Tear Down this Wall:
On the Persistence of Borders in Trade*

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February, 2011

Abstract

Why do borders still matter for economic activity? The reunification of Germany in 1990 provides a unique natural experiment for examining the effect of political borders on trade both in the cross-section and over time. With the fall of the Berlin Wall and the rapid formation of a political and economic union, strong and strictly enforced administrative barriers to trade between East Germany and West Germany were eliminated completely within a very short period of time. The evolution of intra-German trade flows after reunification then provides new insights for both the globalization and border effects literatures. Our estimation results show a remarkable persistence in intra-German trade patterns along the former East-West border; political integration is not rapidly followed by economic integration. Instead, we estimate that it takes at least one generation (between 33 and 40 years or more) to remove the impact of political borders on trade. This finding strongly suggests that border effects are neither statistical artefacts nor mainly driven by administrative or "red tape" barriers to trade, but arise from economic fundamentals.

Keywords: integration; home bias; globalization

JEL: F14; F15

* We thank participants at presentations in Barcelona, Glasgow, München, Nürnberg, Quebec City and Warwick for helpful comments. Financial support from the Fritz-Thyssen-Foundation is gratefully acknowledged.

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I. Introduction

Over the last two decades, trade costs have (again) become a central topic in international economics. Two findings appear particularly notable. First, trade costs continue to matter for economic activity (Anderson and van Wincoop 2004). Second, political borders contribute significantly to overall trade costs (McCallum 1995). In combination, the two findings suggest that the importance of the nation state for patterns of trade is declining slowly – if at all; contrary to conventional wisdom, there is no evidence of a "borderless world" (Leamer 2008).

This paper asks how long it takes to remove the impact of political borders on trade. To answer this question, we explore a near perfect natural experiment. With the fall of the Berlin Wall in 1989 and the subsequent (re-)unification of Germany, formerly strong and strictly enforced administrative barriers to trade between East and West Germany were eliminated completely. We analyze the evolution of intra-German trade patterns after this event and find that the former Iron Curtain still has a very substantial effect on trade, even 20 years after reunification. More generally, our results suggest that the impact of political borders on trade is highly persistent: it will take at least one generation to remove the effect of a political border on trade.

The finding of strong persistence of borders in trade has at least two major implications. On the one hand, policy-makers have a strong interest in how the pattern of trade reacts to institutional changes. For countries that pursue economic integration, the timing and magnitude of trade effects after a removal of trade barriers are of major importance. On the other hand, the persistence of border effects sheds new light on their origins (and may thereby help to design policies aimed at removing such border effects). While, in the wake of McCallum (1995), a large empirical literature, including Nitsch (2000), Anderson and van Wincoop (2003) and others, has established that national borders reduce trade by about 50 percent or more, there is no consensus on an explanation for these border effects. Broadly, three approaches can be distinguished; these explanations may be termed the "political barriers" approach, the "fundamentals" approach and the "artefact" approach, respectively.

According to the “political barriers” approach, borders continue to affect trade mainly because of the existence of non-tariff barriers that diminish trade even after the removal of tariff barriers or the formation of a currency union. Put differently, there continues to be some source of heterogeneity between regions that is related to the political or administrative border, but that cannot be easily controlled for. More specifically, the formation of a free trade area or a currency union is expected to remove some “political barriers” to trade, while political unification eliminates most or even all of these barriers. For example, trade across the US-Canadian or the Franco-German border might still be affected by persistent differences in taxation or a multitude of differences in legal frameworks, trade between German states (*Bundesländer*) less so.

By contrast, according to the “fundamentals” approach, border effects stem largely from some source of heterogeneity between regions which exists independently of the political border and often predates it. For example, ethno-linguistic, social or business networks can drive border effects because political and administrative borders often tend to follow the geography of those networks (Combes, Lafourcade and Mayer 2005, Schulze and Wolf 2009, also Rauch 1999). Similarly, physical geography can give rise to border effects by limiting trade in one direction (across a mountain range) and easing trade in another (over sea, along a river). In contrast to the “political barriers” mentioned above, it will be more difficult and time-consuming to remove the effect of such fundamental factors.

Finally, it has been argued that border effects are at least to some extent a statistical artefact due to difficulties in separating the impact of border-related trade barriers from the impact of geographical distance (Head and Mayer 2002, Hillberry and Hummels 2008) and that of non-directional multilateral barriers to trade (Anderson and van Wincoop 2003). While improved data on distance (such as time-varying and transport-mode-specific distance measures) as well as appropriately refined estimation techniques might help to reduce these problems, the remaining border effect could still be driven by problems of statistical aggregation (Hillberry and Hummels 2008). Fortunately, however, it should be possible to identify the relevance of this possible distortion. For one thing, aggregation bias is rather static. While aggregation bias might inflate estimates of the border effect, a change in borders (such as the removal of the Iron Curtain across Germany) should not systematically affect this biased estimate. Moreover, to the extent that aggregation bias drives the results, the border effect estimates should differ when estimated from two data sets that are radically different in terms of aggregation.

The contribution of this paper is to use variation in the cross-section and over time on the former intra-German border ("Iron Curtain") to distinguish between the three approaches described above. A monetary, economic, and social union between the Federal Republic of Germany (FRG) and the German Democratic Republic (GDR) was enacted in July 1990. A few months later, in October 1990, the accession of the former GDR to the FRG pursuant to Article 23 of West German "Basic Constitutional Law" (*Grundgesetz*) also created a political and legal union between the two territories, eliminating any remaining administrative barriers to trade between East and West Germany. Persistence in trade is then analyzed by examining the pattern of trade within Germany after reunification.[3]

Our empirical analysis is based on two new data sets that cover German domestic trade flows for the period from 1995 through 2004. Both data sets contain information on intra-German trade and were obtained from the same sources, but differ sizably with respect to their levels of geographical detail and industry aggregation. Crucially, the two data sets allow us to identify the effect of the former East-West border after controlling for the effect of administrative borders between the 16 German *Bundesländer* (such as Bavaria and Hesse) on trade. Reviewing the set of hypotheses aimed at explaining observed border effects on trade, any border effect that arises from unaccounted heterogeneity in terms of "political barriers" to trade (such as remaining differences in taxation between states) should be captured by a dummy variable on state borders. More specifically, over the period 1995-2004, we would not expect the continued existence of any significant administrative barrier to trade along the former Iron Curtain in addition to barriers along state borders. However, if border effects arise due to heterogeneity in terms of "fundamentals", we might well find a persistent impact of the former border on trade. For example, social and business networks in East and West Germany might adjust only slowly to the

[3] Other papers examine the speed of trade adjustment after the dissolution of national and colonial ties (e.g., Djankov and Freund 2002, Head, Mayer and Ries 2010).

border change, while some purely geographical barriers might not adjust at all.[4] Hence, an East-West border effect stemming from "fundamentals" would decline only gradually over time, if at all. Finally, if estimates of border effects are indeed a statistical artefact, we would not necessarily expect to find a significant impact of the former East-West border on intra-German trade patterns. However, if we do find such an effect, the estimates of the border effect should differ across the two data sets. Also, there is little reason to expect a systematic decline in the border effect over time.

The paper is organized in eight sections. Next, we briefly outline the historical background of Germany's reunification and describe the most important measures taken to foster integration between East and West. Section III presents our empirical strategy, along with some discussion of appropriate estimation techniques, followed by a description of the data in section IV. Section V contains benchmark results on the former intra-German border and provides some initial robustness checks. In section VI, we present and discuss more detailed results, such as evidence on trade flows specific to industry groups and modes of transportation. We also report some further sensitivity checks. Section VII presents some preliminary results on possible explanations for the border effect. Finally, section VIII provides a brief summary.

[4] In fact, Wolf (2009) shows that the division of Germany after 1945 apparently followed to some extent a pre-existing pattern that can largely be explained by natural geography.

II. Historical background

The state treaty (*Staatsvertrag*) enacted in July 1990 created a monetary, economic, and social union between the FRG and the GDR and thus ended nearly 50 years of division following World War II and the Potsdam Agreement of 1945.[5] According to Article 1 of the treaty, the GDR adopted the FRG's principles of economic policy, including property rights, market competition and free prices. Also, free mobility of capital and labour between the two territories was established. Moreover, chapter IV provided for the immediate harmonisation of the GDR's system of social and health insurance with that existing in the FRG. A few months later, the unification treaty (*Einigungsvertrag*) enacted in October 1990 merged the two territories in a political and legal union according to Article 23 of the West German constitution (*Grundgesetz*), accompanied by several international treaties with the signatory powers to the Potsdam Agreement. According to chapter II of this unification treaty, the GDR adopted the West German constitution. Chapter IV stipulated that the existing international treaties including those governing membership in the European Community were extended to the territory of the GDR. Chapter III of the unification treaty in turn provided the harmonisation of virtually all remaining aspects of the legal framework, including tax laws, thereby eliminating any administrative barriers to trade between East and West Germany. The former GDR became administratively divided into five new states (Brandenburg, Saxony, Saxony-Anhalt, Thuringia, and Mecklenburg-Vorpommern), in addition to Berlin which was reunified in her pre-war borders. Map 1 shows the administrative districts (*Kreise*) and states (*Länder*) of Germany as well as the former inner German border that divided the country up to 1990.

[Map 1 about here]

A major issue in promoting economic integration was the adjustment of infrastructure to the change in borders. First, the railway, road and waterway infrastructure in the former GDR was quantitatively and qualitatively lagging behind that of the FRG and needed to be upgraded with a total investment volume of about

[5] See Wolf (2009) for a long-run analysis of Germany's economic integration since 1885.

91 billion DM (about 45 billion euro). Second, as a result of the decade-long economic division, Germany's infrastructure had a North-South bias against the former Iron Curtain. Given the prediction in 1991 that traffic demand in an East-West direction would increase dramatically after the removal of the border, policy-makers saw an urgent need to improve the infrastructure connecting East and West Germany.[6] In response to these predictions, the federal traffic plan of 1992 earmarked another 57 billion DM (28 billion euro) towards the improvement of rail-, road- and waterway infrastructure in the East-West-direction, the "Traffic Projects German Unification" (*Verkehrsprojekte Deutsche Einheit*, see *Bundesverkehrswegeplan* 1992, p. 19). Over time, the actual volume of these investments tended to grow further. Among these were the extension of the railway connections Hamburg-Berlin, Hannover-Berlin, and Nürnberg-Leipzig-Berlin, the road extension projects A20 (Lübeck to the Polish border), A2/A10 Hannover-Berlin, A9 Nürnberg-Berlin, A44 Kassel-Görlitz and the extension of the central East-West waterway, the Mittellandkanal, connecting Berlin's waterway system and the river Oder to the river Elbe and further to the Rhine. Eckey and Horn (2000) analysed the impact of these infrastructure projects from 1990 to 1999 on railways and roads, especially in terms of the shortest actual distances and the average time it takes to reach any other district from a district in West or East Germany. They concluded that, in 1999, it was especially the average travel time on railways between East and West Germany which had been much reduced – in terms of rail and road Berlin is even the best-connected city in Germany –, while improvements to road infrastructure have been more limited (Eckey and Horn 2000, pp. 87-89). To capture these developments, we experiment in our empirical analysis with proxies for distance based on time-variant transport mode-specific travel distances and time-variant transport mode-specific travel times, in addition to a standard measure of geographical (direct-line) distance.

[6] For example, Mann, Mück, Schubert, Hautzinger and Hamacher (1991, p. B8) estimated an increase in passenger traffic within West Germany 1988-2010 of merely 3% but an increase of 660% in passenger traffic between the former West and East Germany.

III. Empirical strategy

We estimate the effect of the former East-West border on German domestic trade within the framework of the now standard micro-founded formulation of a gravity model from Anderson and van Wincoop (2003, 2004). We modify their approach, whenever necessary, for some characteristics of our data.

Following their approach, at any point in time, exports X from region i to j can be explained by the relative economic size of the exporter and the importer, expressed as the proportion of the product of the exporter's income Y and the importer's expenditure E in overall income. Additionally, exports depend on the bilateral resistance to trade (denoted by t, which is one plus the tariff equivalent of trade barriers) relative to the overall barriers to trade of the respective trading partners (i.e., the inward "multilateral resistance" P and the outward "multilateral resistance" Π). The elasticity of substitution between varieties of k from different exporters i is denoted by σ. The gravity model is then formulated as (for good k, and ignoring the time index):

$$X_{ij}^{k} = \frac{Y_i^k E_j^k}{Y^k} \left(\frac{t_{ij}^k}{P_j^k \Pi_i^k}\right)^{1-\sigma k} \qquad (1)$$

The variables in (1) are not directly observable to us. However, all these variables except the trade costs are region-specific, but not pair-specific. As a result, it is still possible to consistently estimate the average effect of trade costs on trade in (1) by introducing two sets of time-varying dummy variables. These sets of dummy variables, denoted $A_{i,t}^{k}$ and $A_{j,t}^{k}$, are specific to each region and product class k (see Anderson and van Wincoop 2004); they take the value of one whenever a region enters the equation as an exporter or importer, respectively.

Furthermore, the model requires trade flows in values whereas our data comprises (commodity-specific) information on physical quantities. Following Anderson and van Wincoop (2003, 2004), we assume trade costs to be proportional in trade values such that we are dealing with $X_{ij}^{k} = p_i^k t_{ij}^k Z_{ij}^k$, where Z^k_{ij} is the volume of exports in metric tons and p_i^k is the exporter- and product-specific price per ton.[7] Based on this formulation, we may easily substitute X since Z_{ij}^k denotes the observed quantities shipped from i to j and the price term p_i^k is exporter-specific and thus reflected by the respective (time-varying) exporter dummy. Therefore, we replace the unknown terms in (1) as described above by time-varying exporter $A_i^{k'}$ effects – now including price effects p_i^k – and importer A_j^k effects so that we obtain (again dropping the time index):

$$Z_{ij}^k = C\, A_i^{k'} A_j^k (t_{ij}^k)^{-\sigma k}, \tag{2}$$

where C is a constant and the importer- and exporter-specific dummies capture all undirected region-specific heterogeneity, including price effects, multilateral resistance, region-specific infrastructure and the like. The variable t^k_{ij} again denotes one plus the tariff equivalent of bilateral trade barriers which are the main focus of our study.

To analyze these barriers, we have to make some assumptions about the functional form of t^k_{ij}. We assume that costs are incurred (i) by transporting goods over distance using the existing infrastructure on railways, roads and waterways, (ii) when crossing existing administrative borders, and (iii) when crossing the former East-West border. Consider the following functional form (where again we drop a time index; note that we always allow the coefficients to vary over time):

$$t_{ij}^k = (dist_{ij})^{\delta} (\gamma\_adm)^{Adm\_Bord} (\gamma\_EW)^{EW\_Bord} \tag{3}$$

where γ_adm is one plus the tariff equivalent of crossing an administrative border. The variable Adm_Bord is a binary dummy variable which takes the value of one if districts i and j do not belong to the same administrative unit (*Bundesland*) and is zero otherwise. γ_EW is one plus the tariff equivalent of crossing the former East-West border. The variable EW_Bord is a dummy variable equal to one if districts i and j did

[7] Hence, the standard model implicitly assumes that exporters do not differentiate prices across destinations.

not belong to the same territory before 1990 (that is, the GDR or the FRG); it is equal to zero otherwise.

To capture the effect of distance on trade appropriately (and especially that of changing infrastructure), we use two different geographical disaggregations of our trade data. Moreover, in each case, we apply a variety of approaches to proxy for distance. As our benchmark distance measure, we employ a simple linear function of geographical distances. This measure is based on the direct-line (air) distance between districts; it is, by definition, invariant across modes of transportation and also over time. However, we also experiment with distances over which commodities were actually shipped; this measure may vary over time and by mode of transportation, depending on the infrastructure that is in place. Finally, we use the travel times between districts, which may be again transportation mode-specific and variant over time.

Beyond the effect of distance, we assume that trade costs are incurred when crossing existing administrative borders. Specifically, we control for the average effect of crossing the border between German *Bundesländer*, which should capture most administrative barriers to trade arising from some persistent differences in legislation or regional policies. More importantly, we include a control variable for trade costs that are incurred when crossing the former East-West border. We are basically agnostic about the origins of the latter. However, given the other controls, we can distinguish between three hypotheses implied by the approaches outlined above.

H1: If border effects mainly arise from remaining administrative or political barriers to trade, we expect to find – after controlling for administrative borders – a coefficient estimate of $\gamma\_EW = 0$ at all points over the sample 1995-2004. The results are expected to be very similar for the two trade data sets.

H2: If border effects mainly arise from fundamentals such as social and business networks or physical geography, we expect to find $\gamma\_EW \leq 0$ at all points over the sample 1995-2004 and $|\gamma\_EW_{1995}| > |\gamma\_EW_{2004}|$. Again, we expect the results for the two data sets to be very similar.

H3: If border effects mainly arise as a statistical artefact driven by aggregation bias, we expect to find $\gamma\_EW_{1995} = \gamma\_EW_{2004}$. We do not form any expectation on the sign or magnitude of this coefficient. Under H3, we expect the results for the two trade data sets to be quite different.

By focusing on the evolution of the border effect over time, our identification strategy saves us from making demanding assumptions about the elasticity of substitution which is a key parameter for the assessment of the magnitude of the border effect. For our purposes, it is sufficient to assume that the elasticity of substitution for industry-level trade is relatively stable over time, an assumption that is in line with empirical results on US trade (Broda and Weinstein 2006). In addition, to the extent that the substitution elasticity varies across industries, we assume that the industry composition of intra-German trade has not changed dramatically over our sample period.[8]

The standard approach for the empirical analysis is to substitute the trade cost function (3) into the gravity model (1) or (2), to log-linearize the resulting equation, and to estimate the model with OLS or some system estimator. However, in a recent contribution, Santos Silva and Tenreyro (2006) caution that this approach leads to biased estimates unless very specific assumptions are met. The basic difficulty is that 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.[9] Given this, heteroskedasticity of the error term in the stochastic formulation of the model would result in an inefficient, biased and inconsistent estimator.[10] Santos Silva and Tenreyro (2006) demonstrate the magnitude of this inconsistency and strongly recommend estimating the gravity model in its multiplicative form to avoid this problem. An appealing side effect of this strategy is that it also allows us to circumvent the problem of zero observations of the dependent variable, which arises by linearizing

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[8] Indeed, industry shares of intra-German trade turn out to be remarkably stable over time, both within and across territories.

[9] This can be framed in terms of Jensen's inequality stating that $E(\ln(y)) \neq \ln(E(y))$, with y being a random variable.

[10] In fact, in the application of gravity models the resulting estimation errors very often display heteroskedasticity (e.g., Santos Silva and Tenreyro 2006).

equation (2), since the log of zero is not defined.[11] Santos Silva and Tenreyro (2006) propose a Poisson maximum-likelihood (PML) estimator since it is "consistent and reasonably efficient under a wide range of heteroskedasticity patterns [...]" (p. 645).[12] For the PML, it is sufficient to assume that the conditional mean of a dependent variable is proportional to its conditional variance. This estimator is preferable to others without further information on the heteroskedasticity according to Santos Silva and Tenreyro (2006). It attributes the same informative weight to all observations. Moreover, the estimator is numerically equal to the Poisson pseudo-maximum-likelihood (PPML) estimator, which is used for count data models. In order to gain efficiency, it is possible to correct for heteroskedasticity using a robust covariance matrix estimator within the PPML framework. This is the approach that we adopt in our estimation. However, for comparison, and in order to ensure the robustness of our findings, we also report results for other estimators that are frequently used in the literature.

[11] The appearance of zero observations may be due to mistakes or thresholds in reporting trade, but bilateral trade can actually be zero. This event is particularly frequent if trade flows are investigated at a regional and/or sectoral level. The occurrence of zero trade is usually correlated with the covariates.

[12] They present the results of a horse race between various estimation strategies including Tobit, non-linear least squares and Poisson regression models. Investigating simulated and real trade data, they conclude that only the latter approach and NLS deliver consistent estimates, but that NLS is less efficient because the structure of heteroskedasticity is unknown.

IV. Data

The heart of our paper is the empirical analysis of two new and previously unexplored panel data sets of trade flows within Germany. More specifically, our data sets contain information on the annual volume of shipments (in metric tons) between various German regional units for the period from 1995 through 2004, separated by industry and by mode of transportation. The data are obtained from two sources, depending on the mode of transportation. The German Federal Statistical Office (*Statistisches Bundesamt*) collects statistics on intra-German shipments by railway, ship and sea transport.[13] Comparable data on shipments by road have been obtained from the Federal Motor Transport Authority (*Kraftfahrt-Bundesamt*). Since both institutions do not generally publish data that is disaggregated for commodity groups below the level of *Bundesländer*, the entire data set purchased was compiled to our specification.

The data on railways and waterways cover all shipments on German territory. For each mode of transportation, they contain the volume of shipments from origin to destination, while transit shipments (i.e., shipments that only pass through a region) are excluded from our data. The same is true for our data on shipments by road, except that this data is based on a representative sample of companies registered in Germany.[14] The fact that we use shipment data (similar to Wolf 2000 and Hillberry and Hummels 2008, but, in contrast to them, detailed by mode of transportation) gives rise to several issues. First, a number of shipments enter or leave Germany via ports and hubs of air cargo. We address this issue in our empirical analysis by using region fixed effects that vary over time. Second, there will be cases where a trade flow from one German region to another uses more than one mode of transport (for example, road and rail) and hence generates two shipments in our data. We deal with this issue in our robustness analysis and show that it does not bias our estimates of the border effect in any measurable way.

[13] Aggregate figures on freight transport (broken down by means of transportation) are reported in a special series of statistical publications (*Fachserie 8*), while detailed data are generally unpublished, but available in CD-Rom format on request. Our data set does not contain information on air transport (which covers only 0.08 percent of total transport) and transportation of oil through pipelines.

[14] According to estimates by the Federal Motor Transport Authority, shipments by companies registered in Germany deliver slightly more than 75 percent of all shipments by road on German territory.

The raw shipment data comes in two formats of regional and industry classification. At a spatially disaggregated level, the data set covers trade between 101 regional units (*Verkehrsbezirke*, in short: VB) in Germany. These units are constructed along the lines of administrative borders, but have no special purpose except for compiling data on transportation linkages. Most often these units consist of two or three adjacent districts (*Kreise*) within a particular federal state (*Bundesland*).[15] Map 2 provides a map of German *Verkehrsbezirke*. For these finely disaggregated geographical units, trade is grouped into 10 broad industry categories (*Güterabteilungen*). The industry categories are listed in Appendix table A1.

[Map 2 about here]

Alternatively, transport volumes are reported for more finely disaggregated industry categories. These data cover trade in 24 industry groups (*Gütergruppen*) listed in Appendix table A2. However, for confidentiality reasons, the data are only provided for trade between larger geographical units (*Verkehrsgebiete*, VG). These regional units typically comprise about four of the smaller VB units and have, again, no special administrative purpose (though these units often coincide with the boundaries of federal states, especially for smaller states). There are 27 of these regional units (for a total of 16 federal states in Germany); see Map 3.

[Map 3 about here]

In sum, we have two quite different data sets on intra-German trade flows both of which allow us to trace the evolution of shipments across Germany at an unprecedented level of detail. In contrast to other work that uses similar types of data (e.g., Hillberry and Hummels 2008 for the United States), we are, unfortunately, unable to discriminate between producer or wholesale shipments, which arguably might lead to aggregation bias. However, our data allows us to distinguish not only between industry groups but also between modes of transportation at various points in

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[15] Apart from communes, districts are the smallest administrative units in Germany. Cities with a population of more than 50,000 typically form a district of their own. In total, Germany consists of 439 districts.

time and thereby capture a central feature of German domestic trade after 1990. More importantly, the two data sets represent the same totals in each year but at two quite different levels of disaggregation. Comparing results from the two data sets, we can directly address the issue of aggregation bias that Hillberry and Hummels (2008) raise.

Both data sets are large. They comprise about 4 million (=101 exporters × 100 importers × 10 industries × 4 modes of transportation × 10 years) and 700,000 observations (=27 exporters × 26 importers × 24 industries × 4 modes of transportation × 10 years), respectively; many of them are zero. For computational reasons, we run several estimations in which we aggregate the industry series, using their unit values from the German foreign trade statistics as time-varying weights, and also trade over modes of transportation, which leaves us with a total of about 100,000 (VB) and about 7,000 (VG) observations, respectively.[16]

Table 1 describes our raw trade data in more detail. The table reports, for each mode of transportation, the annual volume of shipments (aggregated from industry-level data) and the number of intra-German trade pairs with positive trade. Analogous information for East-West trade is provided separately. Figure 1 provides accompanying graphs of trade shares by transportation mode. As shown, the dominant method of transportation is delivery by road which covers about 80 percent of total trade. Road transport is also the most flexible form of transportation. Almost all regional units within Germany are connected by transport on roads; changes in the volume of intra-German trade have been predominantly covered by variations in the volume of freight shipments by road. Concerning trade across the former East-West border, railway transport has expanded strongly over our sample period, probably benefiting from improvements in infrastructure that allow for speedier transportation. Shipment volumes by rail have more than doubled over the ten-year period. In contrast, water-borne trade between East and West Germany has declined in volume terms. Interestingly, a disproportionately large share of freight shipments has been

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[16] Unfortunately, we are unable to analyze our full data set at the most disaggregated level. Theory-consistent estimation would require the analysis of a (VB) data set with more than 4 million observations and 20,200 dummy variables. In our benchmark estimation, we therefore analyze aggregate data. In robustness checks, we explore various sub-samples of our data set.

initially on waterways, possibly reflecting the rapid re-opening of existing (natural) trade routes after reunification.[17]

[Tables 1a and 1b about here]

[Figure 1 about here]

We complement our trade data with data from a number of other sources. Most notably, we have compiled various measures of transport distances. Our benchmark measure is the great-circle (air) distance (in kilometers) between any two regional units based on the geographic location of the unit's largest city. This measure is typically used in applications of the gravity model for trade between countries. Moreover, given that we are analyzing trade flows within a country and thus focus on smaller geographical units, the definition of the central location of the unit – an issue of frequent concern in this literature – is potentially of lesser importance. On the other hand, the transportation infrastructure may be of particular relevance for the estimation results. To deal with this issue, we have also obtained information on current road, rail, and waterway distances (in kilometers) and travel times (in minutes); this data is provided by the Federal Office for Building and Regional Planning (*Bundesamt für Bauwesen und Raumordnung*).

For the majority of trade pairs in our sample, the distance measures have probably been (roughly) constant over the analyzed 10-year period. However, as outlined in section II, there has also been massive public investment in improving the infrastructure, especially between East and West Germany, over this period. In the early 1990s, the German government initiated a large-scale spending program on rebuilding the infrastructure along the former intra-German border (*Verkehrsprojekte Deutsche Einheit*). In total, there are 17 projects with total expenditures of about 38 billion euro; many of these projects were completed in the period under investigation. Therefore, to correctly identify the effect of distance on trade, we have also obtained time-variant data on road, waterway and railway distances and travel times for 1995, 1999, and 2004 from RRG Spatial Planning and Geoinformation

[17] Nitsch and Wolf (2011) analyze the dynamics of intra-German trade after reunification along the extensive and intensive margins in more detail.

(*Büro für Raumforschung, Raumplanung und Geoinformation*), a private firm specialized in generating geodata.

In the working paper version of this paper (Nitsch and Wolf 2009), we analyze this data in more detail. Across modes of transportation, travel distances remained largely unaffected by improvements in infrastructure. Significant declines, however, can be observed in travel times on railways (and, to a lesser degree, also on roads), especially over distances of medium length. Shipments in East-West direction appear to have benefited most strongly from speedier transportation.

V. Benchmark Results

Tables 2a and 2b present our baseline estimation results. We begin with our sample of trade between geographically finely disaggregated regional units (101 VBs) at the one-digit industry group level (10 industry groups). The raw shipments data are first aggregated over modes of transportation. We then compute a measure of total bilateral trade by aggregating industry data, using their unit values from the German foreign trade statistics as time-varying weights. In total, our VB sample comprises 100,980 observations.[18] In our baseline specification in column 1 of Table 2a, we report results from a PPML estimator with cluster-robust standard errors, controlling for a complete set of time-varying importer and exporter effects (not reported). The remaining two columns tabulate results from alternative estimators to ensure that our findings are not dependent on a particular estimation technique. In all our regressions, we use geographical (air) distance as a proxy for distance-related trade costs.[19]

[Table 2a about here]

The model seems to work well. As expected, the distance coefficient is close to unity. In addition, we find a measurable distortive effect of administrative borders (*Bundesländer*) on intra-German trade flows; the estimated γ coefficient on this state border dummy is negative and statistically significant. The point estimate is large in magnitude, possibly also capturing potential nonlinearities in the effect of distance on trade, but slowly decreasing over time. More importantly, after controlling for this effect, we find an economically large, negative and statistically highly significant effect of the former East-West border on trade. Our estimates indicate that trade between the two formerly separated parts of Germany is still considerably below the sample average even several years after this border had disappeared. The magnitude of the estimated coefficient suggests that "border"-crossing trade in 1995 was about 71 percent lower than the sample average, and still 42 percent below the average of all

[18] The full pooled VB data set comprises 101,000 observations (=101 exporters × 100 importers × 10 years). However, the two-directional VB pair Flensburg/Ostsee-Husum/Nordsee is dropped from the sample. Both VBs represent the same district (Flensburg), which is, for statistical purposes related to shipping data, divided into two separate VBs.
[19] In the working paper version, we present analogous estimation results for measures of trade distances which take into account the existing infrastructure.

trade that crossed a state border within Germany. Interestingly, the estimated border effect on trade gradually (but significantly) decreases over time. However, the coefficient remains (significantly) below zero at the end of the sample period, suggesting that "border"-crossing trade in 2004 was still about 58 percent lower than the sample average (and 28 percent below average state-border-crossing trade).

The two columns on the right of Table 2a show that our estimation results are reasonably insensitive to our choice of estimator. Following the literature, we experiment with a broad range of alternative specifications and estimation techniques. To economize on space, we only tabulate results for OLS and Tobit estimators when a log transformed dependent variable is used (after having added a small value of 100 euro to the value of shipments to avoid zero trade flows).[20] For these modifications, the estimated coefficients on the East-West border dummy show a slightly steeper decline over time. However, the estimated coefficient is still economically large and statistically different from zero at the end of our sample period. Summarizing our findings, the fact that we observe a large but declining effect of the former East-West border on trade, after controlling for administrative borders, suggests that this estimation result is not a mere statistical artefact. Rather, it is consistent with the hypothesis that the border effect is driven by some form of "fundamentals", such as trade networks, which only gradually adjust to the (sudden) change in border barriers.

Next, we explore our sample of data at the level of 27 VG regional units and 24 industry groups, again aggregated over modes of transportation. As before, we aggregate the industry volume series to total shipment values, using the unit values for industry groups from the German foreign trade statistics as time-varying weights, which leaves us with a total of 7,020 observations. Again, we report results from a PPML estimator with cluster-robust standard errors, controlling for a complete set of time-varying importer and exporter fixed effects (not reported) along with results from a set of other estimators.

[Table 2b about here]

[20] In another perturbation, for instance, we added a contiguity dummy to our specification, a standard variable in gravity models that aims to capture possible nonlinearities in the distance effect on trade. This extension, however, leaves our key findings completely unchanged.

Table 2b tabulates the estimation results. Not surprisingly, since we have far fewer observations, the standard errors of all coefficients are higher than in the corresponding columns of table 2a. Also, at this higher level of geographical aggregation, the coefficient on distance is larger than before so that trade tends to decline more rapidly with distance. In contrast, with a sizable fraction of intra-state trade dropped, the estimated coefficients on the state border dummy are smaller in magnitude than the analogues in the respective columns of table 2a; still, they are consistently negative and highly statistically significant.[21] Most notably, our finding of a significant, negative effect of the former East-West border on German domestic trade is strongly confirmed. It appears particularly reassuring that the estimated coefficient of the East-West border dummy is almost of the same magnitude than the one estimated before. Crucially, the border effect estimate shows very similar dynamics over time, with a significant decline to a point estimate of about -0.30 in 2004, which is nearly identical to (and clearly not statistically different from) the corresponding point estimates for trade between smaller regional units (VBs) reported in table 2a. In sum, our estimation results suggest that the former East-West border has a highly persistent impact on Germany's domestic trade. Moreover, trade patterns appear to gradually adjust to the change in borders. In combination, these findings provide strong support for the "fundamentals" hypothesis of border effects in trade.

How long will it take to remove this intra-German East-West border effect entirely? Our estimation results suggest a straightforward answer. If we focus on column 1 of tables 2a and 2b, and hence limit our attention to results from PPML estimations, we can calculate the average annual rate of decline λ of the border effect; this computation also indicates the time it will take to reach an East-West trade level that is not statistically different from comparable trade within the two formerly separated territories (that is, trade between federal states that does not cross the former border). Assuming that the rate of decline λ observed over the period from 1995 through 2004 can be linearly extrapolated, we compute the time that it takes to reach this level as

[21] Similar to our VB sample, we ignore shipments within regional units. As a result, intra-state trade between VBs but within a VG is, by definition, not included in our analysis. All of our results are robust to the inclusion of shipments within VGs.

$$timetozero = \frac{\ln(statistical\ zero / EW\_bord_{2004})}{\ln(1+\lambda)}, \quad (4)$$

where the statistical zero is given by the average standard deviation of the East-West border coefficient over our sample period from 1995 to 2004. From column 1 in table 2a, we obtain an average standard deviation of about 0.03; the analogous estimate from table 2b is about 0.05. The average annual rate of decline of the border effect from table 2a is $\lambda = -0.057$; the average annual rate of decline from table 2b, column 1 is $\lambda = -0.065$. Hence, based on the estimated East-West border effects for 2004, our results imply that it would take a total of at least 33 (until 2022) or up to 46 (until 2035) years after 1989 to reduce the effect of the former Iron Curtain on Germany's domestic trade to a level that is not statistically different from comparable intra-German trade patterns. In the next section we show that this result is robust to many alternative assumptions.

VI. Further Evidence and Robustness Checks

We check the sensitivity of our estimation results along various dimensions. We begin by examining the evolution of intra-German border effects for various subsets of our sample. In a first exercise, we divide shipments by mode of transportation. Again, we aggregate industry-level trade volume data to total shipments between regional units, but now analyze shipments by railway, road, ship and sea transport separately. Figure 2 graphs the results. Not surprisingly, we find strong differences in estimated border coefficients across modes of transportation. The largest border effects are estimated for sea transport. However, our confidence in these estimates is limited. Only very few regional units have direct access to sea transport such that the number of observations with positive shipments is small. Also, sea transport seems to be the appropriate mode of transportation for only a narrow range of goods. In contrast, transport by ship across the former East-West border appears is not significantly different from trade within the two formerly divided territories. A possible explanation is that the necessary infrastructure, rivers and canals, has been ready in place immediately after reunification. In addition, it is interesting to note that for the two modes of water-borne transportation the point estimates of the border effect remain basically unchanged over time. As a result, the decline in the overall border coefficient is entirely driven by road and railway transportation. The border effect estimate is, not surprisingly, dominated by transportation by road which is the most important mode of transportation. However, an even more dramatic decline in the border effect is observed for railway transportation, in line with descriptive results.

[Figure 2 about here]

In another exercise of subsample analysis, we examine border effects for individual goods categories. Figure 3 plots the evolution of the border coefficient at the one-digit goods classification level. Again, we find sizable differences in the magnitude of the estimated border effect, with largest estimates for solid mineral fuels (such as coal) and smallest effects for metal products. Reassuringly, however, there is a decline in the E-W border effect in almost all sectors of industry. We take this as evidence that our baseline results are reasonably robust. Moreover, the estimation results apparently broadly confirm intuition. For instance, strong declines in the border effect are observed in sectors with low substitutability between varieties (such as chemicals and machinery).[22] Also, bulk commodities (such as coal and ores) display the lowest degree of cross-border trade integration at the end of our sample period. Chen (2004) provides estimates of industry-specific border effects for intra-European Union trade.

[Figure 3 about here]

Next, we deal with the issue of intermodal shipments. Our raw data contains shipments by individual mode of transportation. However, some shipments use more than one method of transportation and, therefore, might not be properly recorded in the statistics.[23] In particular, trade flows to regional centers of cargo turnover might be artificially inflated by intermodal delivery. Fortunately, two recent studies by the German Federal Statistical Office (Statistisches Bundesamt 2005, Reim 2007) document that the importance of intermodal shipments in total German trade is very limited (though rising). For 2003, the share of intermodal shipments in total delivery by road (which account for more than 80 percent of total transportation in our sample; see figure 1) is estimated at about 2.8 percent, for railways 15.9 percent, for domestic waterways 6.7 percent and for sea shipments 48.8 percent (Statistisches Bundesamt 2005, pp. 7-8). The relevance of intermodal shipments is even more limited for shipments within Germany, which are the focus of this paper. For 2005, the share of intermodal shipments in total domestic delivery by rail is estimated at about 9.3 percent, for shipments on domestic waterways at about 3.1 percent (Reim 2007, pp. 172-174.). In view of these findings, there is apparently little evidence that intermodal trade introduces any notable bias in our border effects estimates. Still, to examine the importance of this issue for our results, we re-estimate our baseline model, controlling for intermodal transportation. More specifically, dismissing shipments by sea, intermodal trade within Germany is heavily concentrated around a few cargo centers, namely Duisburg, Cologne, Ludwigshafen and Munich (see Statistisches Bundesamt

[22] The estimates for petroleum and petroleum products appear to be affected by German import patterns.

[23] Examples include shipments that use standardized containers which can be easily reloaded between modes of transportation.

2005, pp. 129). As shown in table 3, dropping these regional trade hubs from our VB sample leaves our baseline results essentially unaffected.

[Table 3 about here]

VII. Search for explanations

In a final set of exercises, we aim to provide additional evidence on the potential sources for the estimated border effects in intra-German trade. A possible reason for the persistence in trade patterns is the initial lack of a functional transportation infrastructure. With highly restrictive border controls between East and West Germany in place for more than a quarter of century, allowing border-crossing trade only through a few check points, most of the previously existing transportation network was depleted by the time of reunification.[24, 25] As a result, because of missing infrastructure, trade between the two formerly separated parts of Germany probably faced considerably larger transportation costs (and, therefore, lower trade) than mere geographical distance suggests, an effect which may have faded over time with massive investment in infrastructure. To the extent our border effects estimates are indeed affected by physical barriers to trade, we would expect to find smaller border effects once we properly control for trade costs based on infrastructure that is real-time in existence.

Table 4 illustrates that shipments across the former East-West border indeed benefited most strongly from improvements in infrastructure. The table reports estimation results for regressions of the reduction in transportation costs over the period from 1995 to 2004 (as proxied by the change in travel distance and travel time, respectively) on geographical (air) distance and an interaction term that captures this effect separately for border-crossing distances. As shown, there is considerable variation in changes in infrastructure across modes of transportation. For shipments by railway, for instance, average intra-German travel distances have even increased

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[24] An example is the railway connection between the two largest German cities, Berlin and Hamburg. Initially opened in 1846, the railway line was gradually upgraded to become a prestigious high-speed connection. By the 1930s, several speed records were marked on this route; the "Flying Hamburger" regularly connected the two cities in two hours and 18 minutes (see http://www.deutschebahn.com/site/bahn/en/db__group/corporate__group/history/topics/flying__hamburger/flying__hamburger.html for more details). After German reunification, pre-division speed on this route was not reached before 1997 when travel time was cut from four hours and 3 minutes in 1990 to two hours and 14 minutes. In December 2004, travel time was cut further to one hour and 33 minutes (see http://www.deutschebahn.com/site/bahn/de/unternehmen/presse/bauen__bahn/abgeschlossen/hamburg__berlin.html).

[25] Redding and Sturm (2008) find, for instance, that cities in West Germany close to the East-West German border experienced a substantial decline in population growth relative to other West German cities.

over time, possibly due to closure of inefficient lines. More notably, the coefficients on the interaction term are consistently and significantly negative; border-crossing transportation costs have declined over the sample period.

[Table 4 about here]

Figure 4 graphs border effects estimates based on time-variant (transportation mode-specific) measures of trade distance and travel time. As expected, the point estimates of the effect of the former intra-German border on trade are often somewhat lower for these real-time transport cost measures than for current infrastructure. None of these differences in estimated coefficients, however, is statistically significant. Overall, our key finding of persistence in trade is strongly confirmed.

[Figure 4 about here]

Another possible explanation for the existence of border effects is the importance of business and social networks for trade.[26] Most of these ties have been cut between East and West Germany during the period of German division; it will probably take time to re-establish such linkages after reunification. However, with the gradual re-emergence of business linkages and social networks between the two parts of the country, the estimated intra-German border effect can be expected to decline in magnitude over time.

A prominent proxy for the strength of social and personal ties is the bilateral stock of migrants. Migrants often possess specific knowledge and connections to their former home region, thereby allowing easier establishment of successful trade relationships. As a result, when the reduction in information costs through migrant networks is taken into account, our estimates of the border effect might be affected, depending on the patterns of intra-German migration. More specifically, in view of the much debated phenomenon of strong cross-border migration after reunification, it

[26] For early evidence, see Rauch (1999). Combes, Mayer and Lafourcade (2005) provide complementary trade-creating evidence of social networks for France.

is expected that part of the dynamics in the border effect estimates is explained by emerging migrant networks.[27]

Data for regional migration covering all parts of Germany are readily available at the level of the federal state (*Bundesland*); we use data taken from various issues of the Federal Statistical Office's *Fachserie 1, Reihe 1.2*. Based on this data, table 5 presents summary statistics on migration between German federal states. More specifically, the table reports the annual flow of migrants within and between the two formerly separated territories as a share of the territory's total population. Interestingly, while there is much public discussion on East-West migration, migration patterns between West German states have been even more pronounced. On average, about 10 percent of the West German population migrate across state borders each year, compared with about 4 percent of the East German population annually moving west. Moreover, in view of the relative persistence in migration patterns across state pairs over the sample period, the effect of migrant networks on our estimates of the intra-German border effect appears a priori unclear.

[Table 5 about here]

In our empirical analysis, we use the stock of migrants as proxy for social ties and networks. In particular, we define networks as favourably as possible for cross-border relationships by constructing a stock measure that sums bilateral state-to-state migration flows since 1991. Therefore, we are able to cover migration that has occurred before the beginning of our sample period. At the same time, we ignore the stock of within-territory migration before 1991. In practice, however, the exact definition of the migration measure is of little relevance. In unreported results, for instance, we use the annual flow of migrants as proxy for networks, yielding very similar coefficient estimates. Fuchs-Schündeln and Schündeln (2009, p. 703) note that "the phenomenon of East-West migration is a steady one over the entire time period, and does not only play out in the first years after reunification".

[27] During the years 1991 to 2006, 2.45 million individuals (or 16.6 percent of the East German population in 1990) moved from the former GDR to the former FRG. Fuchs-Schündeln and Schündeln (2009) document major stylized facts of cross-border migration. They argue (p. 703) that "it is clear that East- West migration is an important phenomenon of the German history after reunification, and an important migration episode in general".

Table 6 presents the estimation results. The first column tabulates coefficient estimates for the baseline specification when regional shipments are aggregated to the state level (we note that the estimated coefficients on the East-West border are again very similar to the ones obtained from more disaggregated data); the second column reports analogous results when measures of bilateral in and out migration are added to the benchmark model. As shown, our baseline estimation results are reasonably robust. All our key findings are basically unaffected by aggregation. As before, the point estimates of the border effect are slightly shifted upwards for larger geographical units. More importantly, adding migration has little measurable effect on the results. While the coefficients on the control variables take the expected positive sign and are statistically highly significant, our key finding of a declining but still substantial effect of the former E-W border on trade is confirmed. This is probably driven by the high level of migration within the formerly separated territories, especially the very high level of migration between western federal states. Still, the decline in the border effect appears to be somewhat stronger once we control for migration patterns, thereby illustrating the importance of migration networks for trade.

[Table 6 about here]

VIII. Conclusion

The reunification of Germany in 1990 provides a unique natural experiment to examine the effect of political borders on trade. With the fall of the Berlin Wall and the rapid formation of a political and economic union, strong and strictly enforced administrative barriers to trade between East Germany and West Germany were eliminated completely within a period of no more than two years. The evolution of intra-German trade flows then provides essentially two new insights for both the globalization and border effects literatures.

First, we find little evidence that political integration is rapidly followed by economic integration. Instead, we estimate that the impact of the former East-West border on trade declines very slowly but steadily. It takes at least 33 (and possibly more than 40) years to remove the impact of political borders on trade. This finding of a persistent impact of the former Iron Curtain on German domestic trade flows holds after controlling for administrative borders, contingency effects, time-varying regional effects, and for time-varying and transport-mode specific estimates of the costs of distance. Most notably it also holds using two data sets, which are very different in terms of geographical and industry-group disaggregation.

Second, this particular pattern of change over time strongly suggests that border effects are neither statistical artefacts nor mainly driven by administrative or "red tape" barriers to trade, but arise from more fundamental factors. More specifically, over the period 1995-2004, we would not expect that any administrative barrier to trade continued to exist along the former Iron Curtain in addition to barriers along state borders. Similarly, if estimates of border effects would be a mere statistical artefact (e.g., due to aggregation bias), we would not necessarily expect to find a significant impact of the former East-West border on intra-German trade patterns. And if so, any estimates of border effects should differ across the two data sets, which radically differ in terms of aggregation. Also, there would be little reason to expect a systematic decline in the border effect over time. Given that our estimates of the effects of the former East-West borders hold after controlling for federal state borders, are robust to various levels of aggregation and decline slowly but steadily over time, we conclude that they arise due to heterogeneity in terms of "fundamentals". For example, social and business networks in East and West Germany might adjust only slowly to the border change, while some barriers from physical geography might not adjust at all. This is exactly what the evidence suggests. Borders matter indeed and it is hard to change them, because they are related to underlying economic fundamentals.

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Table 1a: Description of VB Shipments Data

	Road				Railway				Ship				Sea				Total					
	Volume		Trade pairs		Volume		Trade pairs		Volume		Trade pairs		Volume		Trade pairs		Volume		Value		Trade pairs	
	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W
1995	1048	97	8391	2730	167	15	8238	2728	66	6.9	1467	274	3.3	0.9	158	50	1285	120	183	22	9402	3230
1996	1029	96	8527	2841	163	17	7953	2548	61	6.1	1373	244	3.5	1.1	143	46	1256	121	185	24	9400	3243
1997	1045	97	8615	2870	166	20	7923	2549	59	6.1	1372	267	3.9	1.3	134	49	1274	124	196	25	9386	3238
1998	1061	104	8605	2908	160	19	7773	2515	58	5.6	1352	244	3.7	0.8	140	52	1282	129	211	28	9388	3261
1999	1121	117	8580	2897	152	20	7520	2395	56	5.9	1345	249	5.1	1.2	159	60	1335	144	232	32	9349	3226
2000	1123	118	8588	2924	151	22	7112	2255	54	5.7	1296	209	4.6	1.2	161	61	1333	146	261	36	9259	3202
2001	1114	118	8788	3012	148	22	6659	2096	51	4.4	1267	236	4.3	1.1	146	60	1317	145	280	39	9203	3167
2002	1059	122	8808	3032	145	24	6131	1978	50	4.8	1204	214	4.1	1.2	136	54	1259	153	264	40	9110	3168
2003	1088	124	8875	3068	148	25	5671	1804	49	4.6	1220	190	4.3	0.8	144	50	1289	155	277	41	9153	3171
2004	1118	129	8977	3116	155	32	5796	1883	50	4.4	1273	223	4.2	0.8	147	54	1328	167	291	44	9188	3214
Δ%	**7**	**34**	**7**	**14**	**-7**	**110**	**-30**	**-31**	**-24**	**-37**	**-13**	**-19**	**25**	**-19**	**-7**	**8**	**3**	**39**	**59**	**97**	**-2**	**-0**

Notes: Volumes are in millions of metric tons. Values are in billions of euro. The total number of intra-German VB trade pairs is (101×100=) 10100 and (78×23×2=) 3588 for East-West trade.

Table 1b: Description of VG Shipments Data

	Road				Railway				Ship				Sea				Total					
	Volume		Trade pairs		Volume		Trade pairs		Volume		Trade pairs		Volume		Trade pairs		Volume		Value		Trade pairs	
	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W	Total	E-W
1995	713	97	702	252	132	15	702	252	60	6.9	404	104	3.2	0.9	43	15	908	120	185	28	702	252
1996	705	96	702	252	130	17	702	252	54	6.1	399	101	3.4	1.1	38	14	893	121	238	39	702	252
1997	716	97	702	252	132	20	702	252	52	6.1	401	104	3.5	1.3	41	16	904	124	250	39	702	252
1998	735	104	702	252	128	19	702	252	51	5.6	405	102	3.6	0.8	38	14	918	129	268	43	702	252
1999	783	117	702	252	122	20	701	251	50	5.9	401	106	5.0	1.2	42	17	959	144	311	53	702	252
2000	781	118	702	252	122	22	701	251	48	5.7	391	91	4.6	1.2	46	18	955	146	451	75	702	252
2001	791	118	702	252	122	22	701	251	45	4.4	391	103	4.2	1.1	46	18	962	145	466	79	702	252
2002	761	122	702	252	120	24	700	251	45	4.8	382	97	4.0	1.2	44	19	930	153	433	79	702	252
2003	789	124	702	252	123	25	700	250	43	4.6	371	81	4.2	0.8	43	17	959	155	445	76	702	252
2004	809	129	702	252	131	32	691	242	45	4.4	374	93	4.1	0.8	42	18	988	167	451	82	702	252
Δ%	**13**	**34**	**0**	**0**	**-1**	**110**	**-2**	**-4**	**-25**	**-37**	**-7**	**-11**	**28**	**-19**	**-2**	**20**	**9**	**39**	**144**	**188**	**0**	**0**

Notes: Volumes are in millions of metric tons. Values are in billions of euro. The total number of intra-German VG trade pairs is (27×26=) 702 and (21×6×2=) 252 for East-West trade.

Table 2a: Benchmark Results for VB Regional Units

Estimator	Poisson		Pooled OLS		Tobit	
E-W Border, 1995	-0.551	(0.034)	-0.719	(0.042)	-0.743	(0.046)
E-W Border, 1996	-0.511	(0.032)	-0.671	(0.040)	-0.690	(0.046)
E-W Border, 1997	-0.547	(0.031)	-0.673	(0.040)	-0.691	(0.046)
E-W Border, 1998	-0.475	(0.031)	-0.520	(0.041)	-0.535	(0.046)
E-W Border, 1999	-0.438	(0.031)	-0.546	(0.042)	-0.566	(0.046)
E-W Border, 2000	-0.420	(0.031)	-0.570	(0.043)	-0.603	(0.047)
E-W Border, 2001	-0.441	(0.029)	-0.413	(0.042)	-0.505	(0.048)
E-W Border, 2002	-0.317	(0.028)	-0.263	(0.040)	-0.348	(0.048)
E-W Border, 2003	-0.363	(0.028)	-0.298	(0.040)	-0.384	(0.048)
E-W Border, 2004	-0.326	(0.027)	-0.229	(0.038)	-0.306	(0.048)
State Border, 1995	-0.687	(0.040)	-0.680	(0.050)	-0.641	(0.060)
State Border, 1996	-0.650	(0.038)	-0.550	(0.048)	-0.508	(0.060)
State Border, 1997	-0.617	(0.039)	-0.554	(0.049)	-0.510	(0.060)
State Border, 1998	-0.557	(0.037)	-0.536	(0.049)	-0.495	(0.060)
State Border, 1999	-0.563	(0.039)	-0.581	(0.051)	-0.542	(0.060)
State Border, 2000	-0.572	(0.039)	-0.625	(0.052)	-0.590	(0.060)
State Border, 2001	-0.516	(0.038)	-0.488	(0.050)	-0.457	(0.060)
State Border, 2002	-0.522	(0.038)	-0.529	(0.053)	-0.506	(0.060)
State Border, 2003	-0.505	(0.038)	-0.488	(0.050)	-0.458	(0.060)
State Border, 2004	-0.531	(0.038)	-0.445	(0.050)	-0.421	(0.060)
Log Air Distance	-1.064	(0.025)	-1.680	(0.031)	-1.761	(0.011)
p-value, E-W Border, 1995 = E-W Border, 2004	[0.000]		[0.000]		[0.000]	
p-value, State Border, 1995 = State Border, 2004	[0.000]		[0.000]		[0.009]	
R^2	0.74		0.67			
Pseudo R^2					0.24	

Notes: Dependent variable is the value of shipments from district i to district j, aggregated from shipment volume at one-digit goods classification level. Standard errors robust to clustering at district pair level are reported in parentheses. All regressions include time-varying exporter and importer fixed effects. Number of observations is 100,980.

Table 2b: Benchmark Results for VG Regional Units

Estimator	Poisson		Pooled OLS		Tobit	
E-W Border, 1995	-0.555	(0.070)	-0.488	(0.079)	-0.488	(0.049)
E-W Border, 1996	-0.461	(0.064)	-0.451	(0.068)	-0.451	(0.049)
E-W Border, 1997	-0.475	(0.058)	-0.450	(0.064)	-0.450	(0.049)
E-W Border, 1998	-0.444	(0.054)	-0.368	(0.060)	-0.368	(0.049)
E-W Border, 1999	-0.399	(0.054)	-0.335	(0.062)	-0.335	(0.049)
E-W Border, 2000	-0.438	(0.050)	-0.359	(0.058)	-0.359	(0.049)
E-W Border, 2001	-0.452	(0.050)	-0.412	(0.053)	-0.412	(0.049)
E-W Border, 2002	-0.312	(0.049)	-0.267	(0.051)	-0.267	(0.049)
E-W Border, 2003	-0.381	(0.048)	-0.329	(0.053)	-0.329	(0.049)
E-W Border, 2004	-0.304	(0.046)	-0.256	(0.059)	-0.256	(0.049)
State Border, 1995	-0.469	(0.059)	-0.586	(0.092)	-0.586	(0.079)
State Border, 1996	-0.311	(0.057)	-0.385	(0.083)	-0.385	(0.079)
State Border, 1997	-0.281	(0.061)	-0.331	(0.088)	-0.331	(0.079)
State Border, 1998	-0.226	(0.060)	-0.287	(0.083)	-0.287	(0.079)
State Border, 1999	-0.287	(0.060)	-0.376	(0.086)	-0.376	(0.079)
State Border, 2000	-0.274	(0.062)	-0.323	(0.087)	-0.323	(0.079)
State Border, 2001	-0.216	(0.063)	-0.298	(0.088)	-0.298	(0.079)
State Border, 2002	-0.241	(0.060)	-0.289	(0.086)	-0.289	(0.079)
State Border, 2003	-0.231	(0.061)	-0.290	(0.086)	-0.290	(0.079)
State Border, 2004	-0.235	(0.059)	-0.286	(0.083)	-0.286	(0.079)
Log Air Distance	-1.301	(0.038)	-1.368	(0.044)	-1.368	(0.013)
p-value, E-W Border, 1995 = E-W Border, 2004	[0.000]		[0.000]		[0.000]	
p-value, State Border, 1995 = State Border, 2004	[0.000]		[0.000]		[0.007]	
R^2	0.90		0.87			
Pseudo R^2					0.65	

Notes: Dependent variable is the value of shipments from district i to district j, aggregated from shipment volume at two-digit goods classification level. Standard errors robust to clustering at district pair level are reported in parentheses. All regressions include time-varying exporter and importer fixed effects. Number of observations is 7,020.

Table 3: Does Intermodal Trade Matter?

	Benchmark VB trade		Dropping VBs with strong intermodal trade	
E-W Border, 1995	-0.551	(0.034)	-0.514	(0.034)
E-W Border, 1996	-0.511	(0.032)	-0.476	(0.031)
E-W Border, 1997	-0.547	(0.031)	-0.511	(0.031)
E-W Border, 1998	-0.475	(0.031)	-0.442	(0.031)
E-W Border, 1999	-0.438	(0.031)	-0.400	(0.030)
E-W Border, 2000	-0.420	(0.031)	-0.383	(0.031)
E-W Border, 2001	-0.441	(0.029)	-0.408	(0.029)
E-W Border, 2002	-0.317	(0.028)	-0.283	(0.027)
E-W Border, 2003	-0.363	(0.028)	-0.333	(0.028)
E-W Border, 2004	-0.326	(0.027)	-0.303	(0.027)
State Border, 1995	-0.687	(0.040)	-0.621	(0.038)
State Border, 1996	-0.650	(0.038)	-0.593	(0.036)
State Border, 1997	-0.617	(0.039)	-0.560	(0.037)
State Border, 1998	-0.557	(0.037)	-0.494	(0.035)
State Border, 1999	-0.563	(0.039)	-0.513	(0.036)
State Border, 2000	-0.572	(0.039)	-0.517	(0.037)
State Border, 2001	-0.516	(0.038)	-0.457	(0.036)
State Border, 2002	-0.522	(0.038)	-0.463	(0.036)
State Border, 2003	-0.505	(0.038)	-0.445	(0.036)
State Border, 2004	-0.531	(0.038)	-0.469	(0.035)
Log Air Distance	-1.064	(0.025)	-1.121	(0.022)
p-value, E-W Border, 1995 = E-W Border, 2004	[0.000]		[0.000]	
p-value, State Border, 1995 = State Border, 2004	[0.000]		[0.000]	
R^2	0.74		0.39	

Notes: PPML estimation. Dependent variable is the value of shipments from district i to district j, aggregated from shipment volume at one-digit goods classification level. Standard errors robust to clustering at district pair level are reported in parentheses. All regressions include time-varying exporter and importer fixed effects. Number of observations is 96,980.

Table 4: Measuring Improvements in Infrastructure

Mode of Transportation:	Road			Railway		Ship	
Dependent Variable:	**Δ Travel Distance**	**Δ Travel Time**	**Δ Travel Time with Breaks**	**Δ Travel Distance**	**Δ Travel Time**	**Δ Travel Distance**	**Δ Travel Time**
Air Distance	-0.0028** (0.0005)	-0.0081** (0.0014)	-0.0201** (0.0043)	0.0003* (0.0001)	0.0029 (0.0114)	-0.0001 (0.0002)	-0.1976** (0.0073)
E-W Border × Air Distance	-0.0020** (0.0004)	-0.0155** (0.0014)	-0.0553** (0.0100)	-0.0010** (0.0001)	-0.4028** (0.0139)	-0.0107** (0.0004)	-0.3589** (0.0114)
Adj. R^2	0.04	0.11	0.03	0.02	0.29	0.36	0.51

Notes: OLS estimation. Dependent variable is the change in the transport cost measure over the sample period. Robust standard errors are reported in parentheses. Number of observations is 3,025.

Table 5: Intra-German Migration Patterns

	East-East	East-West	West-East	West-West
1991	2.6	5.8	2.1	11.0
1992	2.4	4.6	2.6	10.7
1993	2.6	3.9	2.6	9.8
1994	3.1	3.5	2.8	10.4
1995	3.5	3.5	2.8	10.4
1996	3.9	3.4	2.9	10.1
1997	4.4	3.4	2.8	10.0
1998	4.6	3.7	2.8	10.0
1999	4.5	3.9	2.8	10.1
2000	4.2	4.4	3.1	10.2
2001	4.3	4.9	3.0	10.5
2002	4.3	4.6	3.0	10.3
2003	4.4	4.2	2.9	9.6
2004	4.5	4.0	2.8	9.9

Notes: The figures show migration flows between federal states in percent of total population. Raw data are taken from Statistisches Bundesamt, Fachserie 1, Reihe 1.2.

Table 6: Does Migration Matter?

	Benchmark for State-Level Trade		Adding Controls for Migration	
E-W Border, 1995	-0.565	(0.075)	-0.615	(0.065)
E-W Border, 1996	-0.469	(0.069)	-0.514	(0.060)
E-W Border, 1997	-0.484	(0.065)	-0.520	(0.055)
E-W Border, 1998	-0.453	(0.059)	-0.483	(0.051)
E-W Border, 1999	-0.413	(0.060)	-0.436	(0.051)
E-W Border, 2000	-0.452	(0.054)	-0.494	(0.048)
E-W Border, 2001	-0.468	(0.055)	-0.500	(0.048)
E-W Border, 2002	-0.326	(0.055)	-0.356	(0.048)
E-W Border, 2003	-0.394	(0.054)	-0.434	(0.048)
E-W Border, 2004	-0.315	(0.052)	-0.330	(0.046)
Log Air Distance	-1.310	(0.052)	-0.774	(0.118)
Log In-Migration			0.174	(0.058)
Log Out-Migration			0.179	(0.056)
p-value, E-W Border, 1995 = E-W Border, 2004	[0.000]		[0.000]	
R^2	0.50		0.96	

Notes: PPML estimation. Dependent variable is the value of shipments from state i to state j, aggregated from shipment volume at two-digit goods classification level. Migration refers to the stock of migration since 1991. Standard errors robust to clustering at state pair level are reported in parentheses. All regressions include time-varying exporter and importer fixed effects. Number of observations is 2,400.

Figure 1: Intra-German Trade by Mode of Transportation

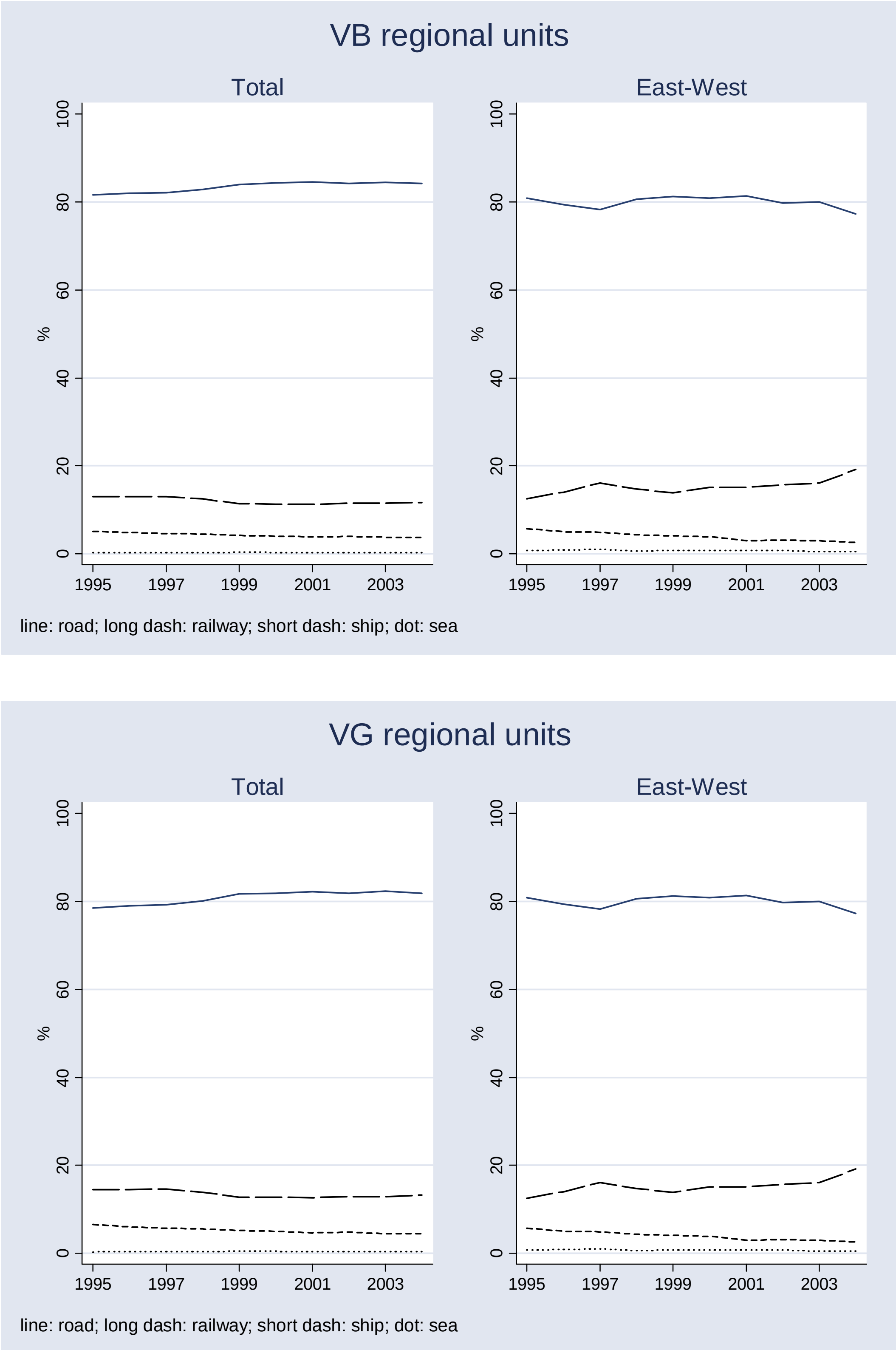


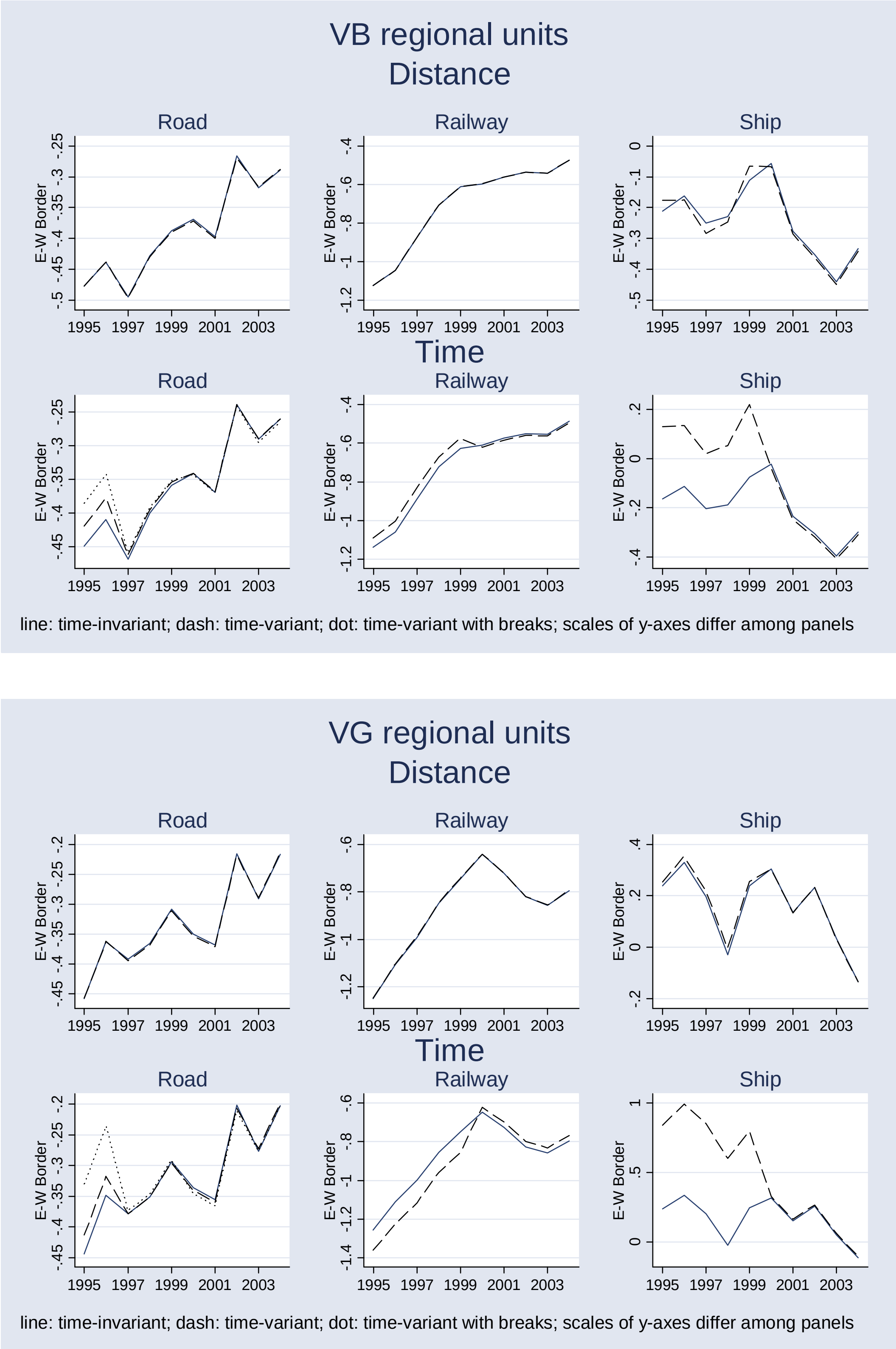
Figure 2: Estimation Results by Mode of Transportation

Notes: Each panel graphs the estimated border coefficient obtained from a regression similar to the specification reported in column 1 of tables 2a and 2b. Instead of total shipments, the dependent variable is the value of shipments by the respective mode of transportation.

Figure 3: Estimation Results by 1-Digit Industry

Notes: Each panel graphs the estimated border coefficient obtained from a regression similar to the specification reported in column1 of table 2a. Instead of total shipments, the dependent variable is the volume of shipments at 1-digit industry level.

Figure 4: Estimation Results with Time-Varying Distance Measures



Notes: Each panel graphs the estimated border coefficient obtained from a regression similar to the specification reported in column 1 of tables 2a and 2b. Instead of direct-line distance, time-invariant and time-variant travel distance measures are used.

Map 1: Map of German States and Districts

Source: Bundesamt für Kartografie und Geodäsie.

Map 2: Map of German States and VB Regional Units

Source: Statistisches Bundesamt.

Map 3: Map of German States and VG Regional Units

Source: Statistisches Bundesamt.

Appendix Table 1: Broad Goods Categories (Güterabteilungen)

0	Agricultural products and live animals
1	Foodstuffs and animal fodder
2	Solid mineral fuels
3	Petroleum products
4	Ores and metal waste
5	Metal products
6	Crude and manufactured minerals, building material
7	Fertilizers
8	Chemicals
9	Machinery, transport equipment, manufactured articles and miscellaneous articles

Appendix Table 2: Disaggregated Goods Categories (Gütergruppen)

01	Cereals
02	Potatoes, other fresh or frozen fruits and vegetables
03	Live animals, sugar beet
04	Wood and cork
05	Textiles, textile articles and man-made fibres, other raw animal and vegetable materials
06	Foodstuff and animal fodder
07	Oil seeds and oleaginous fruits and fats
08	Solid minerals fuels
09	Crude petroleum
10	Petroleum products
11	Iron ore, iron and steel waste and blast furnace dust
12	Non-ferrous ores and waste
13	Metal products
14	Cement, lime, manufactured building materials
15	Crude and manufactured minerals
16	Natural and chemical fertilizers
17	Coal chemicals, tar
18	Chemicals other than coal chemicals and tar
19	Paper pulp and waste paper
20	Transport equipment, machinery, apparatus, engines, whether or not assembled, and parts thereof
21	Manufactures of metal
22	Glass, glassware, ceramic products
23	Leather, textile, clothing, other manufactured articles
24	Miscellaneous articles