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Border Effects and Border Regions: Lessons from the German Unification

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Abstract

This paper examines data on trade flows between West German Bundesländer (federal states) and East Germany to explore the effect of national borders on trade. Although the data cover only a small fraction of intra-German trade flows, I find a home bias of about factor 2.2; West German shipments to East Germany are about 120% larger than deliveries to an otherwise similar foreign country. Based on this result, possible implications for border regions are discussed

JEL classification: F 14, F15

Key words: home bias, intranational trade, gravity regression, unification

I. Introduction

Recent evidence suggests that national borders have a large deterring effect on the shipment of goods. Contrary to the popular belief of global integration and a borderless world, firms sell much more to domestic clients than to otherwise identical foreign customers. John McCallum (1995), for example, finds that trade between Canadian provinces exceeds comparable trade flows between Canadian provinces and US states by factor 20.

Following this striking finding, there are basically two sorts of studies.[1] A first wave of papers aims to provide additional estimates on the size of the border effect. Since Statistics Canada initially appeared to be the only national statistical office in the world that reports intra-national trade data and thereby allows to estimate the border effect directly, these studies began by exploring various extensions of McCallum's original framework (Anderson and Smith [1999], Helliwell [1998]). Later, Shang-Jin Wei (1996) proposed ingenious ways to approximate the missing data so that it was also possible to estimate the home bias for other countries (Head and Mayer [2000], Nitsch [2000a]). Finally, it turned out that intra-national trade data are also available for some more countries.

A second line of research seeks to explain the surprisingly high estimates of the border effect. An interesting empirical contribution is Holger Wolf's (2000) finding that also regions within countries are not fully integrated; while there are no visible barriers to trade, trade within US states is disproportionately large. Most of this work, however, focuses on methodological aspects. James Anderson and Eric van Wincoop (2001a), for instance, show that the border effect is reduced if a theoretically grounded gravity equation is estimated. Carolyn Evans (2001) argues that about one-half of the estimated border effect is due to the fact that fewer goods are available as exports.

This paper explores another unique data set of intra-national trade flows. In particular, I examine data on trade between West German Bundesländer (federal states) and East Germany which are available as a relic of German division. Instead of attempting to propose another explanation of why borders matter, however, these results are meant to provide the basis for a discussion of possible implications for border regions.

To preview the main results, I find a home bias of about factor 2.2, although the data cover only a small fraction of intra-German trade flows. While national borders clearly inhibit trade, it is argued

[1] Johannes Bröcker (1984) provided a first, but largely unnoticed analysis of the effect of borders on trade.

that this does not necessarily imply a negative outlook for the economic development of border regions.

The paper is organized as follows. Section 2 describes the data. Section 3 presents the results. Section 4 discusses some implications for border regions, and section 5 concludes.

II. Methodology and Data[2]

2.1 Methodology

The standard tool to assess the impact of national borders on trade is the gravity model. This simple framework is empirically highly successful in explaining the volume of trade between two geographical areas (usually countries) by the economic size of these areas and the distance between them:

$$(1) \qquad ln(X_{ij}) = \alpha + \beta_1\, ln(Y_i) + \beta_2\, ln(Y_j) + \beta_3\, ln(D_{ij}) + \varepsilon_{ij}$$

where X_{ij} are exports from unit i to unit j, Y_i and Y_j are the GDP of i and j, respectively, and D denotes the distance.[3] This basic specification can then be augmented by other variables which are assumed to affect bilateral trade flows. Other studies, for example, typically find statistically significant coefficients on dummies for country pairs that speak a common language (*LANG*) or share a common border (*ADJA*).[4] Moreover, it has been argued (Deardorff [1997]) that the relative position of a country matters, with countries that are far away from other markets (and therefore face less alternative trade opportunities) trading more with each other. Most notably for our purposes, however, extending the sample to cover also trade flows between domestic locations allows to include a *HOME* dummy which measures the extent to which intra-national trade possibly deviates from external trade. The benchmark specification to be estimated is then given by

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[2] The following two sections draw heavily on Nitsch (2000c).

[3] There is (now) firm theoretical foundation for this regression specification. For instance, models based on CES preferences and goods that are differentiated by region of origin typically yield (a variant of) the following equation: $X_{ij} = Y_i Y_j / Y_w\, (t_{ij}/P_i P_j)^{1-\sigma}$, where t are iceberg costs of trade, P denotes the consumer price index and σ is the elasticity of substitution (see, for instance, Anderson and van Wincoop [2001a]). Various reduced forms of this equation are estimated in empirical work.

(2) $ln(X_{ij}) = a + g\ HOME + b_1\ ln(Y_i) + b_2\ ln(Y_j) + b_3\ ln(D_{ij})$

$$+\ b_4\ LANG + b_5\ ADJA + b_6\ ln(R_i) + b_7\ ln(R_j) + e_{ij}$$

where *HOME* takes the value of one for intra-national trade and zero otherwise, and *R* is the measure of remoteness which is, following Nitsch (2000a), defined as

(3) $R_i = 1 / (S_k\ [Y_k / D_{ik}])$.

<u>2.2 Data</u>

It is one of the contributions of this paper to apply this fairly standard regression framework to a new set of intra-national trade data. Specifically, I explore data on trade flows between West German federal states and the former East Germany for the period 1992-94.[5] This data set on intra-national trade is basically available due to historical accident. With the reunification of Germany in 1990, former external trade between the two German states became, by definition, trade between sub-national units. While this simple redefinition of national boundaries provides, taken for itself, no new insights, it is quite fortunate for our purposes that article 8 of the unification treaty then required the Statistisches Bundesamt (the German Federal Statistical Office) to continue the compilation of intra-German trade data.[6] Therefore, detailed data on trade between the 11 West German states, on the one hand, and former East Germany, on the other hand, are available until 1994.[7] Figure 1 provides a map of Germany.

Another contribution of this paper is the application of finely disaggregated distance data. Recent attempts to approximate the average distance for internal shipments has shown that the standard procedure in gravity models of using the simple distance between particular city pairs (e.g., the two largest cities) can yield seriously distorted results; a problem that appears to be most acute for neighbor territories with a wide variety of potential cross-border trading distances. A natural solution

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[4] Jeffrey Frankel (1997) provides an excellent discussion and numerous applications of the gravity model.

[5] Frankel (pp. 122-24) and Jarko Fidrmuc and Jan Fidrmuc (2001) provide additional evidence and discussion.

[6] The main reason for this clause was the obvious need for detailed information on economic developments in the two parts of Germany.

to this problem appears to be the calculation of average weighted distances for a large sample of cities, as proposed by John Helliwell and Geneviève Verdier (2001). Therefore, I compute the average weighted (great circle) distance between all cities with a population larger than 20,000 for intra-German trade flows, while the average distance for external trade is approximated by the weighted distance between the federal states' cities with a population above 20,000 and the five largest cities in the foreign country. An appendix reports the distances used in the analysis (see also Nitsch [2000b]).

The data sources can be summarized as follows. Intra-German trade data are taken from Statistisches Bundesamt (1995). Comparable external trade data by Bundesland and by country are compiled from detailed machine tables, also supplied by the Statistisches Bundesamt. Finally, all other country specific data such as GDP and population are obtained from the European Commission (1996), with Bundesland GDP data approximated by using weights from detailed regional accounts (VGRdL [1998]).

2.3 Different Concepts of Home Bias

Before I present the results, it is necessary to discuss some qualifications. A first obvious observation is that a simple regression analysis of trade flows from a West German state to East Germany relative to the state's exports to other countries captures only a fraction of the German home bias. For one thing, the analysis ignores intra-state shipments. Fortunately, this problem appears to be of minor importance. Also McCallum's (1995) and Helliwell's (1996) original studies on Canada consider only inter-provincial trade flows. More importantly, however, the analysis also misses, due to the lack of data, deliveries between West German states. In effect, the data set covers only a very specific part of intra-German trade flows so that the results should be interpreted as a lower-bound estimate of the average German home bias.[8]

A second concern is that trade flows between West and East Germany could possibly be distorted. For at least 30 years, trade between the two halves of Germany was artificially suppressed until the political barrier was suddenly lifted in 1990, and it remains unclear how trade has responded to the redrawing of the national border. On the one hand, trade may have fallen since the reunification has

[7] As the Statistisches Bundesamt could no longer rely on customs declarations, companies had to report shipments directly to the office.

[8] A back-of-the-envelope calculation shows that shipments to East Germany make up less than 4% of West Germany's total domestic sales (total production minus exports).

removed the basis for the large part of the few existing intra-German trade relations. The fall of the Berlin wall has also opened up trade opportunities with other Western countries, while a recession in East Germany after the introduction of the Deutschmark may have suppressed trade in general. On the other hand, trade may also have strongly increased, benefitting from the temporal increase in demand associated with the radical switch of the East German economy to a market system and the renewal of the East German infrastructure (mostly financed by government transfers).

While the German case indeed might be too special to draw from it any general conclusions about the impact of national borders on trade, it should be noted that the empirical analysis is based on data for the period from 1992 to 1994, when major adjustments of intra-German trade flows may have been completed. Figure 2 shows that, after a sevenfold increase from 1989 to 1992, West German shipments to the East German Länder were relatively stagnant at about 65 bn. DM, limiting the risk of distorted trade data.

III. Results

3.1 Basic Specification

In a first step, I examine West German shipments to East Germany in relation to West German exports to Austria and the Netherlands. The basic idea is to find export markets which are for a West German firm possibly equally attractive as deliveries to East German customers. Austria and the Netherlands nicely fit this pattern. Both countries are of almost the same (geographic) size and average distance from West Germany as the East German Länder. More importantly, there is no obvious barrier to trade. Germany and the Netherlands are founding members of the European Union (EU), participating in a long process of regional integration since the formation of the European Coal and Steel Community (ECSC) in 1951. Austria, formerly a member of the European Free Trade Agreement (EFTA) and joining the EU in 1994, benefitted from an EU-EFTA free trade agreement which abolished import duties on industrial goods by 1977. Further, both countries speak German (or variants of it), and their currencies (the Austrian Schilling and the Dutch Guilder, respectively) were (almost) fixed to the Deutschmark. In sum, similar to McCallum's (1995) and Helliwell's (1996) Canada-US set-up, there is no reason to expect disproportionately large intra-German trade flows.

Table 1 presents the results for the baseline specification. Columns (1)-(3) report OLS results for the individual years, while column (4) pools observations for the whole period 1992-4. Not surprisingly, the fit of the regression is generally excellent with an adjusted R^2 above 0.9. Also the coefficients on distance (negative) and the exporter's GDP (positive) take the expected sign and are statistically significant. Two observations, however, are particular noteworthy. First, turning to the main variable of interest, the coefficient on the home dummy is 0.46 and significant at the 1 percent level. This suggests that West German shipments to East Germany are on average about 1.6 (=exp[0.46]) times as large as exports to Austria and the Netherlands, after controlling for economic size and distance. Given that the analysis covers only a fraction of intra-German trade flows, this estimate is quite remarkable. Second, contrary to standard results in gravity regressions, the coefficient on the importer's GDP is not statistically different from zero. Usually, this coefficient is strongly positive so that a rise in the importer's GDP is associated with a rise in exports. As the largest importer in the sample is the Netherlands (with a GDP about 50% larger than that of East Germany and Austria), this result suggests that the export volume to the Netherlands is disproportionately low. Hence, the German home bias is probably even larger than indicated by the home dummy.

3.2 Sensitivity Analysis

To explore the robustness of my results, I have performed a large number of sensitivity analyses. For instance, although standard, the use of (real) GDP as a measure of economic size might be inappropriate in the present case since a large share of East Germany's GDP was provided by fiscal transfers from West Germany.[9] To deal with this issue, I use the log of population size as an instrument for the log of GDP.[10] Given that per capita income in East Germany is considerably below that of alternative shipment destinations in the sample, I would expect that this modification yields a lower estimate of the border effect. The first column in table 2 presents the results. As shown, the estimated coefficient on the home dummy indeed drops to 0.37 but the coefficient remains statistically highly significant and economically large; West Germany shipments to East Germany are disproportionately large. The other estimated coefficients are basically unchanged.

[9] The problem would be more severe in an analysis of shipments from East Germany to West Germany. While transfers (at least partly) add to domestic absorption, they leave the production potential completely unaffected.

[10] This procedure is also often used in gravity-type frameworks to control for the potential endogeneity of the GDP variables. According to the export-led growth hypothesis, more exports may contribute to larger GDPs.

In a next step, I add a few explanatory variables which are usually found to affect international trade flows. Specifically, I apply the same sample as before to estimate variants of equation (2). The results are shown in the middle column of table 2.

Looking at the new regressors, it turns out that only the coefficient on the remoteness of the exporter is statistically significant. The negative coefficient implies that the shipments from centrally-located West German states (i.e., Rheinland-Pfalz, Hessen) are disproportionately large. The coefficients on the language and the adjacency dummies are not different from zero at any conventional level of significance, implying that (in this sample) sharing a common language or a common border does not facilitate trade. Most notably for my purposes, the estimated home bias gets larger, rising to factor 2.2 (=exp[0.79]).

In the final column of table 2, I report the results of an alternative regression specification. Anderson and van Wincoop (2001a) have shown that a theoretical gravity equation requires that the elasticities on the income variables should be one. This modification, however, has almost no effect on the results; imposing unitary coefficients leaves the estimated home bias basically unchanged.

In another robustness check, I increase the number of export destinations to deal with the problem of possible misspecification due to the small number of importers. Anderson and Smith (1999) already expand McCallum's original Canada-US data set to cover also Canadian trade with 11 other international trading partners and find surprisingly little variation in the estimated border effects. How then does an extension of our sample affect the results?

Column (1) of table 3 presents the results for a sample of seven German neighbor countries.[11] The increase in the number of observation indeed improves the efficiency of the estimation. The estimated coefficient on the importer's GDP, for instance, becomes statistically significant and is of reasonable magnitude. Also, the coefficients on the adjacency and (German) language dummies become significantly different from zero, meaning that there is larger-than-proportional trade between state-country pairs that share a common border or speak the same language. The coefficient on the additionally included dummy on membership in the European Union (EU) is insignificant. Turning to the key variable of interest, the estimated border effect remains largely unchanged. With this extension, the German home bias is about 2.4.

[11] The countries are Austria, Belgium & Luxembourg, Czechoslovakia (the Czech Republic for 1993-4), Denmark, France, the Netherlands, and Switzerland.

Columns (2) and (3) explore other extended samples. Column (2) shows the results on a sample of West European countries[12], while column (3) combines both previous samples and additionally includes Poland, Slovakia (only for 1993-4) and Hungary as export destinations. The point estimates for all variables are broadly similar. In the total sample (column 3), the home bias is of about factor 2.2.

3.3 Border Effects by State

Finally, I also estimate separate border effects for each West German federal state. The idea is to explore whether some states exhibit a particularly large bias in shipments to East Germany. The results are shown in table 4. Similar to Helliwell's (1998) results for Canadian provinces, the estimated border effects vary considerably across individual states. On the lower end of the range, one state, Schleswig-Holstein, has no measurable trade bias; Schleswig-Holstein's shipments to East Germany do not deviate significantly from the state's border-crossing deliveries, holding other things constant. On the upper end, a home bias of 4.8 (=exp[1.57]) and 2.9 (=exp[1.07]) is found for the city states of Hamburg and Bremen, respectively. Although the data on intra-German trade officially exclude re-exports and East Germany also has access to the sea, this finding might in part result from the cities' port activities.

Unreported results show that differences in import volumes indeed help to explain differences in the estimated home bias between West German states; states with a large share of imports in GDP also report disproportionately large shipments to East Germany. Controlling for this effect, however, does not weaken the key results. The estimated home bias for a state with an average import share is basically unchanged at 2.2, implying that the previous estimates are not distorted by a few West German states operating as hubs for East Germany's imports from the world.

IV. Implications for Border Regions

What do all these results (and others in the literature on border effects) mean for border regions? In the following, I will put these empirical findings into context and discuss some general implications for border regions.

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[12] The sample includes Austria, Belgium & Luxembourg, Denmark, France, Italy, the Netherlands,

4.1 Borders Matter

A first observation is that national borders indeed have a measurable inhibiting effect on trade. The estimation results for Germany have shown that West German deliveries to East Germany exceed comparable border-crossing deliveries to an otherwise identical foreign country by a factor of about 2.2. Moreover, this result is probably only a lower-bound estimate. The data cover only a small fraction of intra-German shipments and apply to a period shortly after unification.

There is also no evidence that this finding suffers from misspecification. Anderson and van Wincoop (2001) argue that most estimates suffer from omitted variables bias and theoretically inconsistent parameters. However, adding remoteness measures and imposing unitary income elasticities has little effect on the German results. Also Keith Head and Thierry Mayer's (2001) critique that many border effect estimates are probably inflated by the use of inappropriate distance data does not apply here. The results are derived from a comparison of direct shipments between regions, with no assumptions for intra-regional trade (and distances).

This implies, however, that border regions may indeed appear to be particularly disadvantaged. If policies, institutions and regulations that separate nations create large barriers to trade, then border regions, offering only limited access to markets due to their geographic location, may indeed be less attractive for firms and workers.

4.2 Trade Patterns Adjust Quickly

This does not mean, however, that border regions necessarily have depressing growth prospects. For one thing, the evolution of intra-German trade flows shows that trade patterns are very responsive to changes in border barriers. After German unification, west German shipments to East Germany increased by factor 7 within three years.

Also other studies have shown that economic integration can very substantially increase international trade. Head and Mayer (2000) and Nitsch (2000a), for example, find a gradual decline in the home bias in the European Union. Helliwell (1998, pp. 21-23) finds that, following the Canada-US Free Trade Agreement, the Canadian border effect fell from 19.5 in 1990 to about 12 in 1993. Anderson and van Wincoop (2001b) report that US-Mexican size-adjusted trade has almost doubled after the North American Free Trade Agreement went into effect.

Spain, Sweden, Switzerland, and the United Kingdom.

4.3 Distance to Border Has No Separate Effect on Trade

Even more encouraging for border regions is that there is generally no association between the geographic location of a region and its estimated home bias. If border regions are indeed disadvantaged, one would expect that these regions also have a particularly large home bias (central regions are expected to trade less internationally due to their larger distance to foreign markets, other things equal). While the results for West German states show some variation in the estimated home bias across individual states, these differences are unrelated to geographic characteristics.

This finding is confirmed by a number of other studies that estimate separate border effects for individual regions. Helliwell (1998, p. 27), for example, notes for Canadian provinces that the ranking of border effects basically follows the ranking in terms of resource dependence and, thus, is mainly determined by the industry mix of the province.

V. Conclusions

This paper explores a new data set on intra-national trade flows. In particular, data on trade volumes between West German Länder and East Germany, available as a relic of Germany's former division, allow to estimate the East Germany bias in West German goods trade. Although the data cover only a small fraction of intra-German shipments, I find that West German deliveries to East Germany exceed comparable border-crossing deliveries to an otherwise identical foreign country by factor 2.5. In a second part, I then discuss the implications of large border effects for border regions. I argue that there is no support for the hypothesis that border regions are necessarily disadvantaged.

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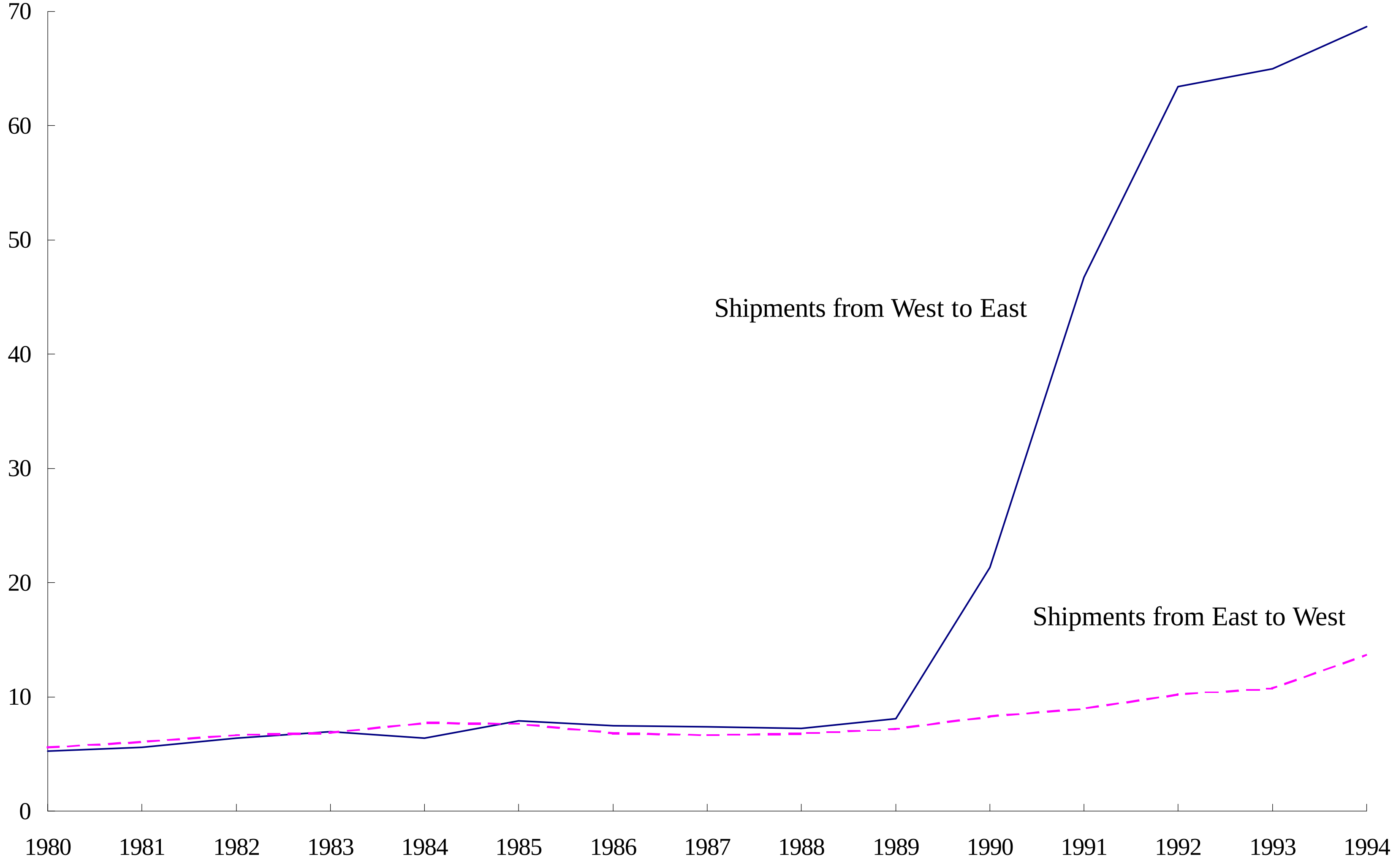
Note: The shaded area are the East German Länder.

Figure 1: Map of Germany



Source: Statistisches Bundesamt (1995).

Figure 2: The Evolution of Trade Between West Germany and East Germany

Table 1: Basic Specification

	(1)	(2)	(3)	(4)
Sample	Austria & the Netherlands	Austria & the Netherlands	Austria & the Netherlands	Austria & the Netherlands
Period	1992	1993	1994	1992-94
Home	0.329#	0.535**	0.474**	0.457**
	(0.170)	(0.151)	(0.144)	(0.087)
ln(Distance)	-0.855**	-0.734**	-0.736**	-0.761**
	(0.117)	(0.147)	(0.150)	(0.077)
ln(GDP_i)	1.045**	1.060**	1.118**	1.075**
	(0.048)	(0.049)	(0.052)	(0.028)
ln(GDP_j)	-0.012	-0.110	-0.097	-0.032
	(0.261)	(0.279)	(0.301)	(0.154)
Estimation method	OLS	OLS	OLS	Pooled OLS
# of observations	33	33	33	99
S.E.R.	0.34	0.33	0.36	0.33
Adj. R^2	0.91	0.92	0.92	0.92

Notes: White heteroskedastic-consistent standard errors are in parentheses. **, *, # denotes significant at 1%, 5% and 10% level, respectively. Constant not reported. Pooled regression includes unreported year dummies.

Table 2: Robustness Check I

	Instrumental Variables	*More Regressors*	*Alternative Specification*
Sample	Austria & the Netherlands	Austria & the Netherlands	Austria & the Netherlands
Period	1992-94	1992-94	1992-94
Home	0.374**	0.790*	0.749**
	(0.128)	(0.340)	(0.340)
ln(Distance)	-0.815**	-0.850**	-0.789**
	(0.079)	(0.133)	(0.143)
ln(GDP_i)	1.027**	1.130**	1.000
	(0.027)	(0.037)	
ln(GDP_j)	-0.079	1.089	1.000
	(0.093)	(1.029)	
Adjacency		-0.062	0.038
		(0.129)	(0.129)
Language		3.892	3.510
		(5.384)	(3.604)
ln($Remote_i$)		-0.696**	-0.512**
		(0.182)	(0.162)
ln($Remote_j$)		-8.295	-7.490
		(12.674)	(9.203)
# of observations	99	99	99
S.E.R.	0.35	0.31	0.33
Adj. R^2	0.91	0.93	0.92

Notes: Pooled OLS. White heteroskedastic-consistent standard errors are in parentheses. **, *, # denotes significant at 1%, 5% and 10% level, respectively. Constant and year dummies not reported. In the IV specification, (the log of) population is used as instrument for (the log of) GDP.

Table 3: Robustness Check II

	More Countries		
	(1)	(2)	(3)
Sample	Neighbor countries	Western Europe	Total
Period	1992-94	1992-94	1992-94
Home	0.883**	0.859**	0.781**
	(0.099)	(0.114)	(0.094)
ln(Distance)	-0.613**	-0.605**	-0.630**
	(0.085)	(0.079)	(0.068)
$\ln(GDP_i)$	1.023**	1.010**	1.044**
	(0.028)	(0.024)	(0.021)
$\ln(GDP_j)$	0.817**	0.813**	0.860**
	(0.044)	(0.038)	(0.029)
Adjacency	0.312**	0.290*	0.290**
	(0.081)	(0.075)	(0.073)
Language	0.247**	0.203#	0.133
	(0.086)	(0.108)	(0.085)
EU	-0.001	-0.066	-0.155*
	(0.089)	(0.095)	(0.074)
$\ln(Remote_i)$	-0.933**	-1.380**	-1.337**
	(0.123)	(0.130)	(0.116)
$\ln(Remote_j)$	-0.161	-0.287*	-0.332**
	(0.113)	(0.115)	(0.110)
# of observations	286	363	473
S.E.R.	0.40	0.42	0.40
Adj. R^2	0.92	0.89	0.93

Notes: Pooled OLS. White heteroskedastic-consistent standard errors are in parentheses. **, *, # denotes significant at 1%, 5% and 10% level, respectively. Constant and year dummies not reported. See text for a detailed list of countries included in the regressions.

Table 4: Border Effects by State

	(1)	(2)
Sample	Total	Total
Period	1992-94	1992-94
Baden-Württemberg	0.912**	0.842**
	(0.069)	(0.092)
Bayern	0.712**	0.544**
	(0.044)	(0.087)
Berlin (West)	0.431**	0.705**
	(0.135)	(0.160)
Bremen	0.938**	1.071**
	(0.137)	(0.154)
Hamburg	1.276**	1.570**
	(0.085)	(0.112)
Hessen	1.114**	0.576**
	(0.039)	(0.082)
Niedersachsen	0.933**	0.742**
	(0.064)	(0.094)
Nordrhein-Westfalen	1.013**	1.014**
	(0.051)	(0.079)
Rheinland-Pfalz	0.851**	0.562**
	(0.045)	(0.082)
Saarland	1.077**	0.814**
	(0.109)	(0.127)
Schleswig-Holstein	-0.032	-0.109
	(0.097)	(0.124)
ln(Distance)	-0.913**	-0.566**
	(0.046)	(0.071)
$\ln(GDP_i)$	1.019**	1.040**
	(0.024)	(0.022)
$\ln(GDP_j)$	0.824**	0.857**
	(0.018)	(0.029)
Adjacency		0.435**
		(0.077)
Language		0.133
		(0.084)
EU		-0.159*
		(0.073)
$\ln(Remote_i)$		-1.325**
		(0.120)
$\ln(Remote_j)$		-0.376**
		(0.113)
# of observations	473	473
S.E.R.	0.46	0.39
Adj. R^2	0.91	0.93

Notes: Pooled OLS. White heteroskedastic-consistent standard errors are in parentheses. **, *, # denotes significant at 1%, 5% and 10% level, respectively. Constant and year dummies not reported.

Appendix: Distance Matrix

	East Germany	France	Belgium& Luxemb.	Nether-lands	Italy	UK	Denmark	Spain
Baden-Württemberg	449	554	409	482	732	849	820	1,115
Bayern	369	698	541	585	734	981	791	1,232
Berlin-West	133	999	634	584	1,139	991	406	1,633
Bremen	323	852	389	300	1,211	690	352	1,541
Hamburg	282	930	479	390	1,243	772	286	1,613
Hessen	342	621	315	349	898	751	655	1,252
Niedersachsen	273	824	392	325	1,143	731	406	1,499
Nordrhein-Westfalen	398	638	206	197	1,046	612	575	1,318
Rheinland-Pfalz	422	549	280	343	861	723	724	1,176
Saarland	499	478	256	347	839	693	790	1,103
Schleswig-Holstein	320	978	519	421	1,299	782	237	1,666

	Sweden	Austria	Switzer-land	Poland	Czech Republic	Slovakia	Hungary
Baden-Württemberg	1,164	505	224	822	538	730	797
Bayern	1,107	356	356	677	387	569	640
Berlin-West	681	536	738	439	367	604	723
Bremen	719	755	692	747	630	881	995
Hamburg	642	736	748	676	592	840	958
Hessen	1,008	567	374	771	529	760	849
Niedersachsen	761	683	637	704	564	815	926
Nordrhein-Westfalen	944	716	356	850	650	893	991
Rheinland-Pfalz	1,083	601	313	845	589	809	891
Saarland	1,153	652	267	921	658	870	945
Schleswig-Holstein	593	782	805	690	631	875	995

Note: See text for details on the calculation of these distances. All distances are in kilometers.