic formulation of the model would result in an inefficient, biased and inconsistent estimator. Santos Silva and Tenreyro (2006) demonstrate the magnitude of this inconsistency and recommend estimating the gravity model in its multiplicative form to avoid this problem. Second - and crucial when dealing with disaggregated data - the approach circumvents as well the problem of zero observations of the left hand side of equation (6), because the log of zero is not defined. The appearance of zero observations may be due to errors or thresholds in reporting trade, or because bilateral trade is actually zero. The occurrence of zero trade is usually correlated with the covariates, hence neglecting zero trade results in a systematic bias. Santos Silva and Tenreyro (2006) propose a pseudo Poisson maximum-likelihood (PPML) estimator, which is "consistent and reasonably efficient under a wide range of heteroskedasticity patterns [...]" (p.645), a crucial feature in the context of spatial aggregation.[29] In this approach, trade flows are entered in levels, while all regressors enter in natural logarithms. I use this PPML estimator in my following analysis.

Main features of the data

My analysis of Germany's economic integration is based on a large and newly compiled dataset on domestic trade flows between all parts of Imperial Germany in her 1871 borders and her neighbours for four benchmark years 1885, 1913, 1925 and 1933. The data is disaggregated for trade on railways and waterways and exists for about 200 groups of commodities. It was annually published from 1885 onwards, first only for trade on railways, and from 1913 onwards for trade on waterways as well. I chose 1885 and 1913 as the first and last available years for the pre-war period. 1925 can be seen as the first year after the First World War with stable economic conditions (the stabilisation of the German currency, the end of the Ruhrkampf, a first settlement of the reparation question and a temporary settlement of various border disputes) when Germany finally regained commercial freedom after the limitations imposed by the Treaty of Versailles. The year 1933 was chosen as the end of the

[29] An alternative approach would be to follow Helpman, Melitz, Rubinstein, "Estimating Trade Flows", and to estimate a two-stage model where first the probability to export at all is estimated and next trade costs conditional on non-zero trade. This has the advantage to distinguish systematically between trade growth along the extensive margin (trade or no trade) and the instensive margin (the volume of trade). However, this distinction is not crucial in our context and it comes at a costs: the variables used to estimate the first stage (in their example religion) can obviously not be identified in the second. Moreover, their framework can also not deal with the possibly large bias that is introduced by the log-transformation of the dependent variable.

Great Depression in Germany, and the last year to reflect the economic situation of the Weimar Republic, prior to a massive centralisation of the federal states (January 1934) and the beginning of the large-scale reorganisation of industrial capacities in preparation of the war (mainly 1936).

In the original source data, Germany was split into 36 domestic trade districts, which closely followed the old administrative borders of the member states, although there was some aggregation of the very minor ones. In most cases the borders of these districts followed the state borders (for example Bavaria, or Alsace and Lorraine), or the district borders of Prussia. Notably, the data include internal trade within each trade district, and it distinguishes bilateral trade from transit flows that merely pass through the district. In the following, when I discuss export shipments between districts, I will always exclude transits flows to avoid double counting. Due to several adjustments of the shape of these districts over time (some districts were split like Bavaria into two, some minor ones were grouped together with others like Leipzig city into Saxony) the districts have to be consolidated over time. This gives a total 21 domestic and further 13 foreign consolidated trade districts (CTDs). Map 1 shows the consolidated trade districts for the period 1883-1913. The district borders make it possible to track the potential fault-lines of fragmentation over time.

[Map 1 about here]

After World War I, the statistics continued even for Alsace and Lorraine, which – remarkably – were still treated as trade districts separate from France. The only difference was that they were treated as foreign districts. Similarly, the now Polish regions of West Prussia and Posen were aggregated into a district called “West-Poland”, given a new number, but kept separate from the rest of Poland. Fortunately for the question of this paper, this allows me to analyze the effects of new political borders on trade flows. Some other territorial changes, however, are more difficult to take into account, because the new borders split old trade districts in a way that the matrix of trade relations between them and all others before and after the war are not fully comparable. This is the case for Upper Silesia, where the most heavily industrialized parts went to Poland after the public vote of 1921, and Schleswig, where the northern part was after 1919 returned to the state of Denmark. Fortunately, the time- and commodity-specific location dummies included in the estimation allow me also to control for such changes in the shape of a district. Map 2 gives the consolidated traffic districts after 1921. With the mentioned exceptions, the post-war districts are identical to the pre-war districts.

[Map 2 about here]

The data were disaggregated into very fine subcategories of goods as in the German foreign trade statistics, but the disaggregation varied over time. For example, hard coal was sometimes separated into raw coal, cokes, and briquets, sometimes not. Fortunately, the changes over time are minor, but some consolidation of the data was necessary to ensure comparability. Here, I explore trade flows for six selected groups of commodities (some of them aggregated from several others), which account for more than 50% of the total volume of goods transported on railways and waterways. I analyze the matrix of bilateral trade flows for these 6 groups based on the consolidated trade districts (see Maps 1 and 2) for the years 1885, 1913, 1925, and 1933, and for the two modes of transport, railways and waterways. The data cover a total of 21 domestic and 13 foreign consolidated trade districts. Since trade on waterways is not available for 1885, I end up with a total of 48,552 observations, obviously many of them zero-observations. If I exclude cases of missing observations, which mostly reflect the lack of disaggregate trade data for trade flows between pairs of foreign districts, there is a total of 39,970 data points in the sample.

Was Germany ever united? Empirical Results for 1885 – 1933

The main empirical results are organised in five tables. Let us start by ignoring the existence of a German state border altogether but simply treat the outer border of Germany as another administrative border, just like the border between, say, Saxony and Prussia. Initially, I also assume that distance enters in the usual log-linear way and add to this a constant, controls for a natural geographical divide between east and west, and controls for differences in altitude, religion, and languages spoken. I first pool over time, goods, and modes of transportation (railways and waterways); later, each of these dimensions will be dealt with separately. Note that wherever I pool over goods, the good-specific trade flows are weighted by their unit values, which I took from the German foreign trade statistics.[30] In all pooled estimations I always add a full set of dummies for time, goods and mode of transportation.[31]

Consider table 1, model I. The overall fit of the model is good with an adjusted R2 of 0.5. The estimated coefficient on distance is above unity, higher than in most empirical studies on aggregate trade flows as shown in Disdier and Head (2008). This might stem from

[30] Because I always include location, good and time-specific dummies to the estimation this procedure for pooled estimations over groups of goods implicitly assumes that the price indices of the six groups under consideration can differ at any location, but that these location-specific differences are proportional across goods.

[31] I repeated all estimations with Tobit and Scaled OLS. These approaches typically fitted the data similarly well, and all main empirical results were qualitatively robust to the use of these estimators. However, the estimated coefficients on trade costs tended to be much lower than the ones estimated with PPML. This reflects the fact that these approaches do not fully account for the information contained in zero-observations and hence underestimate the true trade costs.

transport costs that were relatively high by modern standards. The effect of administrative borders is negative and highly significant. In addition, there is a very large negative impact of language differences on trade. We will have to explore whether this simply reflects the role of external borders (roughly following ethno-linguistic heterogeneity) on trade via tariffs, currencies or quotas, or not. Religious differences however, apparently did not matter much, but there is strong evidence for a natural barrier to trade between eastern and western trade districts, whether they are located within Germany or not. Finally, differences in altitude did affect trade, but with a positive sign. One plausible interpretation would be that this again reflects the geographical east-west divide with a strong integration of both the western uplands and the western lowlands and of the central and eastern uplands and lowlands.

Before we now explore whether the external border of Germany mattered and whether there were differences over time and among goods and modes of transportation, let us relax the strict assumption about distance. Several recent studies have shown that assumptions about distance directly affect the estimation of border effects.[32] Given the huge variation in the sample with respect to distance (with a minimum distance of 24.9 km, a maximum of 2500km and a median of 579km) we can relax the assumption of linearity and test for a non-linear impact of distance on trade. In table 1, column 2, I approximate the underlying distance function allowing for stepwise breaks above the median distance (50% of all observations), above 1000km (18%) and above 1500km (5%). Note that these distance variables are defined additively, hence the effect of distances above the median is the basic distance effect plus the effect of above-median distances. Table 1, model II shows that there is strong evidence that trade is convex in distance rather than (log-) linear: the coefficient of distance on trade increases (in absolute terms) in distance, especially above the median distance. This has obviously an effect on the estimation of any other trade frictions that vary systematically in

[32] See for example Nitsch, “It’s not right”, and Hummels, “Towards a Geography”.

distance (borders, cultural heterogeneity, and altitude), so I will take this into account in all following estimations.

In table 1, model III, we can now test, whether the German external border mattered at all, again pooling over the various dimensions in the data. Not surprisingly, the external borders mattered a lot: two districts that are both part of Germany at a given point in time trade more with each other than with districts outside Germany. Yet there is still a negative and significant effect of administrative borders on trade. Together, this means that any two districts within Germany that were separated by an internal state border (such as Saxony and the Prussian province of Brandenburg) traded less with each other than two districts within the same state (Brandenburg and Pomerania) but more than with a district outside of Germany (Saxony and the Kingdom of Poland). Interestingly, the effect of language on trade is not significant after controlling for the external border. Other lines of fragmentation are still visible and nearly unchanged, especially the effect of natural geography.

In the introduction I have defined economic integration of a specific area as a situation where trade costs within the boundaries of that area, for example Germany in the borders of 1913, are significantly below trade costs across the area's boundaries. As argued above, trade costs are a function of political and administrative boundaries, as well as geographical and cultural differences between districts. Let us therefore explore whether the estimated frictions from geography and culture had different effects on trade within Germany. For example, we do not know whether religious differences between Bavaria and Prussia mattered for trade in the same way as religious differences between Bavaria and Sweden. Similarly, the effect of natural geography on trade between east and west may have been different between the Ruhr and Brandenburg and the Ruhr and the Kingdom of Poland. Quite possibly, such effects were more limited within nation states than between states, due for example to infrastructure policies. In a next step, I consider the entire sample of trade flows across Central Europe but test whether the various trade barriers affected trade within Germany differently compared to trade across the German borders simply by interacting these effects with the external border dummy. Table 1, model IV gives the results. Clearly, the coefficients on geographical barriers for trading partners within Germany were significantly different from those for trading partners on opposite sides of the German border, while those on cultural barriers were not., Religion mattered generally, without significant differences within or across German borders. In turn, language barriers may have had different effects on trade within or across German borders, but the coefficients are not significant . We will have to explore whether this changes over time, especially before and after the war. There is also clear evidence for a natural barrier to trade visible across the entire sample and also within Germany. However, the effect within Germany is much more limited. The overall coefficient is estimated at -1.56 (0.19), while the effect within Germany is -0.86 (= -1.56+0.70). There is virtually no (net-) effect of differences in altitude on trade within Germany.

To what extent do these results suggest that Germany was "united", or economically integrated at least on average over the period 1885-1933, within her respective borders? Clearly, districts within Germany were better integrated than districts on opposite sides of the border, but the degree of internal fragmentation was quite considerable. While the evidence in table 1, models III and IV shows this, we can see it more directly if we restrict the sample to those districts that were part of the German Empire in 1913 (table 1, model V). Here, intra-German administrative borders have nearly the same negative effect on trade as in table 1, model IV above. Also, we see again that the coefficient on the natural geographical divide within Germany is -0.88 (0.09), nearly identical to the -0.86 implied by table 1 (model IV). A notable difference in model V is that the negative effect of language heterogeneity is now significant, but not that of religion. In table 1 (model VI) I repeat the analysis with a control for possible long-run effects of the Zollverein. Did states that joined the Zollverein early (in 1834) continue to be better integrated 50 years after? If so, we would expect a positive sign on the estimated coefficient of Zollverein membership. However, the estimated coefficient has a negative sign and is strongly significant. Controlling for Zollverein membership simultaneously reduces the estimated effect of natural geography, but also reduces some of the effect of administrative borders (because membership is defined along these borders). A negative effect of early Zollverein membership for future integration does not make much sense. Instead, the coefficients of the other variables suggest that the Zollverein dummy captures something different namely the very clear north-south geography of Zollverein membership. I therefore drop the Zollverein dummy for the remaining analysis, because the effect is more directly captured by the various geography variables.

A convenient way to illustrate the effect of internal "borders" on Germany's domestic trade is to calculate their implied tariff equivalents: what tariff would impose the same barrier to trade as the barrier imposed by, say differences in language between two German trade districts? To calculate the tariff equivalents, note that according to (6) the estimated coefficient β from a PPML estimator for any border is $\beta = -\sigma \ln(t_{ij})$. Because we assumed that t^k_{ij} - the markup associated with trade costs - is given by one plus the tariff equivalent of trade barriers the tariff-equivalent of any border can be calculated as $\exp(\frac{\beta}{-\sigma}) - 1$.[33] Apparently, we need to make some assumptions about σ, the elasticity of substitution between varieties of product k to express the effects of trade barriers in terms of tariff equivalents. If we assume an average elasticity of substitution of $\sigma = 5$, which is a typical value taken in the literature we can calculate the total tariff-equivalent of all these internal barriers and that of all

[33] See equation (3) above. In the PPML estimator, all *regressors* are included in natural logarithms, see Santos Silva and Tenreyor, "Log of Gravity". See also Anderson and van Wincoop, "Trade Costs".

external barriers.[34] We can base this calculation on table 1 (model IV), which contains estimates of both internal and external barriers that are directly comparable. According to this, the tariff equivalent of crossing all internal barriers amounts on average over the period 1885-1933 to about 38%, without taking the frictions into account that are implied by geographical distance. This compares to a tariff-equivalent of 114% on average over the period 1885-1933 implied by crossing the external border.[35]

Internal integration did seem to improve over time, especially after 1918 because of trade policy and due to border changes that reduced cultural heterogeneity. In table 2 (models I and II), I repeat the estimation from table 1 (models III and IV), but now distinguish between the pre-war and post-war period. The most striking result of this exercise is that

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[34] Note that we assume that elasticities of substitution remain constant over time. Broda and Weinstein, "Globalization", estimated elasticities of substitution for the US over the period 1972 and 2001 and find some changes over time. However, most of these changes are due to changes in the composition of trade. For the goods that closely correspond to the ones in our sample, these changes are quite small, for example for unmilled oats (SITC 4 digit category 4520) they estimate for 1978-1988 an elasticity of about 5.2, for 1990-2001 and elasticity of 5.0). Similarly, Evans, "The Economic Significance", estimated an elasticity of substitution for agricultural products of 4.63.

[35] The tariff equivalent of all internal barriers to trade is calculated as the product of tariff equivalents of all relevant barriers, each calculated as $\exp(\beta/-5)-1$. Coefficients that are estimated to be not significantly different from zero at the 10% level are included as zero. Given this the tariff equivalent of administrative borders is $\exp(-0.329/-5)-1 = 0.0068 = 6.8\%$. The tariff equivalent of religious heterogeneity is 9.1%, that of language heterogeneity is nil, that of the natural east-west barriers over the entire sample is 36.5%, that of the intra-German east-west barrier after controlling for the former east-west barrier is -13.1%, that of differences in altitude over the entire sample is -2.7%, that of differences in altitude within Germany after controlling for the former is 2.6%. This implies a total ad-valorem tariff equivalent of internal frictions of $(1.068)*(1.091)*(1.365)*(0.869)*(0.973)*(1.026) = 1.38 = 38\%$. Correspondingly, the total tariff equivalent of frictions related to crossing the external border is 114%.

before 1914 German trade districts were - if anything - only slightly better integrated with each other than with trade districts across the German border. When we just estimate the effect of two districts being part of Germany as opposed to one being outside Germany, that border effect is not different from zero before 1914: it is insignificant at any reasonable level. Similarly, if we allow for differences in the effect of cultural heterogeneity and geography within and across Germany's borders as in table 1, model IV we again find that integration within Germany was only slightly better than across the borders of Imperial Germany (table 2, model II).[36]

A different way to make this point is to restrict the sample to those districts that were part of the German Empire in 1913 (!), and to estimate the effect of all lines of "internal" fragmentations on trade over time (table 2, model III). The result is evidence for improved internal integration of Germany. The effect of internal administrative borders on trade, for example between Prussia and Saxony, is significantly higher before 1914 than thereafter (a Wald-coefficient test rejects the null of no differences at the 5% level). Also, language heterogeneity and the geographical divide matter much more before the war than afterwards, while there is some (weakly significant but) visible effect of religion after the war.[37] The effect of distance on trade remains virtually unchanged. How much did integration improve? Assuming again an elasticity of substitution of $\sigma = 5$, the tariff equivalent of crossing all these internal borders over the period 1885-1913 is about 82%, compared to 34% after the war.

[36] When we distinguish between 1885 and 1913, we see that intra-German integration improved over time, but that the impact of the external border is still insignificant in 1913 after controlling for administrative borders, geography and cultural heterogeneity. This result is robust to many variations in the econometric specification.

[37] To interpret the effect of religion after the war note that Alsace-Lorraine and West-Poland are in this regression still part of the sample and both regions have strong catholic majorities.

The estimated effects of the external border in table 2 (models I and II) suggest that rising barriers at Germany's external borders after 1913 may have diverted cross-border trade into the domestic market.[38] It would be beyond the scope of this paper (but certainly worthwhile) to explore the mechanisms that triggered this change in more detail. But to what extent was it a consequence of the war and the following border changes and to what extent was it the effect of the Great Depression? In table 2 (model IV) I distinguish between 1925 - a "normal" year during the interwar period - and 1933, when all the trade barriers imposed in the wake of the great depression were in operation. If we now again calculate the implied total tariff equivalents for the two years in the interwar period, we find that they amount to 39% in 1925 and to just 16% in 1933. In other words, domestic integration improved from 82% to 39% or by about 40 percentage points between the beginning and the end of the World War I, and from 39% to 16% or another 25 percentage points with the Great Depression. International disintegration apparently fostered domestic integration.

One might expect that the internal lines of fragmentation would affect each good and mode of transportation in a different way, especially if geography is taken into account. Table 3, model I therefore restrict the sample to trade on railways only. Compared to the entire sample (within German borders, table 2, model III) there are two key differences. First, the effect of distance is apparently slightly higher for railways than for waterways, both before and after the war. This confirms the argument from Köttgen (1890) on differences in shipment tariffs between railways and waterways, but also the fact that average trade distance on

[38] Another issue that is raised by these results is whether the border changes in the wake of the Versailles treaty had actually a "treatment effect" on trade, given the low level of integration prior to the war along ethno-linguistic lines. I explore this aspect in a companion paper and indeed find that the treatment effect was very weak, see Heinemeyer, Schulze and Wolf, "Endogenous Borders".

railways was below that on waterways.[39] Second, the effect of the natural geographical divide is much lower on railways, especially after the war. This is exactly what we would expect. The system of natural waterways, extended by canals, shaped the economic geography of Germany into an eastern and an western economic region. The advent of railways did initially little to change this because railways followed the existing structure of industrial geography, however railways eventually helped to overcome the east-west divide.[40]

In table 3 (regressions II-VII), I estimate all effects separately for the six different groups of commodities and allow again for changes in coefficients over time. To start with, the overall fit is now better than before, with adjusted R2 typically above 0.80. There are some significant differences between commodities, but the overall picture remains unchanged: integration improved over time. The effect of distance varies roughly in line with the unit value of commodities: geographical distance is less of a barrier to trade in goods with high value per ton, such as paper, chemicals or iron and steel products. Internal state borders have by far the biggest impact on hardcoal, followed by iron and steel products and chemicals, but there is no significant impact on trade in lignite, paper or rye. In contrast, the effect of a natural geographical divide is visible for all commodity groups (except for lignite, where the result is insignificant). Most of these internal trade barriers decline over time or changes are insignificant (based on Wald-test on the coefficients). If we use commodity specific elasticities of substitution based on the estimates of Broda and Weinstein (2006), we can calculate more "fine-tuned" measures of commodity-specific tariff equivalents for German domestic trade (in 1913 borders), before and after the war. Table 4 gives the results. The largest increase in domestic integration is visible for coal and iron and steel products.

[39] For a good exposition of the factors behind this in the context of German domestic trade see Felix Napp-Zinn, *Binnenschiffahrt*.

[40] See Frank, *Regionale Entwicklungsdisparitaeten*.

There is some increase in domestic integration for rye and chemical products but a decrease for paper products. We can expect that this broad trend towards better domestic integration was strengthened by the autarky policies of the Nazi government and the further isolation of Germany from international markets.

All previous estimates for intra-German trade apply to Germany within the borders of 1913 and treat Alsace-Lorraine and West Prussia/ Posen de facto as parts of Germany even after the First World War. While this is not correct historically (and politically), it is also not justified by the development of economic integration, because these regions were poorly integrated into the rest of Germany before 1914.[41] Let us therefore explore some counterfactual borders. What are – or were - the actual economic borders of Germany? Table 5, models I, II and III approach this question by estimating integration across the various lines of internal fragmentation within different borders. First, I focus on those regions that were part of the Weimar Republic and estimate integration before and after the war[42]. Second, I restrict attention to those regions that are part of Germany in the borders of 1990[43] How did integration evolve within these borders? For example, was Germany by 1933 united within the borders of 1990, but maybe not in those of 1933? Table 5 (model I) repeats the evidence from table 2 (model III) to simplify comparison. In table 5 (model II), we see that a Germany with the borders of the Weimar Republic would have been more integrated before 1914 than the German Empire, because trade would not encounter ethno-linguistic frictions in Alsace-Lorraine and West-Poland. The impact of administrative barriers of trade within Germany is nearly identical if we consider the borders of the Weimar Republic or Imperial Germany and

[41] See Schulze and Wolf, "On the Origins" and Heinemeyer, Schulze and Wolf, "Endogenous Borders".

[42] That is, we restrict the sample to the districts 1a – 21, excluding 1b, 6, and 16 on maps 1 and 2.

[43] Here we restrict the sample to districts 3-21, except 6, 7, 8, and 16, ignoring some adjustments of district 9, see maps 1 and 2.

the same holds for the effect of natural geography. The tariff equivalent of all trade barriers before to the war was 36% with the borders of the Weimar Republic (compared to 82% within the borders of 1913), and 21% after the war (compared to 34% with the borders of 1913). Table 5 (model III) shows the results for trade frictions within the borders of Germany today (1990). The key difference again is the absence of frictions from language heterogeneity. Within the current German borders, the total tariff equivalent of internal trade barriers amounts to 34% before the war and 16% after the war. Note that we always find a negative and statistically significant effect of a natural trade barrier east and west of the Elbe, whether we look at Germany in the borders of 1913, 1925 or 1990. And it is always nearly identical: the tariff-equivalent of this effect alone declines from about 25% prior to the war to some 16% after the war, but it still is present, and statistically highly significant.

That the east-west divide is there still in 1933 is important, because this natural barrier runs very closely along the future Iron Curtain, separating the Federal Republic of Germany (FRG) from the German Democratic Republic (GDR). So, was the division of Germany after the Second World War not exogenous, not unpredictable from Germany's economic geography after all? Such an interpretation would probably stretch the evidence too far, and it would be misleading. The internal east-west barrier diminished between 1885 and 1933, and there is every reason to assume that east-west integration continued between 1933 and 1939, in part because of the autarky policies that Germany pursued after 1933 and because of efforts to create a capable armament industry with a geographical centre just in the middle of the estimated east-west divide.[44] Given these efforts, the nearly impregnable border between east and west that existed between about 1946 and 1989, was hardly predictable in 1939. We can safely assume that by the end of the Weimar Republic in 1933 Germany was an economically well integrated area.

[44] This is supported by evidence in Sleifer, *Planning Ahead*.

Conclusion

This paper has asked when and to what extent Germany was ever united as measured by the geography of trade costs. I collected a new and detailed data-set on trade flows between 34 Central European trade districts, including 21 within the territory of the German Empire in 1913. The data were broken down for six groups of commodities and for railways and waterways as modes of transportation (40,000 observations over 1885 – 1933). When analyzed with a gravity model, the data show that by the end of the Weimar Republic in 1933 Germany was economically integrated. But it was not well integrated before World War I, when trade districts within Germany were no better integrated than districts on opposite sides of the borders. Put differently, there were some strikingly high trade barriers within Germany's borders before 1914, both in absolute terms and relative to trade barriers across the external border. These internal barriers had their origins in the German administration, in geographical obstacles to trade and in cultural heterogeneity measured in terms of religion and mother-tongues. Before World War I, West-Prussia and Posen and Alsace and Lorraine were poorly integrated into the German Empire. There was a strong effect from a natural geographical divide between east and west, which reflected the two large systems of waterways and natural resource endowments. That is important, because the divide paralleled the Iron Curtain. But the effect of this divide diminished between 1885 and 1933, and probably further after 1933. The nearly impregnable border between east and west that existed between about 1946 and 1989, was therefore hardly predictable in 1939. We can safely assume that by the end of the Weimar Republic in 1933, Germany was an economically well integrated area.

The geography of trade costs suggests that Germany was “united” by 1933, but not before 1914. It took more than a generation to integrate the German Empire. Future research on the German Empire before 1914 should take this fact into account. Internal integration progressed after 1914 while Germany’s ties to foreign markets weakened. It would be worthwhile exploring what the relationship was between internal integration and external disintegration in the interwar years, and how the situation changed after 1945. The data to do this are in principle available.

Appendix: Statistical Source

Königlich-Preußisches Ministerium der öffentlichen Arbeiten. *Statistik der Güterbewegung auf Deutschen Eisenbahnen im Jahre 1885*, Berlin, 1886.

Kaiserliches Statistisches Amt. *Statistik der Güterbewegung auf Deutschen Eisenbahnen im Jahre 1913*, Berlin, 1914.

Statistisches Reichsamt. *Die Güterbewegung auf Deutschen Eisenbahnen im Jahre 1925*, Berlin 1926.

Statistisches Reichsamt. *Die Güterbewegung auf Deutschen Eisenbahnen im Jahre 1933*, Berlin 1934.

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Statistisches Reichsamt. *Verkehr auf Deutschen Binnenwasserstrassen im Jahre 1925*, Berlin 1926, Reedition as *Statistik des Deutschen Reichs, Volume 326*, Osnabrück, 1977..

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Table 1: In search for "Germany". All Trade Flows, 1885-1933[45]

	All Trade Districts in Central Europe				Trade Districts within German Empire (borders of 1913)	
	1.I	1.II	1.III	1.IV	1.V	1.VI
Constant	**19.763** (37.030)	**19.335** (36.383)	**18.981** (34.697)	**18.097** (25.782)	**19.730** (27.529)	**21.714** (29.399)
German border[46]	-	-	**-0.725** (2.485)	**-1.613** (3.073)	-	-
Administrative borders[47]	**-0.282** (-4.035)	**-0.372** (-5.358)	**-0.348** (-4.956)	**-0.329** (-4.489)	**-0.307** (-3.429)	**-0.221** (-2.501)
In Zollverein34[48]	-	-	-	-	-	**-1.266** (-7.811)
Language Differences	**-0.766** (-4.954)	**-0.641** (-4.181)	-0.240 (-1.083)	0.354 (0.784)	-	-
Language Differences * In Germany[49]	-	-	-	-0.645 (-1.147)	**-0.700** (-1.862)	-0.372 (-1.007)
Religious Differences	0.045 (0.366)	-0.089 (-0.731)	-0.170 (-1.342)	**-0.436** (-1.750)	-	-
Religious Differences *	-	-	-	0.288 (0.985)	-0.144 (-0.794)	-0.199 (-1.151)

45 All results are based on the PPML estimator. The dependent variable is bilateral exports between trade districts, z-stat are given in parentheses. I use Robust Standard Errors and Covariances. Bold letters indicate significance at 10% or better.

46 German border means a dummy variable that is one if one trade districts is part of the German Empire in the borders of 1913 but the other is not and it is zero else.

47 Administrative border means a dummy variable that is one if both trade districts are separated by an administrative border (within Germany or not) and zero else.

48 In Zollverein 34 means a dummy variable that is one if both trade districts are part of the Zollverein in 1834 and zero else.

49 In Germany is a dummy that is one whenever both trade districts are part of the German Empire and zero else.

In Germany						
Natural East West Divide	**-1.064** (-15.122)	**-0.953** (-13.533)	**-0.937** (-13.290)	**-1.557** (-8.081)	-	-
Natural East West Divide * In Germany	-	-	-	**0.703** (3.461)	**-0.877** (-9.655)	**-0.792** (-9.036)
Altitude Differences	**0.035** (2.019)	0.024 (1.393)	0.018 (1.060)	**0.137** (2.748)	-	-
Altitude Differences * In Germany	-	-	-	**-0.127** (-2.483)	-0.021 (-0.959)	**-0.048** (-2.202)
Log(distance)	**-1.603** (-30.495)	**-1.473** (-27.544)	**-1.467** (-27.415)	**-1.470** (-27.061)	**-1.341** (-18.922)	**-1.481** (-20.663)
Log(distance above median)	-	**-0.186** (-7.865)	**-0.188** (-7.888)	**-0.183** (-7.536)	**-0.179** (-4.808)	**-0.176** (-4.872)
Controls at 1000, 1500[50]	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying Imp and Exp Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time/ commodity/ transport Dummies	Yes	Yes	Yes	Yes	Yes	Yes

[50] Distance above median and Controls at 1000 and 1500 means that the distance variable is interacted with a dummy that is one if distance is above a certain threshold (the median distance, 1000km or 1500km) to allow for nonlinear distance effects. Therefore, the effect of a distance of, say, 1800km is the effect of log(distance), plus the effect of log(distance above median) plus the effect of the controls at 1000km and 1500km.

Adj R2 (LR-index)	0.503 (0.767)	0.503 (0.770)	0.504 (0.770)	0.504 (0.770)	0.529 (0.770)	0.529 (0.770)
No. of Obs.	39970	39970	39970	39970	18422	18422

Table 2: Towards Unification? All Trade Flows, 1885-1933[51].

	Sub-Period	All Trade Districts in Central Europe		Trade Districts within German Empire (borders of 1913)	
		2.I	2.II	2.III	2.IV
Constant		**19.039** (28.120)	**17.793** (19.128)	**19.769** (24.304)	**19.769** (24.457)
German border	1885-1913	0.248 (-0.591)	-1.168 (1.532)	-	-
	1925-1933	**-1.460** (3.632)	**-2.261** (2.876)	-	-
Administrative borders	1885-1913	**-0.536** (-5.006)	**-0.455** (-4.084)	**-0.392** (-2.837)	**-0.392** (-2.855)
	1925-1933	**-0.226** (-2.395)	**-0.247** (-2.494)	**-0.248** (-2.129)	-
	1925	-	-	-	**-0.262** (-1.856)
	1933	-	-	-	-0.237 (-1.165)
Language Differences	1885-1913	**-0.678** (-2.133)	0.236 (0.363)	-	-
	1925-1933	0.079 (0.244)	0.595 (0.850)	-	-

[51] All results are based on the PPML estimator. The dependent variable is bilateral exports between trade districts, z-stat are given in parentheses. Robust Standard Errors and Covariance, bold letters indicate significance at 10% or better.

Language Differences * In Germany	1885-1913	-	-1.196 (-1.488)	**-1.466** (-2.631)	**-1.466** (-2.648)
	1925-1933	-	-0.454 (-0.526)	-0.152 (-0.304)	-
	1925	-	-	-	-0.140 (-0.241)
	1933	-	-	-	0.215 (0.213)
Religious Differences	1885-1913	-0.008 (-0.039)	**-0.883** (-2.466)	-	-
	1925-1933	**-0.279** (-1.667)	-0.004 (-0.011)	-	-
Religious Differences * In Germany	1885-1913	-	**1.256** (2.888)	0.453 (1.508)	0.453 (1.517)
	1925-1933	-	-0.451 (-1.102)	-0.485 (-1.645)	-
	1925	-	-	-	**-0.682** (-2.473)
	1933	-	-	-	-0.012 (-0.031)

Table 2 (continued)

Natural East West Divide	1885-1913	**-1.110** (-9.580)	**-1.222** (-4.186)	-	-
	1925-1933	**-0.807** (-8.920)	**-1.764** (-6.631)	-	-
Natural East West Divide * In Germany	1885-1913	-	0.034 (0.108)	**-1.127** (-7.319)	**-1.127** (-7.366)
	1925-1933	-	**1.126** (4.059)	**-0.725** (-6.452)	-
	1925	-	-	-	**-0.722** (-5.363)
	1933	-	-	-	**-0.754** (-3.746)
Altitude Differences	1885-1913	0.043 (1.576)	**0.243** (2.989)	-	-
	1925-1933	0.006 (0.278)	0.083 (1.295)	-	-
Altitude Differences * In Germany	1885-1913	-	**-0.222** (-2.657)	-0.007 (-0.207)	-0.007 (-0.208)
	1925-1933	-	-0.081 (-1.223)	-0.031 (-1.107)	-
	1925	-	-	-	-0.053 (-1.541)
	1933	-	-	-	0.012 (0.236)
Log(distance)	1885-1913	**-1.336** (-16.445)	**-1.364** (-16.484)	**-1.356** (-12.350)	**-1.356** (-12.427)
	1925-1933	**-1.569** (-21.768)	**-1.547** (-21.089)	**-1.330** (-14.479)	-
	1925	-	-	-	**-1.259** (-11.305)
	1933	-	-	-	**-1.472** (-9.187)
Log(distance above median)	1885-1913	**-0.229** (-6.029)	**-0.229** (-5.766)	**-0.220** (-3.231)	**-0.220** (-3.251)
	1925-1933	**-0.159** (-5.157)	**-0.156** (-4.931)	**-0.158** (-3.549)	-

	1925	-	-	-	**-0.150** (-2.871)
	1933	-	-	-	**-0.184** (-2.168)
Var. Imp/ Exp Dummies	Yes	Yes	Yes	Yes	Yes
Time/ comm./ transport	Yes	Yes	Yes	Yes	Yes
Adj R2 (LR-index)	0.505 (0.770)	0.506 (0.771)	0.506 (0.771)	0.530 (0.767)	0.530 (0.768)
No. of Obs.	39970	39970	18422	18422	18422

Table 3: Differences across modes of transport and commodity groups, Trade districts within Germany, 1885-1933[52].

	Period	3.I (Only Railways)	3.II (Hard Coal)	3.III (Lignite)	3.IV (Iron and Steel Products)
Constant		**20.878** (33.685)	**22.745** (12.770)	**19.399** (0.015)	**19.546** (29.662)
Administrative borders	1885-1913	**-0.294** (-2.650)	**-1.294** (-4.447)	-0.771 (0.167)	**-0.625** (-4.555)
	1925-1933	0.013 (0.132)	**-0.640** (-2.593)	0.144 (0.015)	**-0.347** (-2.814)
Language Differences	1885-1913	**-1.715** (-3.861)	**-2.724** (-2.098)	-2.429 (0.001)	0.041 (0.097)
	1925-1933	-0.326 (-0.784)	**-2.115** (-1.958)	-1.785 (0.075)	-0.496 (-0.963)
Religious Differences	1885-1913	**0.847** (3.574)	**1.720** (2.516)	-2.153 (0.157)	-0.263 (-1.012)
	1925-1933	-0.273 (-1.501)	0.118 (0.270)	-0.746 (0.156)	-0.445 (-0.949)
Natural East West Divide	1885-1913	**-0.943** (-7.717)	**-1.809** (-4.908)	-0.314 (0.685)	**-0.678** (-4.097)
	1925-1933	**-0.243** (-2.642)	**-0.568** (-3.487)	-0.769 (0.410)	**-0.498** (-3.662)
Altitude Differences	1885-1913	-0.027 (-0.996)	**0.259** (3.217)	0.140 (0.001)	-0.032 (-1.031)
	1925-1933	**-0.063** (-2.779)	0.041 (0.803)	-0.117 (0.240)	-0.037 (-1.345)
Log(distance)	1885-1913	**-1.564** (-17.551)	**-1.859** (-7.340)	-2.148 (0.356)	**-1.036** (-10.590)
	1925-1933	**-1.651** (-21.495)	**-1.869** (-9.380)	-1.516 (0.958)	**-1.091** (-11.383)

[52] All results are based on the PPML estimator. The dependent variable is bilateral exports between trade districts, z-stat are given in parentheses. Robust Standard Errors and Covariance, bold letters indicate significance at 10% or better.

Log(distance above median)	1885-1913	**-0.215** (-3.824)	**-0.340** (-2.434)	-0.617 (0.657)	**-0.210** (-5.326)
	1925-1933	**-0.122** (-3.379)	**-0.162** (-2.793)	-0.234 (0.465)	**-0.118** (-2.878)
Var. Imp/ Exp Dummies		Yes	Yes	Yes	Yes
Time/ comm./ transport		Yes (w/o transport)	Yes	Yes	Yes
Adj R2 (LR-index)		0.564 (0.817)	0.898 (0.914)	0.767 (0.729)	0.958 (0.940)
No. of Obs.		10544	3071	3071	3070

Table 3 (continued)

	Period	3.V (Chemical Products)	3.VI (Paper and Cardboard)	3. VII (Rye)
Constant		**18.448** (8.253)	**21.004** (36.626)	**23.318** (11.502)
Administrative borders	1885-1913	**-0.288** (-1.831)	-0.078 (-0.723)	-0.412 (-1.073)
	1925-1933	-0.223 (-1.162)	-0.119 (-0.910)	-0.770 (-1.282)
Language Differences * In Germany	1885-1913	-0.309 (-0.168)	-0.144 (-0.251)	-1.283 (-0.861)
	1925-1933	-0.147 (-0.139)	-0.097 (-0.135)	-0.052 (-0.042)
Religious Differences * In Germany	1885-1913	**-1.548** (-2.094)	**-0.396** (-1.733)	-0.899 (-0.708)
	1925-1933	**-2.058** (-5.842)	**-0.677** (-2.560)	-1.156 (-1.332)
Natural East West Divide * In Germany	1885-1913	**-0.792** (-2.398)	**-0.730** (-6.168)	**-1.727** (-2.322)
	1925-1933	**-0.317** (-1.860)	**-0.744** (-5.707)	**-1.614** (-3.619)
Altitude Differences * In Germany	1885-1913	0.066 (0.744)	-0.014 (-0.548)	-0.152 (-1.428)
	1925-1933	0.013 (0.258)	-0.002 (-0.083)	0.046 (0.590)
Log(distance)	1885-1913	**-1.121** (-4.034)	**-1.244** (-15.038)	**-1.795** (-5.006)
	1925-1933	**-1.301** (-8.302)	**-1.021** (-10.372)	**-2.086** (-7.339)
Log(distance above median)	1885-1913	-0.201 (-0.943)	**-0.172** (-3.226)	-0.514 (-0.816)
	1925-1933	-0.110 (-1.243)	**-0.092** (-1.858)	0.038 (0.286)

Var. Imp/ Exp Dummies	Yes	Yes	Yes
Time/ comm./ transport	Yes	Yes	Yes
Adj R2 (LR-index)	0.935 (0.927)	0.878 (0.849)	0.943 (0.896)
No. of Obs.	3070	3070	3070

Table 4: Commodity-specific tariff equivalents, Germany, 1885-1933[53]

	1885-1913	1925-1933
Hard Coal	98%	80%
Lignite	-	-
Iron and Steel Products	39%	24%
Chemical Products	81%	71%
Paper and Cardboard	32%	41%
Rye	63%	58%

[53] All results are based on the corresponding regressions in table 3.

Table 5: Factual and Counterfactual German Borders, 1885-1933[54]

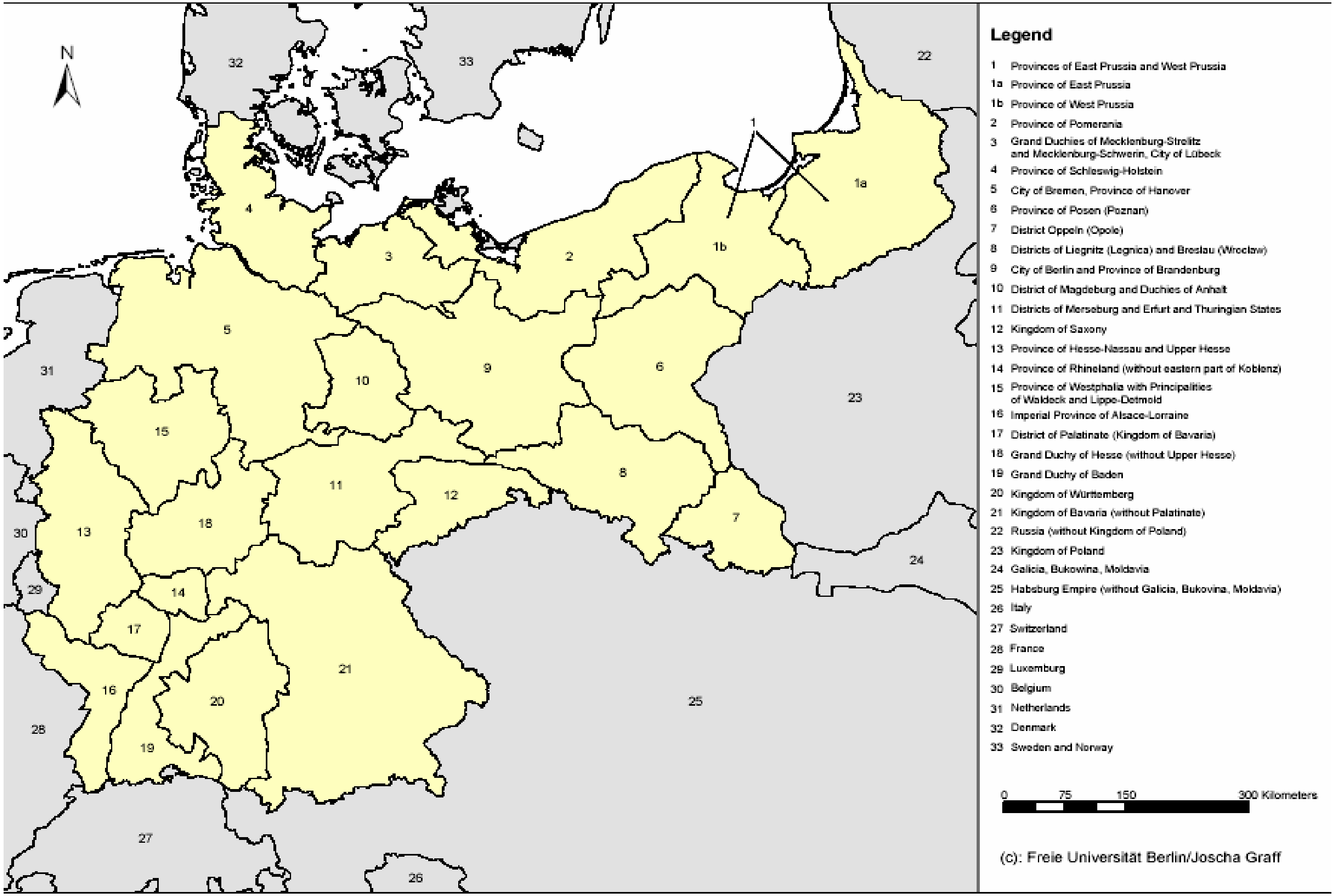
	Period	5. I: Germany, Borders of 1913 (Imperial Germany)	5.II: Germany, Borders of 1919 (Weimar Republic)	5. III: Germany, Borders of 1990 (Federal Republic)
Constant		**19.769** (24.305)	**20.035** (22.736)	**19.141** (19.596)
Administrative borders	1885-1913	**-0.392** (-2.837)	**-0.415** (-2.695)	**-0.335** (-1.809)
	1925-1933	**-0.248** (-2.129)	**-0.238** (-1.909)	-0.233 (-1.583)
Language Differences	1885-1913	**-1.466** (-2.631)	-0.744 (-1.012)	2.979 (1.294)
	1925-1933	-0.152 (-0.304)	-0.303 (-0.496)	0.676 (0.355)
Religious Differences	1885-1913	0.453 (1.508)	0.594 (1.576)	0.559 (1.489)
	1925-1933	-0.485 (-1.645)	-0.424 (-1.430)	-0.522 (-1.563)
Natural East West Divide	1885-1913	**-1.127** (-7.319)	**-1.111** (-6.667)	**-1.118** (-5.715)
	1925-1933	**-0.725** (-6.452)	**-0.724** (-6.013)	**-0.743** (-4.875)
Altitude Differences	1885-1913	-0.007 (-0.207)	-0.006 (-0.153)	-0.033 (-0.682)
	1925-1933	-0.031 (-1.107)	-0.031 (-1.034)	-0.030 (-0.815)

[54] In this table I explore economic integration within various counterfactual borders, for example in the last column I estimate the integration of Germany in modern borders of 1990 back in the period before 1914 and between 1925 and 1933. As before, all results are based on the PPML estimator. The dependent variable is bilateral exports between trade districts, z-stat are given in parentheses. Robust Standard Errors and Covariance, bold letters indicate significance at 10% or better.

Log(distance)	1885-1913	**-1.356** (-12.350)	**-1.402** (-11.462)	**-1.383** (-8.606)
	1925-1933	**-1.330** (-14.479)	**-1.340** (-13.481)	**-1.306** (-10.156)
Log(distance above median)	1885-1913	**-0.220** (-3.231)	**-0.229** (-3.013)	**-0.206** (-1.306)
	1925-1933	**-0.158** (-3.549)	**-0.160** (-3.287)	**-0.237** (-1.765)
Var. Imp/ Exp Dummies		Yes	Yes	Yes
Time/ comm./ transport		Yes	Yes	Yes
Adj R2 (LR-index)		0.530 (0.767)	0.536 (0.768)	0.560 (0.768)
No. of Obs.		18422	15162	10752

PPML, dep. var.: trade, z-stat in parentheses, Robust Standard Errors and Covariance, bold letters indicate significance at 10% or better.

Map 1: Consolidated Trade Districts for German Trade Flows on Railways and Waterways, 1883-1913



Map 2: Consolidated Trade Districts for German Trade Flows on Railways and Waterways, 1924-1933