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Border Effects in Passenger Air Traffic

by

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Abstract:

National borders substantially matter in passenger air traffic. Empirical estimates based upon a new data set on domestic and international departures from German airports indicate that the German border reduces air traffic activity by a factor of four to five. This result adds a further piece of evidence to the significance of border effects in various kinds of economic activity.

Keywords: Border effects, gravity model

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1. Introduction[*]

A traveler flying from Hanover to Bologna has to change at Munich airport, i.e. from a domestic to a border-crossing flight. For the first part of the trip, he may select between eight flights and will be carried by wide-bodied aircraft such as the Airbus 320 or the Boeing 737. For the second part, only four flights per day are available, and the typical aircraft is a narrow-bodied one with a capacity of less than 50 seats. Apparently, there is much lower demand for flights between Munich and Bologna than between Munich and Hanover, although distances are similar and economic activity in the Bologna region is about as high as in the Hanover region. The border between Germany and Italy seems to substantially suppress air traffic activity.

Since the seminal article of McCallum (1995), several studies have been published which empirically examine the impact of national borders on trade flows. The startling result of these studies is the extraordinary size of border effects. The Canada-U.S. border — which is physically almost non-existent — is supposed to reduce trade flows to about 5 per cent. Other studies have identified similar border effects. This paper tries to add to this literature by applying the McCallum approach to a new data set on passenger air traffic, which is completely independent of the ones applied in previous studies.

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The next section describes the gravity model which will be utilized to predict traffic flows and briefly surveys the literature on border effects. Section 3 describes the data set, section 4 presents the econometric results, and section 5 concludes.

2. Gravitation

Gravity models are widely used by trade economists to predict bilateral trade flows between countries. The application of such models to examining the size of border effects started with the above-mentioned article of McCallum (1995). It rests upon the standard gravity equation according to which bilateral trade flows are a log-linear function of the incomes of trading partners and the distance between them. Border effects are identified by a dummy variable that distinguishes between intra-national and international trade flows.

The analysis of McCallum refers to Canadian merchandise trade. Anderson and Smith (1999) and Wall (2000) use a similar data set. They basically confirm the results of McCallum according to which borders tend to reduce trade flows to about 5 per cent of intra-regional flows. Engel and Rogers (1996), Parsley and Wei (2002), and Feenstra (2002) extend the analysis to price dispersions which prove to be affected by large and significant border effects, too. A second type of studies tries to estimate border effects without explicit information on intra-regional trade flows. Although Helliwell and Verdier (2001), Helliwell (2002), and Head and Mayer (2002) have demonstrated that the results crucially depend on the method of calculating implicit information on intra-regional trade flows, these studies substantiate that border effects are not restricted to Canada-U.S. trade. Borders between OECD countries seem to reduce trade flows by a factor of three (Wei 1996), whereas borders between EU countries are found to reduce trade flows by a factor of ten (Nitsch 2000). Moreover, Wolf (2000) has identified significant border effects even in trade between U.S. states, whereas Helliwell and McKitrick (1998) argue that borders between Canadian provinces have no such effect on capital flows.

Several attempts have been made to give a plausible explanation for the large size of border effects. Firstly, Helliwell (1998) has shown that border effects are lower since the NAFTA agreement came into force, which points to the importance of protectionist trade barriers. However, the result of Anderson and Smith (1999) cast doubts on this view, because they find even higher border effects in industries which enjoy free trade than in protected industries. Secondly, models of monopolistic competition can reproduce large border effects resulting from small trade barriers if coupled with small differences in consumer preferences. In accordance with this hypothesis, Feenstra, Markusen and Rose (2001) have found higher border effects for differentiated than for homogenous goods. But it remains an open question also in this context why border effects are so large.

3. The Data Set

The German Federal Statistical Office provides a unique data set on intra-national and international air traffic (Statistisches Bundesamt 2000). It displays the number of departing persons by flight connection (passengers) and by final destination (travelers) for major German airports. The above-mentioned person, who travels rom Hanover to Bologna via Munich, is counted as *passenger* from Hanover to Munich and again from Munich to Bologna, but only once as *traveler* from Hanover to Bologna. Our analysis concentrates on travelers, since these data are not affected by the "hub-and-spoke" policy of airlines.[1]

As air transport statistics are derived from information displayed on flight tickets, a reliable distinction between passengers and travelers is feasible only for departures, not for arrivals. When passengers from abroad arrive at a German airport, their tickets do not carry information about previous connecting flights any more, because the corresponding parts of flight tickets were kept by foreign airport authorities at check-in. It is not feasible, therefore, to identify the true point of departure of the whole trip.

A further statistical distinction is made between non-scheduled flights (predominantly used by tourists) and scheduled flights. As we are interested in flight activities as complements of trade and investment activities, our analysis is based on scheduled flight statistics. Unfortunately, the Federal Statistical Office has abandoned this distinction for intra-EU flights since 1997. Therefore, major EU tourist

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[1] Frankfurt airport is the major German hub for most international and also for several national flights. For flights to Italy the main hub is Munich. An analysis of the regional structure of air traffic relying on passenger data would overestimate the relative importance of regions with a hub and underestimate the importance of other regions.

destinations were removed from the data set by hand.[2] In addition, all airports with less than 10,000 total annual arrivals from Germany were excluded.

The analysis presented in this paper is based upon traveler departures (scheduled flights) from the three largest German airports: Frankfurt, Hamburg, and Munich. The Federal Statistical Office provides information on national flight destinations for 17 German airports. After consolidating the three Berlin airports into one, there remain 14 destinations for national flights from each airport under investigation.

Also for foreign destinations, different airports of individual cities were consolidated and treated as one airport. After removing EU tourist destinations, there remain 101 destinations of international departures from Germany. This gives a total number of 115 destinations for each German airport.

Traveling by aircraft is not a reasonable choice at very short distances. For instance, Stuttgart is only 96 miles away from Frankfurt. Here, traveling by car or train is much more convenient and less time-consuming. In order to take account of this effect, all flight connec-

2 The following airports are excluded as tourist destinations. France: Calvi, Nice; Greece: all destinations; Italy: Catania, Rimini, Cagliari, Lametia Therme, Bari, Brindisi; Portugal: Faro, Funchal; Spain: Malaga, Alicante, Murcia, Ibiza, Menorca, Palma de Mallorca, Arrecife, Fuerte Ventura, Las Palmas, Santa Cruz, Tenerife Norte, Tenerife Almeria; Denmark: Billund; United Kingdom: Stansted.

tions with distances below 150 miles were excluded.[3] This adjustment reduces the number of observations for each airport to a level between 106 and 112. The distance of 150 miles may appear rather arbitrary, but alternative calculations based on somewhat lower or higher critical distances did not significantly change the regression results presented below.

The most recent statistics on airborne passenger traffic refer to the year 2001. As a consequence of September 11, this seems not to be a well-suited base year for analyzing regularities in air traffic. For the year 2000, the Federal Statistical Office has not published any data on intra-German travelers, but only on passengers. Therefore, the year 1999 has been chosen as base of the analysis.

Having established the data set on travelers, the distance between cities had to be identified. For this purpose, the coordinates of city centers (not of airports) were taken from the Appendix of the Encyclopedia Britannica Atlas of the World (1977 edition) and inserted into a calculation program provided by an Indonesian Travel Agency (www.indo.com/distance/index). One might argue that actual flight times would be a more appropriate distance measure, but we prefer geographical distance for two reasons: Firstly, flight times depend on

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3 This applies to flights from Frankfurt to Duesseldorf, Cologne, Nuremberg, Saarbruecken, Muenster, Erfurt, Stuttgart, Luxemburg, and Strasbourg (France), to flights from Hamburg to Hanover, Bremen, and Muenster, and, finally, to flights from Munich to Stuttgart and Nuremberg and the Austrian airports Innsbruck, Linz, and Salzburg.

connection, and one may get substantially different flight times for identical destinations. Secondly, this paper regards air traffic flows as complements of trade and investment flows which are probably more closely related to geographical distance than to flight time. The latter reason also explains why the coordinates of city centers were preferred over the coordinates of airports.

The third variable required is the gross domestic product of airport regions for the year 1999. For EU member countries and the Middle and East European accession countries, regional GDP data are provided by the Statistical Office of the European Community at the level of NUTS-2 regions. The data-base is described in Eurostat (2002); the unpublished data are easily available from Eurostat (or the author) upon request. GDP of European airport regions was calculated from GDP of that NUTS-2 region where the airport is located and surrounding NUTS-2 regions. GDP of North American airport regions were correspondingly calculated from GDP data of U.S. states and Canadian provinces and territories.[4] Detailed information on regional disaggregation is provided in the appendix.

4 GDP by U.S. state can be obtained from the U.S. Bureau of Economic Analysis (www.bea.doc.gov/bea/regional/gsp). GDP by province and territory is provided by Statistics Canada (www.statcan.ca).

4. Results

In accordance with previous studies, the following equation was estimated:

$$t_{ij} = c + \beta_1\ y_{ij} + \beta_2\ dist_{ij} + \beta_3\ Border_{ij} + \varepsilon_{ij}\,.$$

t is the logarithm of the number of persons traveling from i to j, c is a constant, y_{ij} is the logarithm of GDP of i multiplied by the GDP of j, $dist_{ij}$ is the geographical distance between i and j, $Border_{ij}$ takes the value of 1 for national flights and the value of 0 for international flights, and ε_{ij} is an error term.

The OLS regression results for the three airports are presented in Table 1. All coefficients show the expected sign and are statistically significant at the one-per cent level (except for the distance coefficient of Frankfurt and the constant for Hamburg which are significant at the 5-per cent level). The estimated coefficients should be of similar size for all regressions, because y_{ij} is calculated as product of the GDP of each destination and the GDP of the respective airport departure. In fact, the GDP coefficients for Frankfurt and Hamburg and the distance coefficients for Hamburg and Munich are not significantly different from each other. However, the Frankfurt regression displays a distance coefficient and the Munich regression displays a GDP coefficient which significantly differ from the respective coefficients for the other two airports.

Table 1 — *OLS-Estimates of Traveler Departures by Airport*

	Frankfurt	Hamburg	Munich
c	-5.89***	-5.12**	-10.09***
	(2.02)	(2.16)	(2.99)
y	0.77***	0.78***	1.00***
	(0.10)	(0.10)	(0.10)
dist	-0.28**	-0.65***	-0.62***
	(0.13)	(0.10)	(0.09)
Border	1.60***	1.29***	1.56***
	(0.33)	(0.38)	(0.34)
Obs	106	112	110
Adjusted R^2	0.38	0.55	0.57
SEE	1.27	1.03	1.13

Heteroskedasticity-consistent standard errors in parentheses.

*** and ** denote significance at one and five per cent level.

The three border coefficients, finally, do not significantly differ from each other.[5] On average, they indicate that the existence of borders reduces the amount of passenger air transport to about one quarter. This estimate is lower than most of the corresponding estimates of border-effects reviewed in section 2, but it is still substantial.

5 With Frankfurt as the benchmark, the t-values for the difference between border effects are 0.82 for Hamburg and 0.12 for Munich.

Table 2 — OLS-Estimates of Traveler Departures from Frankfurt, Hamburg, and Munich

	All destinations	International destinations	EU destinations
c	-6.13***	-5.63***	-15.04***
	(1.29)	(1.31)	(3.84)
y	0.84***	0.82***	1.25***
	(0.06)	(0.06)	(0.09)
dist	-0.51***	-0.51***	-0.18
	(0.06)	(0.06)	(0.12)
Border	1.52***		1.20***
	(0.22)		(0.36)
DummyHAM	-1.40***	-1.43***	-3.78*
	(0.16)	(0.17)	(2.25)
DummyMUC	-0.94***	-0.99***	-3.45
	(0.17)	(0.18)	(2.26)
Obs	328	298	184
Adjusted R^2	0.58	0.52	0.48
SEE	1.16	1.17	1.39

Heteroskedasticity-consistent standard errors in parentheses.

*** and * denote significance at one and ten per cent level.

In a second step, the data for all airports were pooled into one regression (Table 2, all destinations). The statistical significance of the airport dummies for Hamburg and Munich shows that Frankfurt plays a dominant role among German airports.[6] As explained above, this dominance cannot directly be attributed to the fact that Frankfurt is the main German hub for border-crossing flights, because the dependent variable refers to travelers and not to passengers. Nevertheless, there may exist an indirect hub effect, because many more departures are available from Frankfurt than from any other German airport. Hence, it is often more convenient to start a trip from Frankfurt, even if other airports are closer.

The estimated border coefficient indicates that borders tend to reduce air transport activity to about 22 per cent (1/exp [1.52] = 0.22). This is the basic result of this paper.

The second regression displayed in Table 2 includes flights to international destinations only. The coefficients look very similar to those obtained from the regression on all flights, and there is no statistically significant difference between them.[7] The third regression refers to flights within the European Union (including domestic flights). Again, the regression as a whole is statistically significant and all coefficients show the expected sign. Since flight times between different European locations do not vary very much, distance appears to be of minor

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6 In 1999, 20.0 million travelers (not passengers) departed from Frankfurt, whereas there were 4.3 million traveler departures from Hamburg and 9.1 million from Munich (scheduled flights only).

7 t-values for the divergence of coefficients for international flights from the coefficients for all flights: constant: 0.39; m: 0.34; dist: 0.02; DummyHAM: 0.18; DummyMUC: 0.26.

importance. Intra-European traffic flows are basically governed by the gravitational mass of regions (represented by their GDP) and, again, by significant border effects which are not statistically different from the ones estimated for all destinations.[8] The low importance of airport dummies, finally, can be attributed to the fact that the indirect hub effect in favor of Frankfurt airport is less distinct in European than in long-distance flight connections.

These additional estimates can be regarded as a sensitivity test of the robustness of results as proposed by Helliwell (2002). All in all, the gravity models seems to be able to predict not only trade and capital flows, but also flows in passenger air traffic.

3. Conclusions

Apparently, the perfectly integrated world economy is still a pie-in-the-sky. Geographical distance and national borders continue to matter — even in air traffic which is specifically suited for bridging long distances between countries and continents.

According to our results the existence of the German border reduces the number of traveler departures from German airports by a factor of four to five. It can be expected that the analyzed traffic flows, which exclude tourist flights and are not affected by hub-and-spoke distortions, basically follow the patterns of trade and investment flows

8 With the regression on all destinations as the benchmark, the t-value for differences in border effects is 0.36.

which have been examined in previous studies. As our data set is completely different, the results can be regarded as further and independent evidence for the large and significant impact of borders on the international division of labor.

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Appendix: Cities and Regions

City	Airport(s)	Region(1)
Hamburg	HAM	DE 6/F/93
Hanover	HAJ	DE 92/A4
Bremen	BRE	DE 5/94/91
Duesseldorf	DUS	DE A1/A5
Cologne	CGN	DE A2
Frankfurt	FRA	DE 71/72/73/B1/B3/26
Stuttgart	STR	DE 11/12/13/14
Nuremberg	NUE	DE 25/24
Munich	MUC	DE 21/22/23/27
Berlin	TXL/THF/SXF	DE 3/E3/E4/E8
Saarbruecken	SCN	DE C/B2
Muenster	FMO	DE A3
Leipzig	LEJ	DE D3/E1
Dresden	DRS	DE D2/D1
Erfurt	ERF	DE G/E2
Brussels	BRU	BE
Copenhagen	CPH/AAL	DK
Helsinki	HEL	FI 16/2/13/14/15
Turku	TKU/TMP	FI 17
Paris	ORY/CDG	FR 1/3/21/22/23/24/ FR 25/26/41
Bordeaux	BOD	FR 61/53/63
Lyon	LYS	FR 71/43/72
Marseille	MRS	FR 82/81/83
Nantes	NTE	FR 51/52
Strasbourg	SXB	FR 42
Toulouse	TLS/XTB	FR 62
London	LHR/LGW/LCY/LTN	UK I/J1/J2/J3/J4/ UK H2/H3
Aberdeen	ABZ	UK M1
Belfast	BFS	UK N
Bristol	BRS	UK K1/K2/K3/K4
Edinburgh	EDI	UK M2
Glasgow	GLA	UK M3/M4
Leeds	LBA	UK E2

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City	Airport(s)	Region(1)
Manchester	MAN	UK D3/D2/D4/D5/E1/ UKE3/E4
Newcastle	NCL	UK C2/C1/D1
Birmingham	BHX	UK G3/F1/F2/F3/ UK G1/G2/L1/L2
Dublin	DUB/ORK/SNN	IE
Rome	FCO	IT 6/52/71/72
Milan	BGY/LIN/MXP	IT 2/12/31
Ancona	AOI	IT 53
Bologna	BLQ	IT 4
Florence	FLR/PSA	IT 51
Genoa	GOA	IT 13
Naples	NAP	IT 8/91/92/93
Palermo	PMO	IT A
Turin	TRN	IT 11
Triest	TRS	IT 33
Verona	VRN/VCE	IT 32
Luxembourg	LUX	LU
Amsterdam	AMS	NL 32/11/12/13/21/22/ NL 23/31/41/42
Rotterdam	RTM	NL 33/34
Vienna	VIE	AT 13/11/12
Graz	GRZ	AT 22
Innsbruck	INN	AT 33/34
Klagenfurt	KLU	AT 21
Linz	LNZ	AT 31
Salzburg	SZG	AT 32
Lisboa	LIS	PT 13/12/14/15
Porto	OPO	PT 11
Madrid	MAD	ES 3/23/41/42/43
Barcelona	BCN/GRO	ES 51/24
Bilbao	BIO	ES 21/13/22
Santiago de comp		SCQES 11/12
Sevilla	SVQ/XRY	ES 61
Valencia	VLC	ES 52/62

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City	Airport(s)	Region(1)
Reykjavik	KEF	Iceland
Oslo	OSL/BGO/SVG/TRD	Norway
Zurich	ZRH/BRN/BSL/ VA/LUG	Switzerland
Sofia	SOF	BG
Tallin	TLL	EE
Riga	RIX	LV
Vilnius	VON	LT
Warsaw	WAW	PL 07/02/03/05/OA/ PL OD/OE
Gdansk	GDN	PL OB/OG
Krakow	KRK	PL 06/09
Kattowice	KTW	PL 0C/08
Wroclaw	WRO	PL ¼/0F
Bukarest	OTP	RO
Bratislava	BTS/KSC	SK
Ljubljana	LJU	SI
Prague	PRG	CZ
Budapest	BUD	HU
Montreal	YUL	QC/NF
Halifax	YHZ	NS/PE/NB
Toronto	YTO/YOW	ON/MB/SK/NU
Vancouver	YVR	BC/YT
Calgary	YYC/YEA	AB/NW
New York	JFK/EWR	NY/CT/NJ/VT/RI
Boston	BOS	MA/NH/ME
Philadelphia	PHL/PIT	PA
Baltimore	BWI	MD
Washington DC	DCA/IAD	DC/DE/VA/WV
Detroit	DTW/MSP	MN/ND/SD
Cincinatti	CVG/CLE	OH/MI
Memphis	MEM	TN
Charlotte	CLT/RDU	NC
Atlanta	ATL	GA/SC/AL
Miami	MIA/ORL/RSW/TPA	FL

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City	Airport(s)	Region(1)
Chicago	CHI	IL/IA/WI/IN/KY
Dallas	DAL/HOU/SAT	TX/AR/OK/NM
New Orleans	MSY	LA/MS
St. Louis	MKC/STL	MO
Seattle	SEA	WA/ID/MT
Portland	PDX	OR
Salt Lake City	SLC	UT
Los Angeles	LAX/SAN/SFO	CA
Las Vegas	LAS	NV
Phoenix	PHX	AZ
Denver	DEN	CO/KS/NE/WY
Tel Aviv	TLV	Israel
Hong Kong	HKG	Hong Kong
Tokyo	NRT/NGO/KIX	Japan
Singapore	SIN	Singapore
Taipei	TPE	Taiwan
Sydney	BNE/MEL/PER/SYD/	Australia
Auckland	AKL	New Zealand

(1) The regions of EU member countries and Middle and East European accession countries refer to the NUTS-2 classification of Eurostat, North American regions refer to U.S. states and Canadian provinces and territories.