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Free Mobility of Goods, Price Dispersion and Border Effect

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Prohlašuji, že jsem diplomovou práci „Free Mobility of Goods, Price Dispersion and Border Effect" vypracoval samostatně a použil pouze uvedené prameny a literaturu.

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ABSTRACT

Even under the regime of free mobility of goods the markets seem to be more segmented than is generally thought. This thesis focuses on the dampening effect of national borders on trade, which is accompanied by an extra dispersion of prices of similar goods between different countries. The evidence indicates that the presence of borders depresses the level of foreign trade as well as it enlarges the variation of prices across countries beyond of what can be explained by their physical distance and economic sizes. The comparison of intra- and international trade flows confirms that there is a 'missing trade' between countries. This so-called 'border effect' is evaluated by means of a gravity equation, in which trade flows between countries are positively affected their sizes and negatively by distance plus the presence of borders. In this paper the gravity model is employed for an empirical study of the border effect in the region of Central Europe over period 1993-2001. The results reveal that the intra-national trade exceeds the international trade about seven to ten times after separating the effects of size, distance and similar language.

ABSTRAKT

Dokonce v režimu volného pohybu zboží zůstávají trhy jednotlivých států poměrně segmentovány. Tato práce zkoumá vliv hranic mezi státy na jejich vzájemný obchod a na cenovou disperzi obdobného zboží mezi různými státy. Porovnáním vnitrostátních a mezinárodních obchodních toků je v ekonomické literatuře identifikován „chybějící obchod" mezi státy. Tento tzv. „border effect" se odhaduje pomocí gravitačního modelu, ve kterém obchodní toky jsou kladně spjaty s velikostí zemí a záporně s jejich vzdáleností i existencí hranic. V této práci je uplatněn gravitační model pro posouzení vlivu hranic na obchod zemí v regionu centrální Evropy v letech 1993-2001. Výsledky této analýzy prozrazují, že vnitrostátní obchod převyšuje mezinárodní obchod těchto států

sedmkrát až desetkrát po přihlédnutí k efektům velikosti států, vzdálenosti a jazykové podobnosti.

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List of used abbreviations

AUT – Austria

BAFTA – Baltic Free Trade Area

CEECs – Central and Eastern European countries

CEFTA – Central European Free Trade Area

CES – Constant elasticity of substitution

CZE – Czech Republic

DEU – Germany

EU – European Union

HUN – Hungary

IV – Instrumental variables

MRP – Mutual recognition principle

NAFTA – North American Free Trade Area

NTBs – Non-tariff barriers

OECD – Organisation for Economic Cooperation and Development

OLS – Ordinary least squares

POL – Poland

ROW – Rest of the world

SVK – Slovak Republic

SMP – Single Market Programme

SUR – Seemingly unrelated regression

TBTs – Technical barriers to trade

VAT – Value added tax

Introduction

What is the impact of national borders on trade? And do national borders contribute to price differentials? Answers to both questions are related and have been frequently empirically evaluated during the past decades. The importance of "missing trade" between locations divided by political boundaries has been recognized as the "border effect." Recently the theoretical background to the border effect has also been enriched as a part of international or intra-national macroeconomics.

Not all goods are exported and the volume of those goods traded across borders is lower than simple international trade theory would indicate. Furthermore, prices of goods differ more across countries. This paper targets its attention at the question why even under the regime of free mobility of goods the borders still matter. The empirical evidence suggests that a simple existence of a border makes the international markets more segmented than intra-national markets. There are still some obstacles, which may prevent goods from being freely circulated. On the other hand, there are some natural reasons why across countries some goods vary in prices and the volume of international trade is disproportionately low compared to trade inside countries. It seems that complete market integration becomes almost unrealistic. The economic literature regarding free trade impediments and border-based friction has extended especially in the past ten years.

The European Commission has published several reports about the price variation of goods among the EU member countries as well as measures to moderate this variation. Degryse and Verboven (2000) and De Serres et al. (2001) have investigated price differences across European cities. Engel and Rogers (2000) have researched the price divergence in the EU as a deviation from the purchasing power parity and the welfare costs associated with this price divergence. However, the discussion is not narrowed only to the European Union. The impact of US – Canadian border on price volatility studied Engel and Rogers (1994). Furthermore, the most inspiring work comes again from Canada – US trade study "National borders matter" by John McCallum (1995). One of the of McCallum's results was that trade among Canadian provinces is about twenty times higher than trade between Canadian provinces and US states after adjusting for size and distance. Subsequent to this statement, numerous papers have been written to contribute to this problem sometimes referred as 'the border effect puzzle'. For example, Anderson and van Wincoop (2001, 2001a) reported their solution to the 'puzzle'. For the OECD countries, Wei (1996) contributed to the debate and for the European Union, among others, Nitsch (2000, 2002) or Head and Mayer (2000, 2002) have analyzed the impact of borders on the level of trade. Chen (2002) considered cross-country differences in non-tariff barriers and technical barriers to trade to be a major determinant of border effects.

Domestic trade volumes have been widely observed to exceed the international trade five to twenty times. It is no wonder that national borders hold back a portion of potential trade, however, the magnitude of the effect in regime of free mobility of goods is confusing. Obstfeld and Rogoff (2000) considered the border effect as one of the 'six major puzzles in international macroeconomics.'

This paper is constructed in the following manner. Initially, it concentrates on the market integration in the European Union. It covers necessary aspects of free movements of goods with regard to technical barriers to trade. The second chapter of this paper gives an insight to price dispersion at European market and its probable explanations. The third chapter examines the border effect as a coefficient of "missing trade" between countries that cannot be explained by distance, GDP and possibly other factors. It describes the methodology of the border effect problem and subsequently reviews some outcomes of relevant literature. In the fourth chapter of this paper I use the gravity equation to investigate trade in a region of six central European countries including four new (since 2004) E.U. member states as well as Austria and Germany. I try to find an answer to the question whether there is a significant border effect in these central European countries and if it is declining over time.

1. Chapter One– Free Mobility of Goods

1.1. General principles

Free mobility of goods is one of the four freedoms of Single Market. The Single Market Programme (SMP) aimed to provide the removal of outstanding obstacles to the circulation of manufactured products within the Community. Some trade obstacles like customs and fiscal formalities were widespread. That caused delays for all shipments crossing frontiers. Cross-border shipments should no longer experience physical delays or supplementary costs related to fiscal declarations. Producers would no longer have to adapt their products before placing them on foreign markets. The objective is that consumers benefit from more choice at lower prices without reduced safety.

1.2. Harmonization of manufactured products

Different standards and customs, as well as regulatory differences raise the transaction costs for shipments crossing borders. The European Communities Treaty states that goods should circulate freely within the Internal Market. Member states may restrict the free movement of goods only in exceptional cases, for example when there is a danger resulting from issues such as public health, environment, or consumer protection. The risks vary by product sector. Pharmaceuticals and construction products obviously present higher risks than textiles or clocks for example. Harmonizing technical regulations has been introduced to the EU legislation in order to minimize risks and ensure legal certainty across member states, particularly in the higher risk product sectors. Lower risk sectors have not in general been the subject of legislation on a European level. Trade in this 'non-harmonized' sector relies on the mutual recognition principle (MRP) under which products legally manufactured or marketed in one Member State should in principle move freely throughout the Community. Approximately half of intra-EU trade in goods is covered by EU technical harmonization, the other half contains the 'non-harmonized' sector, which is either regulated by national technical regulations (30%) or not specifically regulated at all (20%).

Prior to the Single Market, a type of harmonization known as the 'old approach' involved an extensive product-by-product requirements. Comprehensive directives were problematical to agree by the European Council. It involved highly technical specifications and delays to achieve required unanimity in the Council. This approach was recognized to be slow and ineffective hence in the 1980s there was a tendency to reduce the intervention of public authorities.

Legislative harmonization based on the 'new approach' principle is limited to essential requirements that products placed on the market must satisfy in order to benefit from free movement. These essential requirements must be met either by harmonized standards or by applying to other technical specifications of products. Utilizing this approach turned out to be efficient and easier for updating harmonization with a significant participation from the industry.

1.3. Technical barriers to trade

Technical and non-tariff barriers to trade are policy-related factors in explaining border effects and therefore have both political implication and significance. Although various measures were put into practice in order to remove these barriers, Chen (2002) reports that in 1996, almost 80% of intra-EU trade in goods was still affected by technical barriers to trade (TBTs).

The removal of these barriers is one of the main policy guidelines of the Single Market to guarantee equal conditions of market access. Trade in such settings promotes efficiency while helping it to reduce the segmentation of the EU market and thus reinforces competition. Technical barriers to trade occurs if a producer is required to alter his product due to requirements of importing country, for instance rules for safety, health, environmental and consumer protection. Such product alternation could contribute to border effect because it imposes certain additional costs on exporters who want to enter foreign markets. Apart of the technical regulations, producers can set voluntary standards or non-regulatory barriers. Various measures have been undertaken by the EU Commission to eliminate the TBTs but with varied effectiveness. Trade flows in those industries with no TBTs, or with TBTs that were eventually removed are expected to exhibit lower border effects. For example, according to European Commission, measures employed to games and toys were successful and all significant barriers were probably removed. However, for instance, measures for ready-mix concrete have been proposed or implemented, but either not effective or with operational problems, which may account for its strong border effect.

The analysis of border effect in Chapter IV in this paper involves besides Germany and Austria four Central and Eastern European countries (CEECs). Since their accession to the EU is associated with the removal of technical barriers to trade, it has several implications. Brenton et al. (2000) distinguish trade in sectors through technical regulation approach in the EU and the CEECs. About two thirds of intra-EU trade as well as CEECs-to-EU trade is in sectors where technical regulations matter. But the proportion of old approach, new approach and mutual recognition principle does not fluctuate across countries in the intra-EU trade as much as in imports from the CEECs. For example: *"products subject to new approach directives in the EU form a much larger share of exports to the EU of the Czech Republic and of Slovenia than for other CEECs. In this case the main sectors are those producing machinery. Old approach products are of greatest importance to Slovakia, Estonia and Hungary. For these countries the main sectors include motor vehicles and parts, prepared meats and petroleum products."*[1] Brenton et al. (2000) show that besides Lithuania, Bulgaria and Romania[2] the remaining CEECs are more comparable to the current EU countries in terms of the weight of old approach products in their exports to the EU.

[1] Brenton et al. (2000), p.7.
[2] Imports from these three countries in old approach products are below the average for extra-EU imports.

A measure of comparative advantage of each of the CEECs in their trade with the EU after classifying sectors consistent with the harmonization approach uncovers the following interesting remarks. The CEECs have a minority of old approach sectors where they have a comparative advantage in their trade with the EU. Therefore the impact upon EU imports of products from old approach sectors will be small following their access to the Single Market, moreover, *"the main impact of accession may be to intensify competition in old approach sectors in CEEC markets."* [3] On the contrary, a substantial comparative advantage is revealed in new approach sectors of CEECs and consequently, after accession the technical barriers to trade will be alleviated and the competition in new approach products should intensify.

[3] Brenton et al. (2000). p.11.

2. Chapter Two - Price dispersion

Borders are proven to cause an extra dispersion in prices between cities in different countries beyond what can be explained by physical distance. Research indicates that price dispersion of the same good is much bigger across cities in different countries than across cities in the same country, even if one controls for distance (Engel and Rogers 1994, 2000). Moreover, the use of different currencies enhances the impact of national borders. This evidence is rationalized by nominal exchange rate volatility among countries (e.g. Parsley and Wei 2001). It this does not necessarily imply that the use of different currencies forms a barrier to trade, however, empirical studies (Rose 1999, 2000) found that trade across regions with the same currency is much more developed.

2.1. Price Dispersion in Europe

2.1.1. Deviations from Purchasing Power Parity

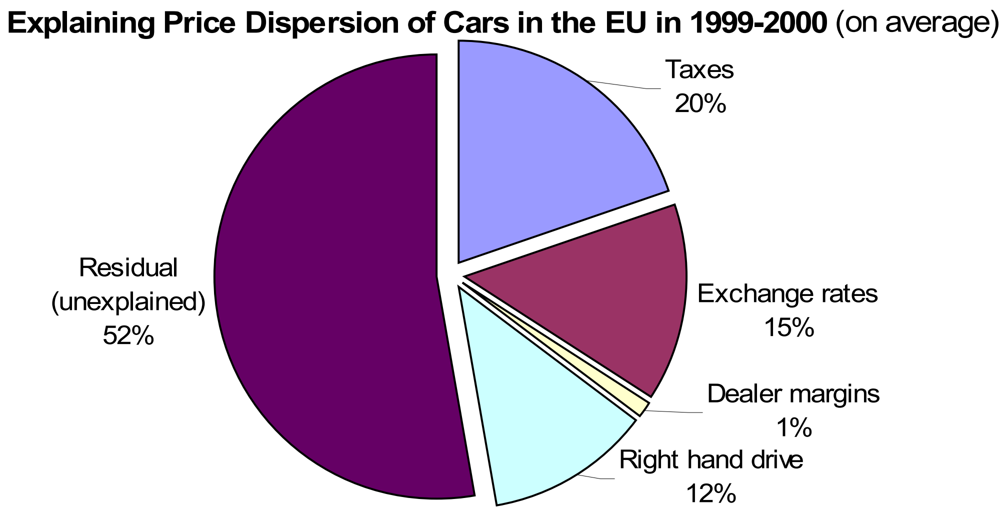
A study of Engel and Rogers (2000) explores that the law of one price fails to hold across European cities. The smallest relative price variability over the period 1981-1997 was reported between cross-border cities in the following pairs of countries: Belgium-Luxembourg, Germany-Austria and Germany-Netherlands while the largest for Italy-Switzerland, Spain-Switzerland, and Switzerland-Portugal. Over the whole period the average intra-national price variance was found to be 0.16 but the international as high as 2.69. Using disaggregated data the highest variance of the twelve-month change in the relative price was identified for recreation, books, clothing and footwear and household equipment. The lowest on the contrary was uncovered for fruit, fuel and energy, rents and breads and cereals.

De Serres et al. (2001) also examined the deviations from the law of one price. The authors estimated "width" of the border using price data on disaggregated groups of goods that are quite homogeneous and tradable. They found that for a given distance, traversing a national border boosts notably the price-level differential among European cities. *"Since 1970, for* *instance, the share of intra euro area trade in total trade has almost doubled and intra-industry trade flows — an indicator for industrial diversification — have risen sharply. At the same time, integration led to a lower dispersion of prices across countries, even though it remains fairly high and price convergence has progressed little in recent years."*[4]

2.1.2. Price Dispersion of cars

Prices of some products in Europe display more discrepancy than other products. In the car sector, for instance, prices still are not converging even in the countries, which adapted the euro.

Figure 1.



Source: Degryse and Verboven (2000).

As indicated by Degryse and Verboven (2000), given pre-tax prices in May 2002, the price of the same Volkswagen Golf, for example, varies by as much as 30% in different countries. The widest price differentials can be observed for Vauxhall, Opel, Saab, Fiat, Lancia and Alfa Romeo - plus Honda and Suzuki while Mercedes-Benz, BMW, Ford, Volvo and Land Rover have the narrowest. Prices in United Kingdom are the highest for more than half the models. Germany and Austria seem to be the most expensive in the euro zone, while Spain, Greece and Finland - plus Denmark (which is not

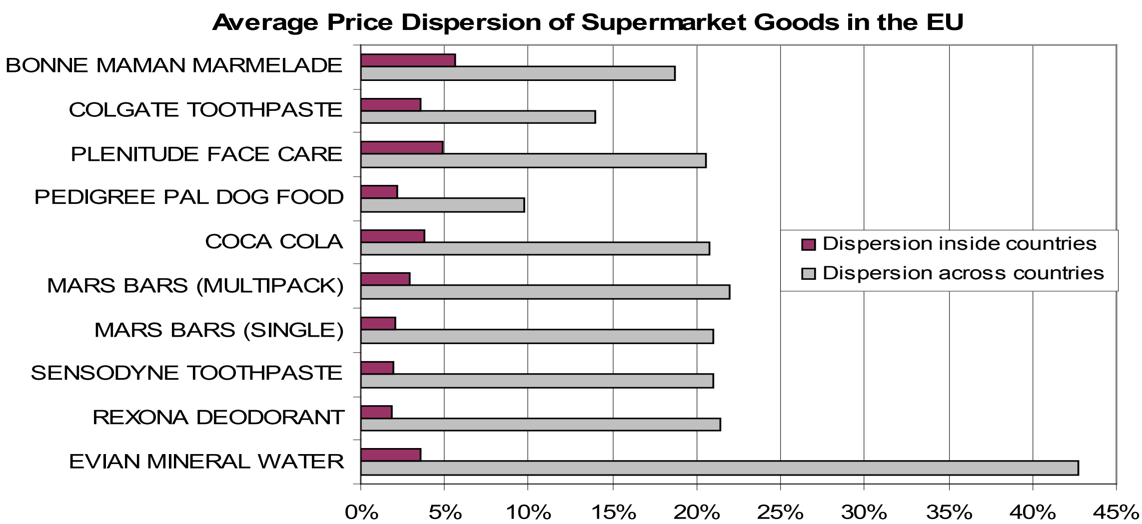
[4] De Serres et al. (2001), p.4.

in the euro zone) - are the cheapest. From Figure 1 can be concluded that taxes, exchange rates, right hand drive and dealer margin together explain almost one half of price dispersion but other 52 percent remain unexplained by these factors.

2.1.3. Price Dispersion in supermarket goods

Considerable price differences remain in the EU for supermarket goods. These price differences are much larger than price differences inside any single Member State. For consumer electronic products, the maximum price differences across Member States are typically between 30 and 50%, but regional price differences are usually between 10 and 30%.[5] So price differences across Member States are usually more than three times higher than regional price differences within Member States. Figure 2 illustrates the inequality of price dispersion within and across countries for selected everyday supermarket products.

Figure 2. Relative difference in intra- and inter-country price dispersion for selected products (excluding VAT)



Source: Price differences for supermarket goods in Europe (2002).

In addition, prices differ consistently over time and thus price data are required for more than one period, preferably two or three years. In general, in a stable competitive market price differences below 5% are often considered to

[5] See Price differences for supermarket goods in Europe (2002).

be normal. For markets in new products it is necessary to examine whether there is a trend of price convergence over time.

2.2. Explanations of Price Differences

In a world with tariffs and quantitative restrictions the price differences are simple to explain. Both measures lift up the costs of traded goods compared to domestic substitutes and it extends the distortion or a gap between international and domestic prices. But under the free trade regime there have been other identified causes behind cross-border price differentials.

2.2.1. Natural causes

2.2.1.1. Distance, shipping costs, and exchange rate variability

One substantial portion of the dispersion in prices can be seen in association distance, shipping costs, and exchange rate variability. According to Samuelson's 'iceberg' model[6], the variation of relative prices is supposed to increase with transportation costs, which depend positively on distance. At the same time, nominal exchange rate variability explains in part the price volatility but is smoothed by a sticky good pricing mechanism as implied by Engel and Rogers (1994, 2000). They distinguish two types of border effects that generate relative price variation. First one has its roots in insufficient market integration such as factual barriers that depress trade. Second one is *"sticky-consumer-price cum volatile exchange-rate effect."* It takes into account local currency pricing implications. A failure of the law of one price leads to inefficiency and welfare losses. Nevertheless, *"even if failures of the law of one price were eliminated through fixed exchange rates, welfare is not necessarily improved."* [7] In a currency union the price differentials become more transparent. I think that such transparency is a natural force to make the prices more balanced at least for durable goods, likewise for goods produced

[6] Noted in Parsley and Wei (2001).
[7] Engel and Rogers (2000), p.16.

by monopolistic competitive firms. The low perishability of goods encourages arbitrage opportunities.

2.2.1.2. Size of the economy

Parsley and Wei (2001) focus on price dispersion within the US, within Japan, and between US-Japan city pairs. Prices within countries have been more dispersed in the US relative to Japan, which can be presumably attributed to the relative sizes of the two economies. In addition, Japanese prices expressed in US dollars were substantially higher then US prices suggesting an evidence of systematic violation of the law of one price. Nevertheless, they found declining relative price dispersion over time. Since the retail price of a product could contain a non-tradable component, for example labor, Parsley and Wei (2001) also tested whether relative wage variability matters. However, its impact turned up to be very low.

2.2.1.3. Local preferences

Local preferences and culture seem to play an important role in explaining price differences for some products. People in some countries are used to consume very different quantity of certain product than in other countries. For instance, butter is more often used for cooking in the North European countries than in the South European countries. The smaller market in the South European countries seems to imply a higher price. The negative correlation between relative quantities and relative prices is known as the ‘Gerschenkron effect’.

Market size, differences in consumer tastes, landscape, climate etc. can probably explain some of the larger price dispersion found on the EU-level and these factors will continue to exist even in a perfectly functioning Internal Market. The price differences at the EU-level however seem to be significantly larger than what could be explained by natural factors.

2.2.2. Structural causes

Structural causes include the value added tax (VAT) and excise taxes, income differences, regulation on shop opening hours, regulation on land use and shop sizes, labor regulation, advertising rules and other types of regulations affecting the cost of selling goods. Income levels seem to explain only a limited part of grocery price dispersion in Europe according to Communication from the Commission (2001).

2.2.2.1. Market structure

Member States that have a larger market share of hyper-markets and discount stores, along with a strong presence of international grocery retailers, tend to be cheaper than those which do not. Arrangement and importance of traders should tell us something about market power. High concentration of few retailers, wholesalers and producers may cause deviation from prices which one would expect in competitive market (adjusted to natural and other structural causes). It is remarkable that the market share of the five biggest food retailers is around 90 percent in Finland and Sweden though it is only 25 percent in Italy.[8] Similarly Sweden, Denmark and Finland, where the major retail players dominate are as well the three states with the highest price level. On the other hand, larger retail groups are capable of having lower costs that benefit consumers.

2.2.2.2. Taxation

The issue of a common level of taxation is interesting. There is a scope for corporate tax convergence in EU. Motivation for more harmonized tax system is that it should improve fairness, efficiency, simplicity and transparency. It is believed to reduce the home bias, orientate investment decisions more efficiently to contribute to overall economic effectiveness and welfare. But Baldwin and Krugman (2001) come to a conclusion that unified tax on capital income would be currently more harming due to the existence of an advantage of agglomeration. Enterprises located in core of

[8] See Internal Market Scoreboard (2002).

Europe benefit from this advantage therefore it is all right to be in higher tax-level zone. According to this theory, if the taxes were obliged to unify then even more firms would escape the periphery and move to the core.

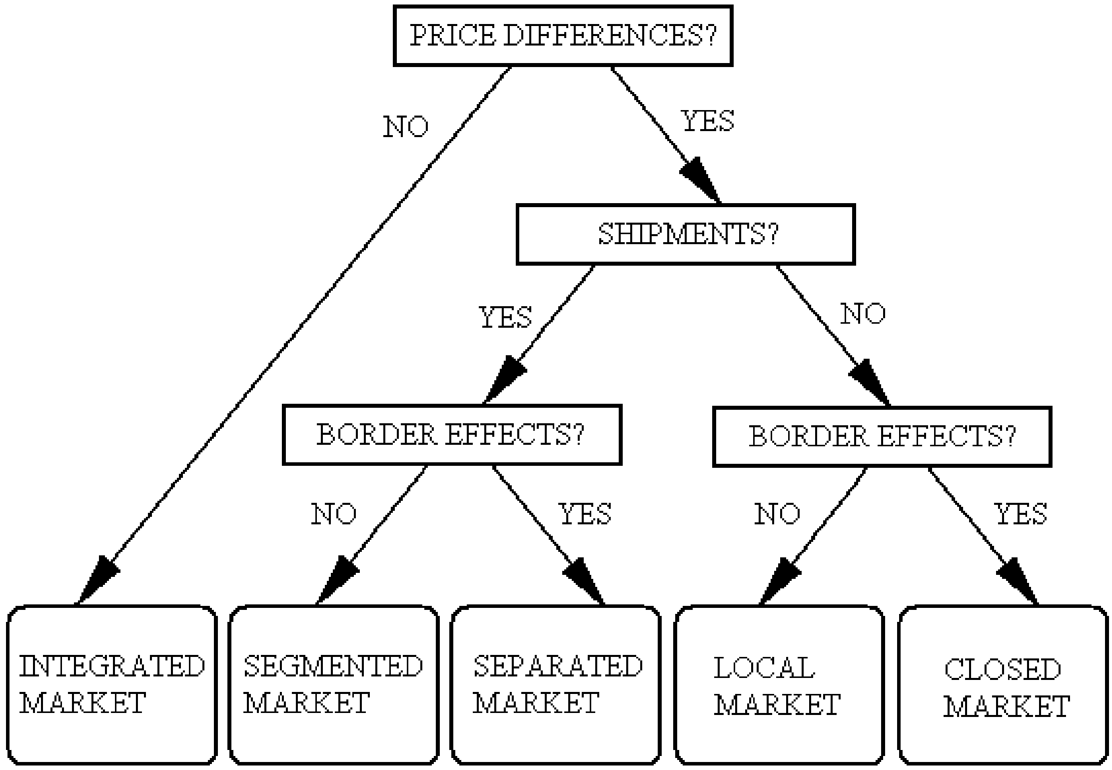
When concentrating on supermarket goods, we can see that VAT does not contribute very much to price dispersion in Europe. The most expensive and far above the EU average are prices (including VAT) for supermarket goods in Sweden, next Denmark, followed by Finland, Ireland, then Great Britain and Greece. Excluding VAT, Sweden is still on the top, the sequence continues by Great Britain, Greece, Finland, Denmark and Ireland. The rest of member states are below the EU average price level, no matter on VAT, among those Spain, subsequently Netherlands and Germany offer the least expensive supermarket goods. This outcome does not cover excise taxes, which would influence the price for some products.

2.3. Markets segmentation

There is an analogy between studies estimating border impact on price dispersion and on trade quantity. Until now, little attention of the paper was devoted to border effect in a sense of 'missing trade' between countries. It will be the core of the two subsequent parts. I think that high price variation between countries is also a logical result of an under-proportionate trade level between them. Assumingly, if any frictions occur in trading, then demand and supply curve meets at a different price and quantity point for each good in each country.

The more integrated the market is, the lower the price differences are observed and the more consumers should save due to increased efficiency. The border effect technique provides an interesting device to distinguish economic markets based on shipments and price data as shown on Figure 3. Therefore, price convergence tells a lot about market integration. As a bridge to the next section I refer to Figure 3 combining price data, shipments data and border effects.

Figure 3: Market segmentation



Following Sleuwaegen et al. (2001), the subsequent elements can be stated relating the segmentation of markets to border effects, price differences and shipments.

- For an **integrated** economic market is significant that there are no substantial price differences between regions.
- In a **segmented** economic market there are on a regular basis present specific industry shipments between regions worldwide; no border effects are present but normalized prices differ between regions.
- If shipments are taking place between regions, but border effects still exist, then the market as considered to be **separated**. In this case prices between regions tend to vary.
- When there are no shipments between regions and no border effects are present for that specific industry, then the market can be considered as **local.**

- If no shipments are taking place, but if border effects exist for that industry, then the market is **closed** and firms behave within a multidomestic structure.

3. Chapter Three - Border effect

3.1. A borderless world?

In the age of globalization and trade liberalization one may think that national borders ceased to have any economic significance and thus only represent arbitrary political lines on the Earth's surface. For example Kenichi Ohmae of McKinsey in "The Borderless World" declared:

"National borders have effectively disappeared and, along with them, the economic logic that made them useful lines of demarcation in the first place."[9]

However, recent literature rejects this hypothesis. National borders matter when firms have greater access to domestic consumers than to consumers in other nations. In this sense we talk of a home bias, in other words, an "excessive" intra-national trade that cannot be explained just by a physical distance. The border effect explains the extent to which domestic subunits trade more with each other than with foreign units of identical size and distance. It is usually measured as the average deviation between actual trade and the 'normal trade' that would be expected in an integrated economy without border-related barriers. Thus, a border effect indicates the level of market integration. Its value would be hypothetically equal one in a model of perfect integration, in which propensities for international and internal trade equal each other. Sometimes in the literature the term 'border effect' relates to the extra dispersion in prices, which was discussed in Chapter II. In this paper I relate this term and quantify its value based on trade flows. Besides, a few authors use the term 'home bias' for consumer preferences of domestic to foreign goods. To make the terminology transparent in this paper, I assume the consumer tastes and preferences for domestic goods to be only one of the factors behind the home bias.

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[9] Quoted in Head (2003), p.10. from Kenichi Ohmae's The Borderless World: Power and Strategy in the Interlinked Economy. New York: HarperCollins, 1990.

3.2. Evolution of the gravity equation

3.2.1. Law of Universal Gravitation

The impact of economies' sizes, the distance between them as well as international borders on trade is typically estimated by the so called 'gravity equation'. The expression actually comes from the application of Isaac Newton's "Law of Universal Gravitation"[10] to international economics. He discovered in 1687 that attractive force (F_{ij}) between two objects is positively affected by their masses (M_i and M_i) and negatively by the distance squared (D^2_{ij}). This equation is given by

$$F_{ij} = G \frac{M_i M_j}{D_{ij}^2}, \quad (1)$$

where G is the gravitational constant.

3.2.2. Empirical application to economics

In economics, gravity equations became at first only a favorite empirical instrument. The attractive force from equation (1) is substituted by volume of bilateral trade and mass of object by the size of the country, measured usually by GDP. Naturally, distance does not need to be substituted by any other variable. This type of gravity model was introduced to international trade by Jan Tinbergen in 1962, Hans Linneman in 1966[11] as a prediction of the volume of trade increasing with national incomes of the trading partners and decreasing with the distance between them. The relationship is expressed as:

$$F_{ij} = G \frac{M_i^{\alpha} M_j^{\beta}}{D_{ij}^{\theta}}, \quad (2)$$

where F_{ij} is the trade flow from origin *i* to destination *j*. However, by substituting variables in the relationship, gravity equations have served a tool

[10] Mentioned in Head (2003).
[11] Mentioned in McCallum(1995).

to estimate not only trade flows but also various 'social interactions,'[12] such as tourism, migration flows, equity flows or foreign direct investment. [13]

In order to fit the equation in ordinary least squares estimation, it is often represented in log-liner form as:

$$ln(F_{ij}) = ln(G) + \alpha\, ln(M_i) + \beta\, ln(M_j) - \theta\, ln(D_{ij}) + \varepsilon_{ij} \qquad (3)$$

3.2.3. Theoretical foundations

The gravity model became attractive because of its apparent empirical success since it was already in the year 1979 considered as *"probably the most successful empirical device of the last twenty-five years."*[14] However, it lacked theoretical foundations until 1980's when among others, Anderson (1979) derived gravity equation from the properties of expenditure systems with constant elasticity of substitution (CES) preferences and goods differentiated by origin. Bergstrand (1985)[15] enriched the gravity model within a structure of monopolistic competition models and Deardorff (1995) used the Ricardian and Heckscher-Ohlin frameworks to rationalize specialization. The standard gravity model assumes that the gravity equation is universal for all trading pairs, conversely a heterogeneous gravity model allows intercept and slope coefficients to vary across all country pairs combinations.

The concept of gravity-type equations has further developed. Anderson and van Wincoop (2001) added to the model other theoretical background. Their model also features relative prices. They criticized the measure of 'remoteness' in the previous literature, because this 'atheoretic' index does not take into account national border barriers, the focus of this literature. They claim that McCallum's large border effect is the result of

[12] See Head (2003).
[13] Anderson and van Wincoop (2001) mention a few authors.
[14] Anderson (1979).
[15] Noted in Wall (2000).

omitted variables bias and the small size of the Canadian economy. They rigorously rewrote the gravity model using the term 'multilateral resistances'[16] that serves as a proxy for trade costs. Their theoretical approach revealed that *"trade between regions is determined by **relative** trade barriers."*[17] In other words, in equilibrium, bilateral trade is subject to both origin and destination price levels, which are themselves associated with the presence of trade barriers.

Three key implications based on this finding are the following:

- Trade impediments restrain more of size-adjusted trade <u>between</u> large countries than between small countries.
- Trade impediments intensify size-adjusted trade <u>inside</u> small countries more than inside large countries.
- Trade impediments raise domestic size-adjusted trade in country A relative to size-adjusted trade between countries A and B by more the larger is country B and the smaller is country A.

According to Anderson and van Wincoop (2001a), the gravity model can be further developed because *"its attractiveness combines ease of estimation, success in prediction and the consistency and power of readily understood general equilibrium structure."*[18]

3.3. Methodology of estimating the border effect

3.3.1. Inclusion of "Home" dummy

Gravity equations were used in international trade before McCallum(1995) but he probably influenced many others to compare intra-national to international trade flows. His results suggested a very high border effect as well as did the results of several other 'followers'. The border effect is usually computed by a gravity equation augmented by a '*Home*' dummy variable. Again, trade flows are negatively affected by distance and

[16] It is a kind of consumer price index, which depends positively on trade with all trading partners.
[17] Anderson and van Wincoop (2001) p.9.
[18] Anderson and van Wincoop (2001a), p.31.

positively by income. In literature the level of trade predicted by the gravity model using countries' economic sizes and distance is named the 'normal' or potential trade. The coefficient γ of the *Home* dummy variable then measures the deviation from the 'normal' trade. The following relationship represents the basic gravity equation in log-linear form to compare intra versus international trade flows.

$$ln(X_{ij}) = \alpha + \beta_1\, ln(Y_i) + \beta_2\, ln(Y_j) + \beta_3\, ln(D_{ij}) + \gamma HOME + \varepsilon_{ij} \quad (5)$$

McCallum (1995) used a similar equation where X stands for the exports from region i to region j, Y_i and Y_j denote the GDP of countries i and j, respectively, D represents the distance between i and j, and *HOME* is a dummy variable for intra-national trade equal to one (when $i = j$), and zero for international trade. The border effect is then computed as $exp\ (\gamma)$. Later, economists used also additional variables. These were most frequently measures for common language, sharing border (adjacency) and remoteness. Remoteness used in gravity model measures the location of one state relative to all other states. Language or adjacency dummies are equal to one for trade between countries sharing the same language or border, respectively, otherwise equal to zero. A small puzzle is how to calculate trade within a country (X_{ii}) when there is no trade statistics at an intra-national level. Such 'export to itself' is just a country's total production less the sum of its exports to the rest of the world, following e.g. Wei (1996).

3.3.2. Effects of borders, GDPs and distance

We expect certain intuitively reasonable behavior of the gravity model. Higher GDP for the country pair should increase trade. Next, the smaller the distance between two countries, the higher they trade with each other, we suppose. The function of the gravity equation is then to judge if this intra-national trade systematically exceed international trade. Sharing a language, a land border, or a regional trade agreement is believed to increase bilateral trade by economically and statistically significant amounts. After inclusion of dummies for common language and adjacency we translate the border effect as the extra propensity to trade inside a country relative to trade with a state that is neither sharing the same language, nor border.

In the gravity equations distance affects trade negatively due to several reasons. As noted by Head (2003), distance covers effects of transport, time, synchronization, communication and transaction costs as well as 'cultural distance'.

3.3.3. Intra-national distances

As a measure of an internal distance (D_{ii}) several methods were suggested to approximate the average distance of shipments of goods within a country. Wei (1996) used a quarter of the distance from the country's economic center to the nearest neighbor. Wolf (2000) employed one-half the minimum distance to the nearest neighboring state. Such approach *"implicitly assumes an even spatial distribution of activity within a state. If, instead, a state is dominated by a single city, the correct intrastate distance is closer to zero. More generally, the higher the share of the largest production/consumption cluster in a state relative to state size, the lower the effective intrastate distance."*[19] Head and Mayer (2002) again directed their attention towards the different measures of calculating distances between and within countries. They introduced a new measure of effective distance containing a harmonic mean, which is more sensitive to (the variation of) the distribution of economic activity within a country. *"Since the harmonic mean is known to be less than the arithmetic mean whenever there is variation, this implies that arithmetic mean distances overstate effective distances."*[20] A unique formula they used to calculate both distances between and intra economies. They argue that distance mismeasurement overestimates the

[19] Wolf (2000), section IV.
[20] Head and Mayer (2002), p.13.

internal distance relative to the external distance, which mechanically inflates the border effect, as shown originally by Wei (1996).[21]

For the analysis in Chapter Four I adopt a measure introduced by Nitch (2000), in which internal distance is (a perimeter of a circle) computed as a square root of the ratio of country area and π. This measure is less data-demanding than the one suggested by Head and Mayer (2002), still it overcomes some weaknesses of previous measures. However, outcomes of Head and Mayer (2002) indicate that Nitsch's measure reduced by one third is probably more realistic, Brülhart and Trionfetti (2002) even devalue this measure by two thirds.

3.4. Review of some empirical results

3.4.1. Border effects in North America

The volume of trade between the United States and Canada is greater that between any other two countries in the world[22] - they are each other's largest trading partners - hence this attracted many economists to take a closer look at their trading patterns.

In the most influential paper, McCallum (1995) analyzed US-Canadian trade for the period 1988-1990. His gravity model estimated that in the year 1988 trade between provinces within Canada exceeded 22 times the amount of trade between the provinces and the states of the U.S. after controlling for size and distance. McCallum's model has been soon refined and widened. Anderson and Smith (1999) discussed the following explanation to his border effect factor of 22: the border is asymmetric, it reduces trade more for U.S. exports to Canada than for Canadian exports to the U.S. and impact of borders heterogeneous across provinces. McCallum (1995) states that over time (from 1950 to 1993) the Canada – U.S. trade was gradually increasing

[21] To my knowledge, the lowest estimate measure for intra-national distance used Brülhart and Trionfetti (2002). Their formula would lead to, for example, only 53 km internal distance of Czech Republic or only 112 km of Germany, which is 2 to 3 times less than by means of measures used in Section IV of this paper, based on Nitsch's formula and Head and Mayer's revision.
[22] See Wall (2000).

without any obvious effect of NAFTA formation. Ceglowski (2000) correspondingly remarks that even after the formation of the Canada – U.S. Free Trade Area there was *"no evidence of a significant, sustained fall in the border effect between 1988 and 1996."* However Helliwell (1998) [23] using post-NAFTA data observed a decline of the border effect ratio to about a factor of twelve for the period 1994 – 96.

According to estimation of Helliwell (2002), the existence of the Canada – United States border discourages more than 90 percent of cross-border trade. Vancouver and San Francisco, for instance, are both cities of roughly equal size and approximately the same distance from Toronto. Yet, firms in Toronto export more than 10 times as much to Vancouver as they do to San Francisco. On the other hand, theoretically grounded approach by Anderson and van Wincoop (2001) estimated the borders-related reduction of trade to be only 44 % between the US and Canada and 29 % among other industrialized countries for 1993 data.[24] McCallum's factor of 22 was computed from the Canadian perspective. This is a result of the size of Canadian economy because *"even a moderate barrier between Canada and the rest of the world leads to high multilateral resistance for the provinces because it affects trade barriers between a province and almost all of its potential trading partners."*[25] That is the reason for the high level of interprovincial trade. Although Anderson and van Wincoop (2001) found inter-provincial trade 16.4 times higher than state-province trade (after controlling for distance and size), the inter-US state trade turned out to be only 1.5 times state province trade.

Wolf (2000) found an existence of the border effect even within the U.S. states. It is somewhat surprising that excessive home trade exists on sub-national level in a setting without any formal and informal trade barriers. He reports the border effect values between 3.28 and 4.39. Although Head

[23] mentioned in Wall (2000)
[24] Anderson and van Wincoop (2001), p.2.
[25] Anderson and van Wincoop (2001), p.2.

and Mayer (2002) attribute about one third of Wolf's border impact to the improper distance measures, other fraction to the neighborhood effect and Census Divisions[26] grouping effect, the reminder is still remarkably high.

3.4.2. Border effects in Europe

Over the past forty years tariffs and quantitative restrictions have been removed within the European Union, as well as on (non-agricultural) trade between the EU and CEECs after the implementation of the Single Market Programme (SMP). The abolition of border controls on intra-EU trade was another important step toward deeper market integration designed to increase intra-EU competition and consequently intra-EU trade. It was accompanied by harmonization and mutual recognition of standards and other regulations.

The integration of markets in member countries of the European Union is expected to be large, hence the borders are supposed to matter less and less. Despite the existence of Internal market trade does not behave like in a single geographical region. According to Nitsch's (2000) outcome of gravity model for EU countries, the trade inside states exceeds on average ten times the EU international trade.

3.4.2.1. Industry-level border effects

For the European Union, Head and Mayer (2000) estimated industry-level border effects. Their model establishes a relation between the relative amounts consumers spend on foreign and domestic goods and their relative prices net of transport costs. The border effect measures divergence from the predicted consumption ratios. The coefficients of the border variable can be understood as the importance of missing trade.

They classified industries in terms of increasing magnitude of border effects. It seems noteworthy that ingestible products, i.e. food, beverages, tobacco and drugs, figure heavily among those with large border effects.

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[26] "These are nine regional groups of states that have no political significance." Head and Mayer (2002), p.22.

Given the border coefficients, there are two ways to quantify the magnitude of border effects. First, the ratio of imports from self to imports from others, holding other things equal, for example, when the border coefficient for cycles is 1.82, the magnitude of the border effect is exp (1.82) = 6.17. This means that trade in the cycles industry within a single EU country is six times larger than trade among countries of the EU. For the 1996 data, Chen's (2002) results reveal the largest border effects for ready-mix concrete, then carpentry, mortars, printing and metal structures. On the other hand, a border effect below one, suggesting a favorable position of foreign goods was found the lowest in the industry of aluminum, then agricultural tractors or games and toys. Among 18 industries, according to Brülhart and Trionfetti (2002), borders matter a lot for tobacco products (116,7), meat products (33,1) and least for timber and furniture (1,5) and motor vehicles (0,8).

An alternative quantification of border effects is realized by their conversion to distance equivalents. Using a 'normal' distance coefficient in the gravity-equation and the average internal distance in the EU (140 miles), the implied border "width" of the cycles industry is 888 miles. On average for all industries Head and Mayer (2000) found that in the period 1984-1986 crossing a border was equal to bridging a distance of 2304 miles. Similarly, when examining the evolution of border effects over time (period 1976 to 1995), Head and Mayer found that border effects within Europe[27] have declined substantially until 1986, but since then remained stable.

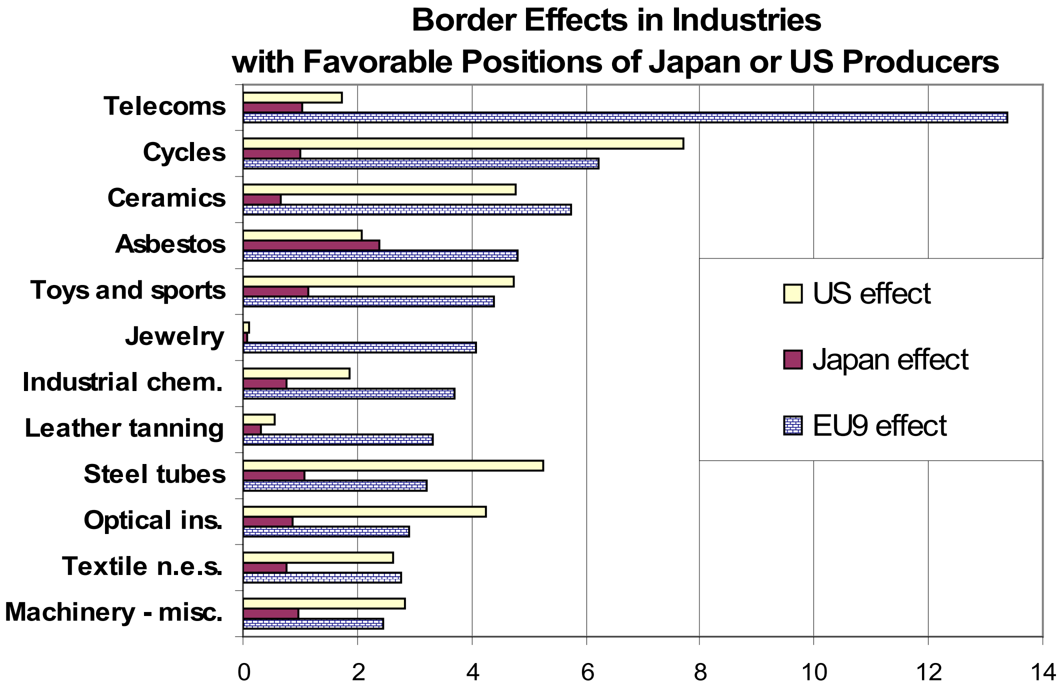
In another paper, Head and Mayer (2001) computed industry-level border effects on average within Europe and between Europe and the US, respectively Japan for the period 1981-1994. From Figure 4 it can be seen that in certain number of industries European consumers prefer 'on average' Japanese products over domestic products. This was the case of optical instruments, ceramics, jewelry, telecoms, cycles, etc. In these industries, the

[27] Nine EU countries. (Belgium and Luxembourg are aggregated.)

border effect coefficient is lower or close to one, which indicates a preference for Japanese products and which seems to reflect a favorable competitive position for Japanese producers. However, for the majority of other industries exists a very large border effect towards Japan, much larger than the border effect towards other European countries. This is the case for the agro-food industry such as wine, distilling, bread or dairy. Other products are facing considerable border effect within EU but much bigger towards Japan, for instance wood, cement or carpentry, in which the cross-border trade is also very limited for the reason of high transportation costs or even the lack of transport possibilities. Lastly, there are some very important industries in the Japanese economy including motor vehicle parts and motor vehicle bodies, plastics, pharmaceuticals, electrical and electronic appliances where Japanese producers face a major border effect compared to European producers, suggesting serious artificial barriers to trade in relation to transport costs.

It is interesting to see the comparison of the intra-EU border effects to the border effects of trade between the EU and the United States. There are some recognizable similarities with the Japanese border effects: the agro-food industry and goods that are difficult to transport show a much higher border effect than the intra-EU border effect for those industries, both for the US and Japan. But compared to Japan, the TV and video industry border effects, for example, are higher towards the US. This corresponds with a weak penetration of American producers in the European TV and video industry. Only three industries where consumers prefer American products rather than domestic products appear: jewelry, leather tanning and starch. On the other hand, in some industries the ‘average’ EU consumer prefers American products to products from other EU countries, but not to domestic products. This is the case for industries like shipbuilding, telecom or industrial chemicals. Those interregional border effects are also useful to indicate a level of globalization that goes beyond the borders of the EU of a specific industry. A wide comparison of border effects for a wide range of industries within the EU relative to the trade EU–US and EU–Japan respectively is provided in Table A 1 in Appendix.

Figure 4.



Source: Table A 1

Head and Mayer (2002) recalculated their earlier results using improved measures of effective distance. They employed the same data period (1993-1995) also to get more comparable results with the US data set. According to them, the former mismeasurement of distance led to an overestimation of border effect. They emphasize that the key problem in methodology is measuring the internal distance within country. *"Our central argument is that most measures of internal distances overestimate internal distances with respect to international distances because they try to calculate average distances between consumers and producers without taking into account the fact that, inside countries, goods tend to travel over smaller distances."*[28] They explained high levels of border effect by their low transportability. Using new distance measures they managed to reduce these

[28] Head and Mayer (2002), p.10.

effects but they did not managed to solve the border effect puzzle completely. However, they conclude: "*With our measure of distance, we find that post-single market Europe in 1992-1995 was only marginally fragmented with a border effect of 3.12.*" [29]

3.4.2.2. Country-specific border effects

The unification of Germany deserved an extensive study about economic developments in the two parts. Some information offers Nitch (2002) by analyzing trade between East and West Germany from intra-national data on trade flows during the period 1992-1994. He obtained a border effect size of about 2.2 relating to trade between East and West German states. Another noteworthy Nitch's observation comes from estimating the border effect in Germany relative to all its neighbor countries. While coefficients on importer's GDP, adjacency and language dummies are statistically significant and large, a dummy included on membership in the European Union is not. With or without the EU dummy the German border effect is roughly 2.4.[30]

Brülhart and Trionfetti (2002) estimated the border effect separately for six European countries over years 1970-85. The variance of country-specific border estimates is intense. The highest factor[31] was observed for France (76.7), West Germany (26.8) and the United Kingdom (17.1), the lowest for Netherlands (3.0), Belgium (1.6) and Italy (0.45). Later, based only upon 1996 data, Chen (2002) presents a completely different outcome: Germany and the United Kingdom show the smallest home biases impacts (2,6 and 3,2 respectively). They are followed by France (7,1), Italy (7,5), Portugal (7,8), Spain (9,0), and at last Finland (38,5). Since the smallest countries such as Finland or Portugal display the largest effects,[32] so it seems that country size matters but surprisingly in somewhat inverse way compared

[29] Head and Mayer (2000), p.30.
[30] Nitsch (2002), p.8.
[31] Numbers in brackets are mean coefficients on Home dummy on the power of *e.* See Brülhart and Trionfetti (2002), Table 3 and 4.

to Brülhart and Trionfetti (2002). More likely is the fact that the late accessions of Spain, Portugal (in 1986) and Finland (in 1995) to the EU cause their higher border effects and consequently a lower degree of market integration.

Using a country-specific gravity equation Wei (1996) receives various home biases for OECD countries over the period from 1982 to 1994. The smallest ratio of import from self to import from a foreign country was identified for the U.S. (about 1.5), Australia, Germany, UK, Japan, Netherlands (all slightly above 2), highest between 4 and 6 for Portugal, Mexico, Austria and Spain.

By means of gravity equation, Fidrmuc and Fidrmuc (2000) estimated the dynamics in trade with regards to disintegration processes in Europe, particularly trade between Czech and Slovak republic, among Baltic States, between Croatia and Slovenia, among Russia, Belarus and Ukraine or between West and East Germany. He also reminds a disintegration action when Ireland decided to abandon the Sterling link and introduce the Punt in 1979. Such monetary disintegration did not negatively affect Irish trade with the UK what can be found surprising and in contrast to analogical Rose's (1999) evaluation of trade impacts of European Monetary Union.

3.4.3. Trading blocs of countries

Dynamic use of the gravity model can show what impact has the establishment of formal preferential trade areas such as the EU and the Central European Free Trade Association (CEFTA) or even the impact of reunification on trade between East and West Germany (e.g. Nitsch (2002)). It is worth knowing whether regional trading blocks such as North American Free Trade Area (NAFTA) or European Union make national borders less important. Anderson and van Wincoop (2001a) computed the effect on trade and welfare due to creation of NAFTA. The rise in exports was substantial: Exports from Mexico both to US and Canada rose by 59 percent and imports

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[32] This is coherent with Anderson and van Wincoop (2001), who rationalize that a small drop in

from both US and Canada increased by 74 percent. Despite such crucial stimulation of trade the welfare effect was estimated to be very low: 0.1 for US and Canada as well and –0.3 for Mexico.

Wei (1996) noticed that while in EU member countries border effect declined dramatically over 1982-1994, in EFTA countries relatively increased and on OECD average slightly decreased. Gravity-type studies, which do not include intra-national observations, e.g. Fidrmuc and Fidrmuc (2000) or Dzurilla (2003), logically do not incorporate the home dummy. Instead, the focus on only international trade can provide better comparison of effects such as international agreements or political integration and disintegration. Dzurilla (2003) augmented the basic gravity equation by eight dummy variables to separate effects of trade preferential agreements and features. Besides adjacency and common language it was membership in EU, CEFTA, BAFTA and a group of future EU countries (for trade with EU) and two more geographic variables for land or sea border (landlocked and island status). Based on his results, the relative importance of these effects is worthwhile to see. The BAFTA effect appears to be the most strong with a value of exp(2.247) = 9.46. The effect of common language in his regression is exp(0.6) = 1.82. The third largest impact is CEFTA effect reaching value of exp(0.783) = 2.19. The EU dummy is reaching exp (0.411) = 1.5, which is consistent to EU-dummy estimates of Fidrmuc and Fidrmuc (2000) for most of the years between 1990-1998. On the other hand, Nitsch (2002) by examining trade flows between Germany and its neighbors found that added EU dummy into the gravity equation is not significant. The results of Dzurilla (2003) attribute still not negligible importance to the common border dummy and a dummy for EU versus accession countries trade. The measures of landlocked and island status have minor importance (the former one is with negative sign). To conclude, the coefficients of ln(GDP) of exporting and importing country reported by Dzurilla were 1.079 and 0.807

international trade lead to a much larger increase in border effects within small countries.

respectively and coefficients on ln(distance) was –1.441, which is very high (in absolute value) compared to studies including intra-national trade.

3.4.4. The impact of common language

The effect of common language can be separated from the pure effect of borders by means of a dummy variable equal to one for trade observations between a pair of countries speaking the same language and zero otherwise. The intuition is that an imperfect ability to communicate due to language barriers raises transaction costs. Indeed, common language effect has been proven to be an important factor influencing trade. Since countries speaking the same language possibly share similar culture, history or experienced some colonial relations, the language dummy could proxy for these effects. Brülhart and Trionfetti (2002) report the coefficients on the language dummy ranging from 0.62 to 0.97, suggesting that sharing language usually makes those countries trade from exp (0.62) = 1.9 to exp (0.97) = 2.6 as much with each other than with a country speaking different language. Somewhat higher impact of language estimated Head and Mayer (2000), who arrived to the common language effect slightly declining for EU9 in time (1978-1995), from exp (1.34) to exp (1.14). Fidrmuc and Fidrmuc (2000) estimated a dummy for countries speaking English to be about 1.1 but with increasing tendency in time.

The similarity of Czech and Slovak language probably has consequences in the fact that Slovakia despite its low share on the European market is the second biggest trade partner of Czech Republic. Even within one country like bilingual Belgium I expect trade being affected by reduced interactions between Flanders and Wallonia due to the language barrier. However, since the language effect is possible to isolate, the next few pages relate to the fundamental effect of borders.

3.5. Explanations of border effect

Presumably, regions within countries have more in common and are economically tied up. Besides the fact that they share similar policies, institutions and regulations it is noteworthy that their growth as well as their inflation rates are more linked, their business cycles are far more synchronized, their risk-sharing is more intense and not surprisingly, they trade more with each other. However, the remarkable magnitude of the border effect deserves further explanations.

Why international borders inhibit trade to such extend? While distance serves as a proxy for transport costs, apparently *"national borders proxy for a wide range of trading frictions, including tariffs and non-tariff measures imposed intentionally by national governments, as well as costs associated with customs clearance and currency exchange that inevitably arise when shipping goods across differing national jurisdictions."*[33] International traders are exposed to insecurity, arising also from differences in technical regulations, in institutional and legal structure. The *Home* dummy for internal trade captures these factors, as well as differences in preferences.

Theory[34] suggests that the border effect is incorporated in two factors: the degree of substitutability between domestic and foreign made goods and the tariff equivalent of the border related barrier. Primarily, the high degree of substitution between home goods and imported goods may constrain a large part of trade flows even if trade barriers are subtle. Secondly, in the part of international trade, where tariffs and quotas no longer exist, other factors are considered as trade barriers. The intuition is that non-tariff barriers like additional transaction costs, exchange rate variability or special standards, which some products are obliged to meet, can be represented as a tariff or a quota in reducing or even removing foreign competition for

[33] Hillberry and Hummels (2002a), p.1.
[34] Anderson and van Wincoop (2001), Evans (2001) and Wei (1996).

domestic producers. These industries exposed to non-tariff barriers are likely to show significant border effects.

On the other hand, a different explanation suggests that border effects occur endogenously. If it is true, then factors behind it have no policy implications. The rationalization is that with the aim of eliminating trade costs, agglomerations of intermediate and final goods producers are growing up, thus generating endogenous border effects since intermediate goods are traded relatively local and within borders, as affirmed by Hillberry and Hummels (2002).

Understanding the sources of border effects permits to better examine their welfare implications and possible recommendation of policy decisions. *"If technical barriers to trade or non-tariff barriers appear as important determinants of border effects, we would conclude that crossing the border has some welfare consequences and that the removal of those barriers would be beneficial. By contrast, if information costs or spatial agglomeration matter, we would rather claim that the policy implications of border effects are negligible."*[35]

3.5.1. Technical barriers to trade

Brenton and Vancauteren (2001) find the border effect too large to be explained only by technical barriers to trade also because substantial border effects persist in sectors where TBTs are not important. On the other hand, Chen (2002) demonstrates that industries, in which TBTs are removed display a very low border effect while on the contrary, for industries where no measure was adopted, remains a substantial border effect. For the other industries in-between those extremes, are also medium border effects. It can be deduced that deeper market integration through removed TBTs diminishes the impact of borders on trade flows. Chen (2002) still expects further decrease in the magnitude of the border effect due to more advanced market

[35] Chen (2002), p.10.

integration, though keeping in mind that policy-related factors are not the only explanation.

3.5.2. Exchange rate volatility and currency effects

One could consider that exchange rate variability depress trade amount. Compared to the literature about the effects on differences in relative prices, however, there exists a quantity of empirical work that does not prove that exchange rate volatility discourages trade. Wei (1996) supported this evidence for OECD countries since some of his exchange rate volatility measures had 'improper' signs.

Countries using different currencies face a barrier since there are costs in exchanging money in spot and forward markets and agents cannot always hedge the uncertainty about currency movements. A common currency can besides eliminating these costs promote trade due to grater transparency of price differentials. Rose (1999) investigated an effect of monetary unions on trade. The study using a gravity model shows that the effect of currency unions on international trade is large. He made use of a large cross-country data set to show that two countries with the same currency trade over three times as much than comparable countries with their own currencies. Although reducing exchange rate volatility increases trade, the result of a common currency is much larger than that of eliminating exchange rate volatility but retaining independent currencies. His evidence rejects an assumption that a common currency is equivalent to reducing exchange rate volatility to zero.

3.5.3. Informal barriers to trade

Possible hidden costs are 'widening' the border. Obtaining information about distant markets is not free so there are some information costs that decrease the volume of trade. Information costs may play a role to explain border effects, especially for differentiated products. The cost differences for retrieving information about the existence or characteristics of foreign goods could represent the informal barriers to trade. According to Rauch (1999),[36] search costs are a barrier to trade for differentiated products because this kind of international trade deserves networks of trading contacts, which are determined partially by search-reducing proximity, partially by common language and common knowledge of official institutions and culture. Results of Chen (2002) supported the relevancy of product-specific information costs in explaining border effect. It is unfortunately contradictory to results of Evans (1999) who shows that differentiated goods display lower border effect, and to those of Hillberry (1999) who finds no relevance in product-specific information costs.

The costs of imperfect contract enforcement as mentioned by Anderson (1999) are rising from possible opportunistic behavior. Often in international business more costs are sunk when potential traders rather move away from the transaction to avoid possible losses. These costs appear like 'a tax on trade'. They tend to be lower if trading partners have language and cultural similarities or if traded goods are simpler, moreover *"the holdup problem should be less significant when legal systems are similar or when contract enforcement is powerful and impartial."* [37]

3.5.4. Business and social networks

Economic agents face search costs if they want to look for a trading partner outside an existing network. Wolf (2000) finds a home bias even within the United States as the impact of administrative intra-national state line on trade. Analogically, Combes et al. (2002) find out a border effect from data on bilateral trade between 94 French regions. They attribute more than 60 % of this 'puzzling' outcome to business and social networks, represented by inter-plants connections and employment composition in terms of place of birth. The impact of local social networks depends on how many people that are born in one region but are working in any other. As pointed out by Rauch (2001): *"Immigrants know the characteristics of many domestic buyers and sellers and carry this*

[36] Noted in Chen (2002).

knowledge abroad".[38] In the same sense they 'import' their tastes and preferences for products of their native country, hence support bilateral trade. Business networks matter, for example, due to the effects of barriers to entry and collusion inside business groups. Social and business networks in general as well as infrastructure and information networks are much easier and natural to establish within a single country, so this could explain a substantial part of the home bias. Combes at al. (2002) consider the results of impacts of administrative borders in France similar to Wolf's counterpart for trade inside the United States. They conclude: *"When controlling for both type of networks, a French region is estimated to trade only twice more with itself than with a non adjacent region of similar size and distance."*[39]

In addition, another geographic factor matters since a lot of state boundaries were set in the middle of a river or at the mountain ridges (Czech republic is a good example), where road and rail network cannot be so dense. Such geographical 'irregularity' is not well captured in the distance variable in the gravity model.

3.5.5. Impact of intermediate input trade

Recent studies of Wolf (1997, 2000) reveal that intermediate goods are generally shipped over shorter distances than are final goods. This clustering of intermediate stages of production might contribute a lot to the border 'width'. In the standard gravity structure the home bias is exogenous. There is way of imagining home bias as endogenous if the effects of trade frictions and intermediate goods are incorporated into the model. In contrary to more traditional gravity model framework based on the level of trade, Hillberry and Hummels (2002) developed a model, which covers different characteristics of intermediate and final goods. From the composition of trade is witnessed that final goods are delivered over long distances but intermediate goods are dealt in general locally. Late stage firms (with high

[37] Anderson (1999), p.15.
[38] Quoted in Combes et al. (2002), p.3.
[39] Combes at al. (2002), p24.

ratios of gross output to value added) send goods to remote markets therefore tend to be exporters. Thus, production concentration is influenced by intermediate inputs, which are asymmetrically absorbed over space according to industry co-location and idiosyncratic production effects. As a consequence, a spatial clustering of producers broadens the border effect.

Production of some firms is linked to certain geographic location in which it benefits from natural resources or agglomeration externalities. Hillberry (1999) uses a 'geographic concentration' index, which measures an industry dependency on a specific location. A lower value index suggests that the considered industry is not reliant on a particular geographic location, while industries, which require certain locations display higher values. Firms not attached to any particular zone are likely to choose their place of production in an attempt to minimize cross-border transaction costs; therefore, border effects could become more intense. Hence in general, an inverse relation between the border effect magnitude and the 'geographic concentration' index for the corresponding industry is expected. Chen (2002) provides an example of the high index value for copper in the US indicating high industry dependency on a special location. This effect can cause the endogeneity at least in a part of the border effect for some industries not only in the US.

Hillberry and Hummels (2002a) attribute a part of the border effect to the geographic frictions originating in a kind of 'hub and spoke' arrangement. While manufacturing establishments can ship over long distances, for wholesalers it is too costly or may face 'exclusive territory' pact. Chen (2002) explains about one half of the border effect by agglomeration of producers. With the intention of reducing the need for cross-border trade to avoid trade costs, intermediate and final good producers are closely connected in each country. Chen (2002) remarks: "*If border effects appear to arise endogenously as a consequence of the optimal location choices of producers, we would conclude that the welfare* *implications of border effects are probably small, and that little is left for policy makers. ... By contrast, non-tariff barriers are not significant. However, technical barriers to trade only provide an incomplete explanation for the presence of border effects since the spatial clustering of firms, together with the existence of informal barriers to trade such as product-specific information costs, are also shown to contribute to the overall effect."*[40]

3.5.6. Market size

Brülhart and Trionfetti (2002) found out that demand is more home biased for goods made in sectors with increasing returns to scale in production and monopolistic competition markets. Because of one type of magnification effect, country's exports comprise relatively more of the goods for which it has a comparatively larger domestic market. The weight of scale economies then positively supports this relationship. According to Head and Ries (2001)[41], the size of the magnification effect is related positively to trade costs in the constant returns to scale sectors and negatively in the increasing returns to scale sectors. Another type of magnification effect associated with transport costs was uncovered by Hanson and Xiang (2002): *"Relative to small countries, large countries have high exports of goods subject to strong scale economies and high transport costs. For industries with moderately high transport costs, export production appears to concentrate in neighborhoods with strong regional demand. Export production in these industries may concentrate in small countries, as long as these countries have large neighbors that increase effective demand for goods produced in the country."*[42] In addition, exports of differentiated goods relatively to export of homogeneous goods are considered as more income elastic.

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[40] Chen (2002), p.2.
[41] Noted by Brülhart and Trionfetti (2002), p.5.
[42] Hanson and Xiang (2002), p.27.

3.5.7. Costs of a firm

According to Berezin (2000), other explanation arises from examining size of the country and costs of a firm, which would potentially expand abroad. He states that transport costs and tariffs are not the major part of the costs that need to be spent by companies who wish to sell their products in far-off markets. The bigger the country size (measured by the number of markets in a country), the more the firm will grow domestically. Despite very low trade barriers the presence of national borders can be discouraging to a significant fraction of cross-border trade when firms experience start-up costs during the penetrating of new markets. The additional fixed costs of exporting can be related to the establishment of brand recognition, advertising, distribution network and becoming familiar with the infrastructure and different types of institutions. For such reasons the profitability of exporting appears uncertain, at least in the short term.

The impact of borders becomes less and less extensive due to the evolution of new information technologies, which help to reduce international transaction costs, relative to national transaction costs. As e-commerce expands and more customers use the Internet to purchase goods they previously bought through conventional means, it is probable that this leads to an increase in exports. The cost of expanding into new markets for Internet companies is quite low and so it is expected that online retailers seek a global presence much earlier than traditional ‘brick and mortar’ companies. Indeed, that is what we have seen in the past few years, with companies like Amazon.com quickly expanding beyond the United States to offer products in Germany and the United Kingdom. In previous years, the idea that a bookseller that began operations in 1996 could become a major global player within two years would seem incomprehensible, but the advantage of Internet retailing has made this possible to happen.

Since costs of transportation and communication are expected in general to be declining, the existing border barriers are little by little reducing their importance.

3.5.8. Transportability

Some goods can be either perishable (can get easily decayed or damaged) or too heavy in weight. Since they are difficult to ship over long distances, they display larger border effect than other products. The border effect then rises with higher ratio of weight-to-value of a commodity. Since the freight costs are higher for massive, high weight-to-value raw materials than for manufactures, there is assumed to be a negative relationship between weight-to-value and bilateral trade. Based on cross-industry evaluation by Head and Mayer (2002), the largest border effect was exhibited in industries supplying coal (498.3), natural sands (277.4), gravel and crushed stones (243.4) or rough wood (49.8) in the U.S. and respectively in the European Union it was tobacco (2870.3), cement (960.8), oil refining (730.3) and carpentry (718.8). In order to separate the transportability effect the same authors included a transportability index in their regression. For goods, which are transported half the average distance of aggregated flows, the border effect falls about 60 percent but still remains quite high. However, *"The most easily transportable industries have no border effect nor positive effect of adjacency."*[43] Slightly different specification used Chen (2002) to adjust for transportability by including weight-to-value variable. It exhibits a negative and highly significant coefficient, meaning that bilateral trade falls with a high weight-to-value. In addition, the inclusion of the variable affects depreciates the size of the border coefficient. I think that complicatedly transportable goods are likely to be highly substituted between home and foreign varieties, therefore exhibiting large border effects.

[43] Head and Mayer (2002), p.30.

3.5.9. Preferences for domestic goods

Consumers are used to certain behavior and buy goods according to their tastes. Habitually, products they buy the most are produced in their country. Such consumer home bias differs across countries but as noted by Vancauteren (2002) is not too variable throughout time. Information about consumer preferences can be obtained from consumer surveys. One of them, according to Brenton and Vancauteren (2001), suggests that consumers favor goods with home location of production regardless the country of ownership of the production. In the European Union, the Community law rejects mandatory labeling of goods with their national origin but such voluntary labeling is frequently used. Brenton and Vancauteren (2001) identify a large source of the border effect just in consumer home bias, differences in preferences and local marketing network of buyers and sellers.

National bias in favor of domestic goods may both reduce foreign imports and keep domestic prices relatively high. If consumers prefer particular domestic produced good to its imported counterpart, it may prevent foreign producers to enter the domestic market despite relatively high domestic prices. Neven, and al. (1991)[44] confirm this assumption by a model, in which prices behave subject to a non-cooperative equilibrium. They explain how the comparatively higher domestic prices could stimulate the domestic market share.

3.6. Welfare implications

Among a variety of factors, which raise the border effect one can distinguish those that are related to policy and those that are not, and hence evaluate their respective political consequences. Whether technical barriers to trade or non-tariff barriers play an important role in impeding cross-border trade, we can deduce that crossing the border has some welfare implications and that the removal of those barriers would be effective. On the contrary, if only

[44] Noted in Vancauteren (2002).

spatial agglomeration or information costs were relevant, we would conclude that the policy consequences of border effects are of minor importance.

Based on a study among OECD countries,[45] border barriers are sizeable and have welfare significance. If one supposes an elasticity of substitution equal to five, a tariff equivalent of most border barriers reaches 50%. Even under an unrealistic assumption of elasticity of substitution that is equal to ten then the tariff equivalent of borders would be around 20%. When measuring welfare as a percentage rise in the real level of consumption, for example Canada's estimated welfare effect of border barriers is 52%! Larger countries rely on international trade less so therefore welfare effect in the US is just 6.4%. For that reason, smaller countries should be more convinced to eliminate trade barriers. In the model non-border barriers are captured by distance. Hence, decreasing costs of transportation and communication would make the reduction of border barriers even more welfare efficient.

Correspondingly with Rose (1999), Anderson and van Wincoop (2001a) made some estimation on effects of currency unions. Under dollarization of Argentina, its trade to the US is assumed to rise by 132% and welfare by merely 3.3%. On the other hand, trade of potentially dollarized Canada would rise by 'only' 38% and welfare by 30%. In the most extreme scenario, Anderson and van Wincoop (2001a) modeled the largest potential monetary union, among all countries in the world. Such arrangement would lift trade by only 10%, but welfare is assumed to increase as much as 21% according to them. Nevertheless, they concluded that the overall implied costs of monetary union are extremely high compared to the costs of foreign exchange and exchange rate uncertainty.

3.7. Limitations of the model

One problem of interpreting the border effect arises from the aggregation of data flow. Most of the literature does not take into account that not all goods

[45] Anderson and van Wincoop (2001a).

are exported. Heterogeneous fixed costs of trade make export for some industries less profitable than for other ones. For such reason, additional fixed costs for sales abroad account for different 'availability' of goods at domestic markets versus foreign markets. This phenomenon, studied by Evans (2001) or Hillberry (2002), explains why, for example, only one fourth of all US firms in 1992 sold their products to other countries. If borders were 'erased', there will most likely be a smaller number of zero trade observations; that implicates a compositional change of trade. Thus, because of the aggregation of trade flows, the border effect in most empirical models can be overestimated for goods that are actually traded across the border. To eliminate the inaccuracy induced by aggregation, the model would have to incorporate the border-generated changes in the variety of traded goods, the differences in goods responsiveness to borders and the geography of production. After controlling for such 'aggregation bias', Hillberry's (2002) estimates of aggregate border effect for Canadian provinces with U.S. states fell from McCallum-style estimates of 20.9 to 5.7.[46]

Evans's (2001) model allows heterogeneity across firms since a firm decides to enter the international market only if it is profitable. The degree of profitability is then determined by the combination of fixed trade costs, ad valorem costs of trade, transport costs and elasticity of substitution. Hence, Evans used the gravity model specially designed to take into consideration only the share of goods, which are in reality available both at home and abroad. In comparison to results of the more conventional gravity models, the border effect using Evans's model decreases for each of the twenty industries by 18 to 77 percent. On an average this is a decrease of 44.6 percent.[47]

Another limitation of gravity type equations is the assumption of homotheticity in demand, which arises from the assumption of CES preferences. In reality, not all countries consume a bundle of goods in the

[46] Hillberry (2002), p.518.

same proportions. Consumers in rich countries demand more luxury goods relative to necessities than do consumers in poorer countries. Producers in rich countries tend to specialize in luxuries and to trade more profoundly with other rich countries. Therefore, non-homotheticicities in demand can explain a large part of the border effect. Deardorff (1995) remarks: *"Generalizing the result to arbitrary preference, I found that this gravity equation would still hold on average, but that individual trade flows would exceed or fall short of it depending on a weighted correlation between the exporter's and the importer's deviations from the world average supplies and demands. This in turn was suggestive of how particular non-homotheticicities in demand could interact with factor endowments and factor proportions to cause countries to trade excessively (compared to the simple frictionless gravity equation) with countries like themselves."*[48] The size of border effect estimations can also be decreased by introduction of relative prices as suggested by Anderson and van Wincoop (2001).

Lastly, an essay by Calvo (2002) attacks the core of the results in previous border-related gravity studies. This rather isolated critique is directed towards a difference in the empirical definitions of the variables due to 'ill-defined' intra-national trade variables (X_{ii} and D_{ii}). In order to obtain homogenous definitions of the variables for both intra-and international trade flows, he uses for international trade data only from 'merged pairs of neighbor countries.' In such framework, the gravity model is not working successfully for data from 14 EU countries because intra-national variables cannot exploit the robustness from international variables as maintained by Calvo.

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[47] Computed based on Evans (2001), Table 3, p.43.
[48] Deardorff (1995), p.25.

4. Chapter Four - Empirical study of border effect in Central European countries

While there are several border effect studies focusing on the EU countries there may not be any available reference regarding Central European economies in transition. The objective of this section is to examine the border effect, in other words, to compare the relative volumes of intra-versus inter-national trade in a sample of Visegrad Four (V4) countries accompanied by Germany and Austria. Following the empirical gravity equation framework, a set of regressions under various variable specifications will provide relevant outcomes of gravity model in this region.

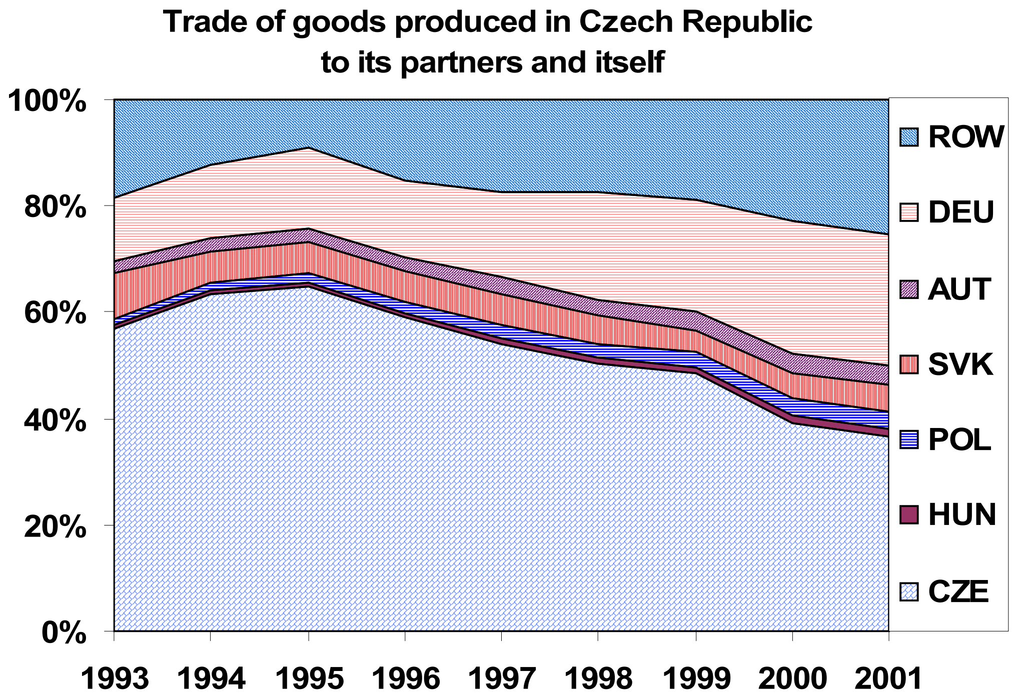
4.1. The data

In the model I use macroeconomic data of six countries; they are Austria, Czech Republic, Germany, Hungary, Poland and Slovakia. The goal is to investigate the impact of borders in this central European region. Data used are since 1993 (after the division of Czechoslovakia) until 2001. Previous to employing the gravity equation to the study of border effect it is meaningful to inspect the development of the trade characteristics in the mentioned countries during this period.

4.2. Exports

Since the Czech Republic is situated in the middle of the region of the six inspected countries, its exports are oriented especially to the markets of its neighbor countries. Therefore, as an example, on Figure 5 are represented the proportions of its exports and its domestic trade. From this figure we recognize certain evolution of exports from the Czech republic to its partners and domestic goods trade during 1993 to 2001. The percentage of intra-national trade in overall trade was the highest (over 60 percent) in 1995 and then decreased steadily to less than 40 percent in 2001.

Figure 5.



Source: Author's calculation based on OECD data.

Looking at the exports from Czech republic, one can see sharp increase of trade to Germany, its biggest trading partner, during years 1993 to 1995, then a steady period, and afterwards we see a moderate increase up until 2001. On a nine-year average, Czech republic exported 38 percent of all exports to Germany. Czech exports to its second largest trading partner, Slovakia, declined continually after the division of Czechoslovakia. To the rest of the world (ROW) Czech exports have risen gradually after 1995.

A brief insight to analogous evolution of exports from other countries reveals for instance that Hungarian exports to Germany increased following the same path as Czech trade to Germany. Stable growth of trade flows from Hungary to Austria is comparable to development of trade flows from Czech Republic to Austria and to Poland. Exports from Hungary to Czech republic, Slovakia and Poland and from Czech Republic to Hungary were during the whole period relatively low and increased only by a small amount. Poland's export to Germany grew moderately and almost doubled during this time.

4.3. Imports

Table 1 provides information about change in real imports. It is logical and visible at first sight that the four countries in transition experienced much higher volatility in the volume of imports compared to Germany and Austria. However, this volatility alleviates from 2000 to 2002 for Visegrad Four countries although the evolution of Austrian and German imports was somewhat unstable during these later years.

Table 1. Percentage change in real imports from previous year

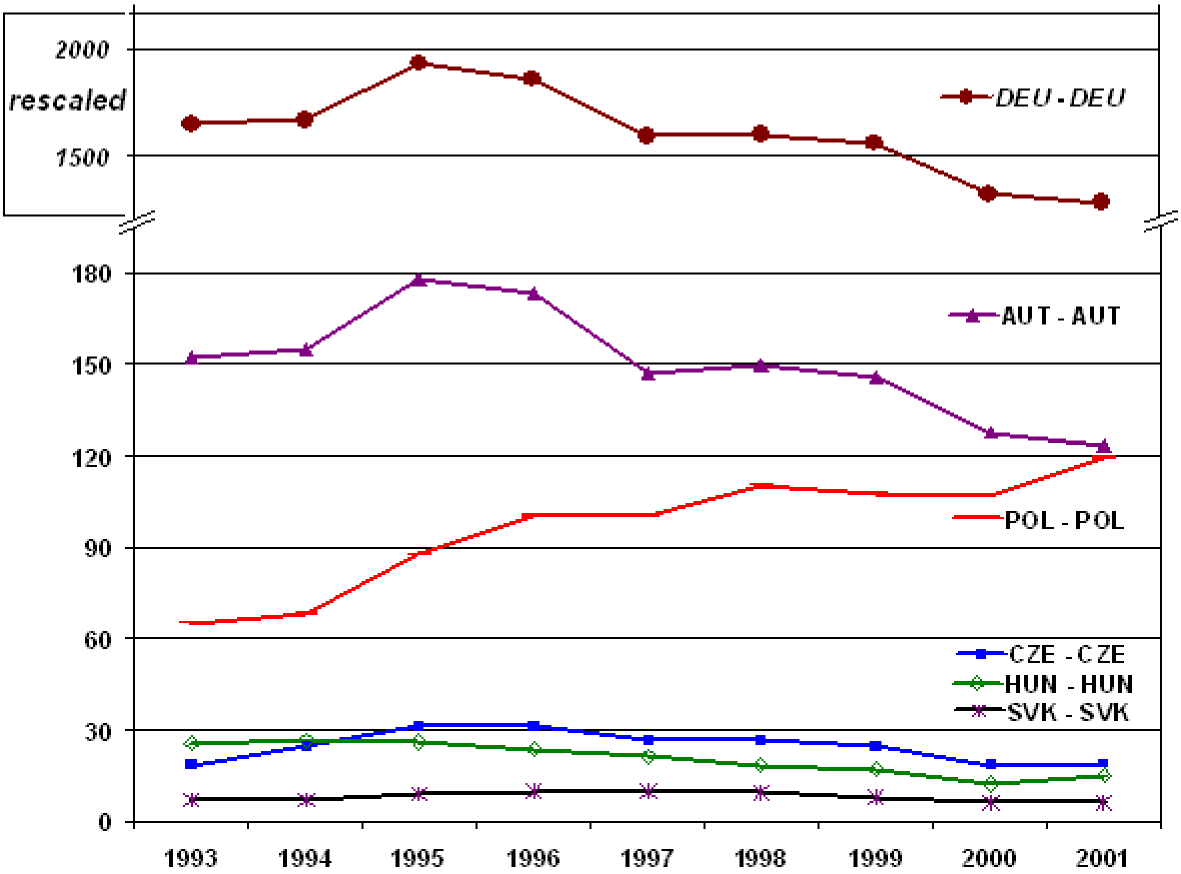
	1994	1995	1996	1997	1998	1999	2000	2001	2002
Czech Republic	7.58	21.19	13.36	8.08	6.57	5.42	16.96	13.58	4.29
Hungary	8.84	-0.71	6.21	24.62	22.78	12.32	21.08	6.30	8.90
Poland	11.34	24.22	28.01	21.40	18.54	0.98	15.56	-5.35	2.47
Slovak Republic	-5.39	11.53	19.81	13.78	16.85	-6.32	10.22	11.66	5.31
Austria	8.18	5.64	4.95	12.03	5.71	9.02	11.58	5.93	0.03
Germany	7.38	5.55	3.09	8.29	9.11	8.48	10.53	0.96	-2.11
European Union	8.11	7.46	4.03	9.47	10.04	7.52	11.37	1.38	0.15
Total OECD	9.77	8.75	8.55	10.61	7.45	8.51	12.33	-1.23	2.71

Source: OECD

Excluding Poland's imports in 2001 and Slovak imports in 1994 and 1999 the change in real imports for any other year and country out of this sample was always positive. The evolution of EU imports is parallel to German imports but shifted about one percent upwards with the exception of the year 1999 when the EU import grew less than the German. The total OECD imports growth was fairly above the EU average besides years 1998 and 2001.

4.4. Internal trade

Figure 6. Level of intra-country trade in bil. USD.



Source: Author's calculation based on OECD data.

Curves at Figure 6 illustrate the evolution of trade of domestic produced goods in each of the six countries. In most countries the domestic trade has a tendency to decrease due to the increased international trade. On the contrary, the intra-Poland trade has almost doubled during the considered period. Intra-Hungarian trade halved from 1993 to 2000, then increased slightly.

4.5. Gravity equation technique in practice

The data for years 1993-2001 comprises 324 observations of trade flows (including internal trade) and their corresponding distances, yearly GDPs, 'remoteness' and a set of dummy variables. All data on bilateral trade are taken from OECD Statistical Compendium database.

Ordinary least squares (OLS) estimation is used with robust option for white heteroskedasticity-consistent standard errors and covariance. In accordance with Wei (1996), Helliwell (1996, 1997) and Nitsch (2000), I estimate all years simultaneously with permitting only year-specific intercepts; other coefficients are held stable over years. It is achieved by replacing a general constant by nine separate one-year-dummies to stand for constants of each year for the time period from 1993 to 2001. A dummy for the year 1994, for example, carries a value of one only in the observations of that year and zero otherwise. The equation develops into:

$$\begin{aligned} ln(X_{ijt}) = {} & \alpha_1\, dum93 + \alpha_2\, dum94 + \alpha_3\, dum95 + \alpha_4\, dum96 + \alpha_5\, dum97 + \\ & + \alpha_6\, dum98 + \alpha_7\, dum99 + \alpha_8\, dum00 + \alpha_9\, dum01 + \\ & + \gamma HOME + \beta_1\, ln(Y_{it}) + \beta_2\, ln(Y_{jt}) + \beta_3\, ln(D_{ij}) + \varepsilon_{ij} \end{aligned} \tag{6}$$

This is the basic log-linear gravity equation allowing for year-specific fixed effects. Variables Y_i and Y_j stand for GDP of exporting and importing country, respectively and D_{ij} is a relevant distance. The GDPs and trade levels are expressed in current US dollars. It is not necessary to convert the values to constant prices since the year-specific dummies capture the fixed effects of each year. The *HOME* dummy carries a value of one for intra-national trade, zero for international trade. The border effect is then computed as $exp\ (\gamma)$. A border effect grater than one suggests a preference for trading domestically rather than internationally. The model can be augmented by other variables, such as remoteness and dummies for common border (adjacency), common language or membership in the EU:

$$\begin{aligned} ln(X_{ijt}) = {} & \alpha_1\, dum93 + \ldots + \alpha_9\, dum01 + \\ & + \gamma HOME + \beta_1\, ln(Y_{it}) + \beta_2\, ln(Y_{jt}) + \beta_3\, ln(D_{ij}) + \\ & + \beta_4\, ln(R_{ij}) + \beta_5\, LANG_{ij} + \beta_6\, ADJ_{ij} + \beta_7\, EU_{ij} + \varepsilon_{ij} \end{aligned} \tag{7}$$

The measure of relative remoteness R_{ij} , which was used for instance by Brenton and Vancauteren (2001), is specified as GDP-weighted average distance between the importer country *i* and all other trading partners other than *j*. ADJ_{ij} is a dummy for adjacency equal to one if trading countries *i* and *j* are sharing a common border. This variable takes a value of one in the case of domestic trade, equally to Wei (1996) but unlike Helliwell (1997) and Chen (2002). The dependent variable contains both international X_{ij} $(i \neq j)$ and domestic X_{ii} trade flows at aggregated level. Following previous studies (Wei (1996), Nitsch (2000), Evans (2001) and Head and Mayer (2000)), domestic trade X_{ii} for country *i* is given as the difference between its total output and its total exports to the rest of the world. International distances are measured between the economic centers of each country. I use minimum driving distance as a measure of distance between the capital cities in each state (with the exception of Germany, where Frankfurt am Main is used). Since road distances are available, it would not make sense to calculate great circle distances for our narrow sample of countries using longitude and latitude as e.g. Dzurilla (2003). For estimating the average internal distance within a country I use at first the measure of Nitsch (2000). This approach proposes D_{ij} to be a radius of a country as if it were a circle.

4.5.1. Results

It might be useful to inspect the behavior of the model when given different sets of independent variables. Six of the model specifications cases are reported in Table 2. It is apparent that diverse specification of the model yields different results. However, some of the variants of the model that generate coefficients neither reasonable nor significant will be omitted in the later analysis. The results in the basic version of the gravity model in first column of Table 2 show the border effect of 18.36 after controlling for size and distance. The R-squared is sufficiently high. A measure of remoteness at column II adds almost nothing to the overall explanatory power of the regression and it is not statistically significant; therefore I will omit it in subsequent computations. Remoteness would make more sense in a set of countries, which includes some 'geographic outliers' like Portugal, Greece or Iceland. In our sample all countries are accumulated in one part of Europe,

Table 2. Results

Column	I	II	III	IV	V	VI	VII
HOME	2.91	2.96	2.33	3.20	2.68	2.86	2.52
	(0.14)	(0.14)	(0.12)	(0.14)	(0.12)	(0.14)	(0.14)
Border effect	*18.36*	*19.22*	*10.23*	*24.53*	*14.53*	*17.48*	*12.43*
Ln (GDP i)	0.62	0.64	0.56	0.58	0.50	0.66	0.65
	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)
Ln (GDP j)	0.63	0.63	0.57	0.59	0.51	0.67	0.63
	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)
Ln (Dist ij)	-0.32	-0.28	-0.16	-0.05	0.24	-0.38	0.09
	(0.07)	(0.07)	(0.06)	(0.08)	(0.07)	(0.07)	(0.07)
Ln (R ij)		-0.11					-0.20
		(0.09)					(0.07)
Language			1.54		1.74		1.93
			(0.13)		(0.12)		(0.11)
Adjacency				0.55	0.80		0.67
				(0.11)	(0.09)		(0.09)
EU						-0.38	-0.98
						(0.19)	(0.15)
R-squared	0.90	0.90	0.94	0.91	0.94	0.94	0.95
Observations	324	324	324	324	324	324	0.434
Stand. Error of Est.	0.63	0.63	0.52	0.61	0.66	0.62	57.87
D-W statistic	1.86	1.85	1.84	2.04	1.89	1.88	1.90

Note: Year-specific constants are included in all regressions but not reported here.
Standard errors are in parenthesis.

where they have similar trading opportunities regarding both trade between themselves and the rest of the world. Nevertheless, our report of weak remoteness influence is somewhat similar to Nitsch's (2002) findings for ten EU countries. With his data set from twelve EU countries (after Portugal's and Spain's accession) the remoteness effect did not prove to be convincingly 'better'.[49]

[49] Similarly, lacking importance of the Log(Remote) variable predicts a model of Brülhart and Trionfetti (2002) for 6 importing and 22 exporting countries.

In column III of Table 2, the language effect turned out to be very important. After controlling for common language, the border effect drops to 10.2 (for countries not sharing the same language). The elasticity of importing (*i*) and exporting (*j*) countries' GDP on trade are stable between 0.62 and 0.64 at the first two columns. Some studies implicitly 'normalize' this elasticity equal to one (to support the theoretical derivation of gravity equation) but practically this coefficient was estimated in various studies between 0.6 and 1.2 depending on the sample. Our estimate is hence on the lower bound. Worth noting is the relatively low (in absolute value) coefficient on distance. Most literature studying intra-national home bias in North America (e.g. McCallum, 1995; Hillberry and Hummels, 2002a) as well as in Europe (Head and Mayer, 2002) found the slope for distance to be around minus one.

Once the adjacency effect (reported in column IV of Table 2) is added to the equation, the effect of distance almost disappears and becomes statistically insignificant. Then it would make no more sense to call our model a 'gravity' equation! In our sample of six countries we thus observe that more than kilometers traversed matters the adjacency of the trading partner. This fact proposes a strange conclusion: Distance does not influence trade between non-adjacent countries. This effect would probably be less pronounced if we extend our sample to more countries since in our sample there are 36 types of trade flow directions but only ten non-adjacent ones. In column V are included both language and adjacency effects. The effect of distance becomes statistically significant, but positively (!) affecting trade. This odd finding suggests that distances between some relevant economic centers should be reconsidered. Column VI reports the effect of an 'EU' dummy to control the effect of trade flows between Austria and Germany. Unexpectedly, its coefficient has a negative sign with a value of –0.38.

4.5.2. Distance experiment

Highly important is the robustness check for distance. The way distances are measured seems to matter for the size of the border effect. It is possible that the internal distance has been overstated in the literature since a vast part of goods can be traded within one industrial zone, in which the shipment distance is almost negligible. At first, I force only the intra-national approximation of Nitsch's average distance to fall by one third, which is consistent with the spirit of the most recent literature (Head and Mayer (2002), Hillberry and Hummels (2002a) and Brülhart and Trionfetti (2002)). We would have expected that reductions in internal distances relative to external distances automatically give additional explanatory power to the distance variable. But results in column III and IV of Table 3, which were constructed after devaluation of the internal distances by one third, are almost identical to the results in columns I and II, which use Nitch's original internal distance measure. The distance coefficients did not change although the border coefficients slightly decreased. In other words, for a given data the border coefficient is sensitive to the way domestic distances are measured, but not extremely as Head and Mayer (2002) reveal.

The lack of information on domestic shipment distances is however not the only problem. Results of a regression with omitted Austria and Germany observations (not reported here) suggested that the distance elasticity becomes then much more important (rises in absolute value to almost one from previous 0.2). I think this is a consequence of the geographic proximity of Vienna and Bratislava, which is lower than internal distances[50] of Slovakia and Austria, respectively. Excluding Austria hence removes this distance bias from the model. Such behavior of the model encourages me to another distance experiment. Analogically to assigning Frankfurt as the economic center of Germany instead of its capital city, I try to make imaginary economic centers of Austria and Slovakia more towards

[50] Even when using the lower internal distance measure. See Appendix Tables A2.1-3 for details.

the center of the country. The capital of Slovakia, Bratislava, is attached to the Austrian border but a lot of economic activity in Slovakia is located more towards the east. To set the average economic center more symmetrically, I arbitrarily assume Banska Bystrica to be the geographically and economically weighted center of Slovakia. Next, in the case of Austria instead of Vienna, I assume St. Pölten to be the midpoint. It is surely not any exaggerated shift since it is only 66 kilometers to the west from Vienna. The results are reviewed in columns V and VI of Table 3.

Table 3. Results of a distance check

Column	I	II	III	IV	V	VI
Distance measure	Nitsch's original		Lower internal distance		Geographically centered	
HOME	2.91	2.33	2.78	2.26	2.51	2.05
	(0.14)	(0.12)	(0.15)	(0.13)	(0.17)	(0.15)
Border effect	*18.36*	*10.23*	*16.18*	*9.58*	*12.30*	*7.77*
Ln (Y_i)	0.62	0.56	0.62	0.56	0.67	0.60
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
Ln (Y_j)	0.63	0.57	0.63	0.57	0.68	0.61
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
Ln (D_{ij})	-0.32	-0.16	-0.32	-0.16	-0.56	-0.35
	(0.07)	(0.06)	(0.07)	(0.06)	(0.01)	(0.08)
Language		1.54		1.54		1.52
		(0.13)		(0.13)		(0.13)
R-squared	0.90	0.94	0.90	0.94	0.91	0.94
Observations	324	324	324	324	324	324
S.E. of Est.	0.63	0.52	0.63	0.52	0.62	0.51
D-W statistic	1.86	1.84	1.86	1.84	1.93	1.86

Note: Year-specific constants are included in all regressions but not reported here. Standard errors in parenthesis. All coefficients are significant at 1% level.

Such distance adjustments meet the expectations. The Ln (D_{ij}) coefficient gains both value and significance. Indeed, it increases (in absolute terms) from former –0.32 to almost double in the basic specification (column V). It must be noted that the border coefficient falls to 2.51, suggesting a border effect of 12.3. Moreover, the importance of countries' GDP rises to some extent even though the total explanatory power of the model remains unchanged. After adding language and adjacency dummies into the model with adjusted distances is noteworthy that while language maintains almost the same econometric power, the adjacency (not reported in Table 3) starts to gain significance.

There may be some loss of precision in the driving distance recalculations but I have no reason to expect that, for example, direct or great circle (air) distances would yield better results. Nevertheless I employed them to the model just to make sure.[51] The outcome figures (not reported here) moderately undervalue the distance variable and overvalue the border variable, which is exactly the opposite of what the aim was of previous geographical shift of the economic center.

4.5.3. Sensitivity analysis

By definition, country's export (on the left side of regression) is included in country's GDP (on the right side). To make sure that the potential endogeneity in our model does not alter the results obtained by OLS, it is advisable to employ instrumental variables (IV) estimator. Consistently with the literature (e.g. Nitsch, 2000), a total countries' population $(Pop_{it}\ ,\ Pop_{jt})$ is chosen to instrument for their GDPs. For an overview of the IV estimation procedure, see. e.g. Greene (2001). Similarly with the literature, the results are qualitatively the same when instrumenting with the log of population and the border effect changes only slightly. To test the null hypothesis of exogeneity of GDP we employ the well-known Hausman test. The value of the test statistics (H = 1.10238) is the same in regressions, to which enters our first, respectively second distance measure, but have risen to (H = 16.62491) using the third distance measure.[52] However, both figures are low enough to stay below the relevant 95% critical value. Therefore, in any of the cases, the Hausman test does not reject the hypothesis of exogeneity of GDP at standard significance levels.

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[51] Straight-line distances calculated in program Pjsoft Infomapa 9.0, (European map).

4.5.4. Dynamic analysis

From the data set of 324 observations of trade flows (including internal trade) we can recognize certain trends. With the exception of Poland all the countries have fading 'export to itself,' in other words the consumption of its own production since the year 1995 (Slovakia from 1996) until 2001 (Czech republic and Hungary until 2000). Consistently, in most cases (including Poland) trade flows to other related countries have risen in time. Hence we can say that mentioned economies are more and more open and the border effect diminished in the past years.

It is important to study the evolution of the border effect year by year from 1993 through 2001, and so we can follow the changes in trade over time. It is estimated again by OLS method but nine separate year-specific *Home* dummies enter the regression instead of a unique *Home* variable. This allows us to capture the dynamics of border effect while leaving other variables the same for the whole period. As demonstrated at Figure 7, there has been a sharp, systematic and almost linear reduction in the border effect during this period. There is a clear downward tendency in the border coefficient. It declines each year by five to twenty three percent and it is strongly statistically significant. The GDPs, distance and common language elasticity remain the same. Over the nine years the border has fallen by almost two thirds, from exp(2.78) = 16.1 to exp (1.71) = 5.5. The smallest change was observed in the year 1999 while the largest border effect decline occurred in the subsequent year 2000. Results are reported in Table A 5. The decrease in the border impact is consistent with the evolution of external and internal trade presented earlier in Chapter IV. An analogy can be made to results of Dzurilla (2003), who finds increasing significance of both trade between EU and the new accession countries and between CEFTA countries over years 1996-2000. Nevertheless, the magnitude of the drop in the border effect is impressive; no other study reports such a large decrease in the

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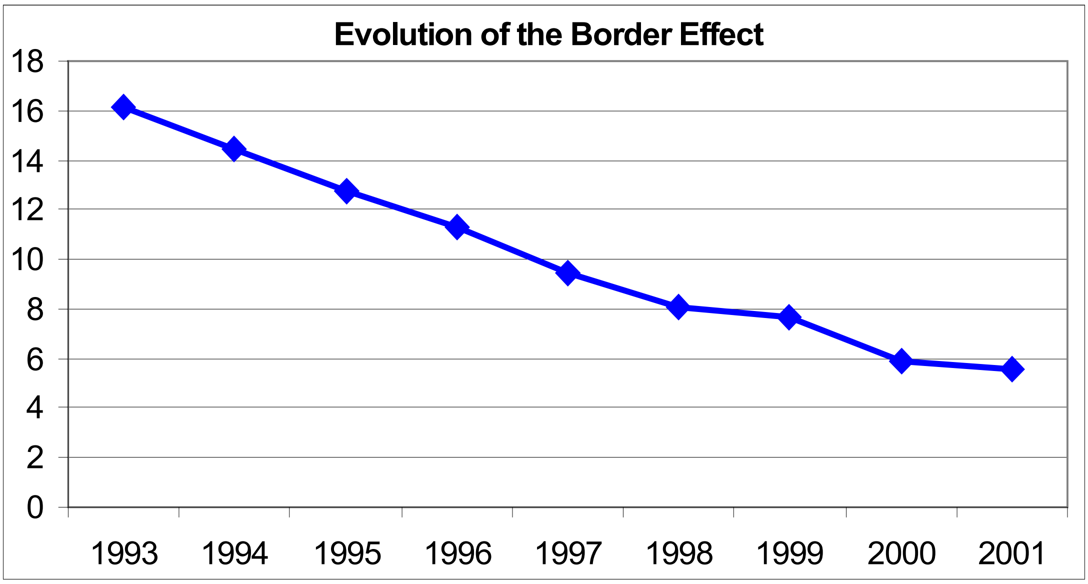
[52] The measures are in the same order as in Table 3.

border effect for a similar period. For example Brenton and Vancauteren (2001) report no systematic fall in the border effect for nine EU countries between 1988 and 1997.

Figure 7.



Source: Table A 5.

4.5.5. Results comparison

I compare the results with a number of papers studying border effect in the European Union or OECD countries. The *Home* coefficients gained from regressions in this paper are higher then in for example Chen (2002), who suggests that an average EU country out of a group of seven trades about 6.5 times [= exp (1.87)] more internally than with a partner EU country, after controlling for a number of factors. Nitsch's (2000) results for European Union in 1979-1990 show smaller border effect in the basic specification (6.8) but when including a common language dummy it rises to 8.8, which is between respective figures in column IV and VI of Table 3. Wei's (1996) value of border impact (although for OECD countries) is also slightly lower then our outcome in the basic gravity specification but falls rapidly down with the addition of variables for remoteness, linguistic ties and adjacency.

Chen (2002) proved that the economic impact of the border is greatly reduced if one adds to the gravity specification the origin and destination fixed-effects across industries to control for omitted relative prices. This approves the results suggested by Anderson and van Wincoop (2001) and Hillberry and Hummels (2002a) that neglecting relative prices tends to overvalue the importance of border.

The coefficients on any of our distance measures (in absolute values) are much smaller than their counterparts in Chen (2002) equal to -1.68, Wei (1996) equal to -1.39 or the 'average distance coefficient' equal to -0.94, which was computed by a meta-analysis of 595 regressions from 35 papers.[53] It must me noted that theoretical arguments of Anderson and van Wincoop (2001)) explain that the distance elasticity of trade is determined by the elasticity of substitution between goods times the elasticity of trade costs with respect to distance. It is therefore not possible without knowing the values of the two factors to argue whether the coefficient is too large or too small. However, empirical gravity equation relative to theoretically derived gravity equation has an advantage due to its easier simplification and estimation, without a necessity to know the elasticity of substitution, whose value is doubtful.

4.5.6. Trade between Czech Republic and Slovakia

Slovakia has remained Czech Republic's second largest trade partner even nine years after the division of the federation. Nevertheless, its position has been steadily declining. In 1993 the Czech Republic imported 15.9% products from Slovakia and exported there 19.7%. Until the year 2002 these figures declined to 5.2% of Czech imports and 7.7% of its exports. This development more deeply perceptible relative to other former federations, as informs Fidrmuc and Fidrmuc (2000): *"…the relations between former constituent parts of a federation retain some of their specific nature years after the break-up. … The Czech and Slovak Republics, which enjoy greater proximity to Western Europe, experienced a deeper collapse of bilateral trade that the Baltics or Belarus, Russia and Ukraine, despite generally lower barriers to trade than within the former Czechoslovakia. The prospects* *of an early EU membership for the Czech Republic, Slovenia and Estonia also may have contributed to the further deterioration of trade within their traditional partners in the late 1990s."*[54]

It is probable that the impact of the border between Czech Republic and Slovakia is not as serious as other borders in the selected group. I make use of the gravity equation to find out the impact if their mutual border including the entire time period and compare it to the impact of other borders. Primarily, we would like to know how the internal trade of the two countries is excessive respective to their bilateral trade. Unfortunately, the precise amount cannot be reached, since there is not enough observations to evaluate the border effect from only two countries data, however, a relative comparison can be based on the following idea. I retain the same six countries data but change the Home dummy for the CZE-SVK and SVK-CZE observations from zero to one and add their respective GDPs together. By such operation the 'Czechoslovak' trade is treated as internal. The results show that the border coefficient of the remaining borders has importantly risen. This suggests that the separate effect of Czechoslovak border is substantially below the average in border impact in the six countries sample.

To verify this outcome I use another specification of gravity equation with trade dummies, where instead of the home dummy there are thirty dummies for each of the possible international trade directions. For example, a dummy POL – HUN carries a value of one only in nine observations, where Poland exports to Hungary and zero otherwise. The *exp* of the coefficient on the trade direction dummy can be that interpreted as the volume of bilateral trade compared to internal trade of the six countries after controlling for size and distance. Language and year specific intercepts are omitted at this gravity equation specification. The coefficient on logarithm of distance depends greatly on the measure of distance. It is not statistically significant in the regression using Nitsch's original distance measure neither the one

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[53] See Head (2003).

with lowered internal distance. On the contrary, distance becomes significant when using the geographically adjusted measure. Its elasticity is -0.29 and corresponding coefficients on exporter and importer GDPs respectively are 0.61 and 0.65. The border-specific coefficients are reported in Table 4. The figures are ordered from the lowest resistance of border at the first column to the highest at the third column.

Table 4: The "resistance" of borders; one-way trade directions

CZE – SVK	-1.22	DEU – POL	-3.26	SVK – POL	-3.64
SVK – CZE	-1.45	SVK - HUN	-3.29	AUT - SVK	-3.65
DEU – AUT	-2.69	CZE - POL	-3.30	SVK - AUT	-3.77
AUT – HUN	-3.01	AUT - CZE	-3.40	HUN - SVK	-3.79
DEU – CZE	-3.13	CZE – HUN	-3.41	HUN - CZE	-3.81
DEU – HUN	-3.14	POL - DEU	-3.44	POL - SVK	-3.92
HUN – DEU	-3.14	DEU - SVK	-3.46	HUN - POL	-4.01
CZE – DEU	-3.15	CZE - AUT	-3.53	POL - HUN	-4.19
AUT – DEU	-3.16	POL - CZE	-3.56	AUT - POL	-4.42
HUN – AUT	-3.24	SVK - DEU	-3.62	POL - AUT	-4.74

Each of the thirty coefficients on trade directions is positive and strongly statistically significant. Moreover, according to the results we can assume there is a weaker impact of the border between the Czech and the Slovak republics. Indeed, the respective dummies CZE-SVK and SVK-CZE in Table 4 are considerably lower than the others. Subsequently, it is not surprising that trade between Austria and Poland and trade between Hungary and Poland happens to be most restricted since there are two borders between the two sets of trade partners.

It can be noticed that it does not matter too much which direction the trade takes place between a two given trade partners. In Table 4 both directions of bilateral trade can be observed in the same column, only with two exceptions. Hence, one more regression provides the impact of a particular border without distinguishing the direction of trade.

Again, all of the coefficients were significant and the coefficients on GDPs and distance practically did not change. We can compute that Czech

[54] Fidrmuc and Fidrmuc (2000), p.18.

Republic and Slovakia traded in the examined period only about 3.8 times less between each other then all six countries traded domestically on an average.[55]

Table 5: The “resistance” of borders.

1.	CZE ↔ SVK	-1.34	6.	POL ↔ DEU	-3.35	11.	HUN ↔ CZE	-3.61
2.	DEU ↔ AUT	-2.92	7.	CZE ↔ POL	-3.43	12.	SVK ↔ AUT	-3.71
3.	AUT ↔ HUN	-3.13	8.	AUT ↔ CZE	-3.47	13.	POL ↔ SVK	-3.78
4.	DEU ↔ HUN	-3.14	9.	SVK ↔ HUN	-3.54	14.	HUN ↔ POL	-4.10
5.	CZE ↔ DEU	-3.14	10.	SVK ↔ DEU	-3.54	15.	POL ↔ AUT	-4.58

When from the sample are excluded intra-national observations, the dummy for CZE-SVK border should be positive. Indeed, resulting number is 2.44, suggesting that trade of successors of Czechoslovakia exceeds the ‘ordinary’ trade in the sample eleven times. It is consistent with the study of Fidrmuc and Fidrmuc (2000), who found this dummy positive, highly significant and declining from 2.9 in 1993 to 1.9 in 1998. It implies that the preference to trade with its former part of the federation decreases. In 1993 it was about eighteen times, still in the year 1998 the trade between Czech and Slovak Republic exceeded the conventional trade seven times. This suggests that there is still a large part of disproportionately high trade between the two countries and it probably arises from their previous relations inside the former Czechoslovakia.

[55] 1/exp(-1.34) = 3.8.

5. Conclusion

John McCallum in “National borders matter” (1995) inspired other recent economists to examine the impact of national borders on trade. The evidence indicates that the presence of borders decreases the level of goods traded internationally and also the price variation of goods across countries. Although consumer preferences on the whole are not biased toward domestically produced goods we see that most of the output that is consumed is domestically produced. This implies the existence of a border effect, which is slowly weakening along with a declining trend in international market segmentation.

Price differences of the same products across Member States of the European Union were generally found to be more than three times higher than regional price differences within Member States. There is still a scope for a price convergence and market integration, which should result in savings for customers. Nevertheless, even in fully integrated markets, a certain variation of price is to be expected, for example due to transport costs and consumer preferences.

European countries were in general recognized to trade five to ten times more domestically then internationally. A part of this border effect could be attributed to technical barriers to trade, informal barriers, business and social networks and currency effects. This paper also covers a few reasons, which suggest that border effects are to some extent endogenous. This is the case, for instance, of the impact of intermediate input trade, costs of a firm, low transportability of some goods and preferences for domestic goods. Therefore, due to the endogenous factors we can conclude that a part of the effect is ‘natural’ and will be present even in frictionless integrated markets.

The empirical study of border effect covers a sample of Visegrad Four countries accompanied by Germany and Austria. The home bias proves to be important and significant. It implies the average border effect to be between

7.7 and 10.2 depending on the choice of the distance measurement. For instance, employing the geographically centered distance measure suggested by author, the border effect reveals that subunits within a country trade 7.7 times more with each other than with foreign subunits after controlling for size, distance and language. Potential difficulties with endogeneity of GDP in the model were diminished by the instrumental variable method supported by the Hausman specification test, which permits to treat GDP as exogenous. The dynamic analysis shows a systematic and large fall of the border effect in the examined period. It can be attributed to the ongoing integration of EU and V4 markets. By the final years of the tested period the value of border effect converged to values identified in the European Union.

The Czech Republic and the Slovak Republic still share a lot of similarities from the time they were a federation. Among a set of all country-pair borders the least trade-dampening effect was identified for border between these two countries. Although their bilateral trade has more or less declined in time, it still remains over-proportionate to what a standard gravity model would predict. This illustrates a significant influence of distance unrelated factors such as language, customs union, similar standards, knowledge of the market and environment.

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Appendix

Table A 1 - Industry-level border effects for EU9, Japan and US

Industry	EU9 effect	Japan effect	US effect	Industry	EU9 effect	Japan effect	US effect
Man-made fibres	1.79	2.44	6.88	Vegetables	14.83	609.74	65.1
Machinery - misc.	2.44	0.98	2.85	Wood n.e.s.	15.13	21.4	65.61
Textile n.e.s.	2.77	0.75	2.61	Tools etc.	15.26	14.83	45.77
Optical ins.	2.9	0.88	4.24	Aerospace	15.75	129.5	44.83
Steel tubes	3.21	1.08	5.27	Fish	16.28	42.52	8.66
Leather tanning	3.31	0.3	0.57	Soap	16.47	33.99	27.78
Industrial chem.	3.71	0.77	1.87	Paper processing	16.51	36.23	88.37
Jewellery	4.07	0.06	0.09	Electrical plant	17.33	76.69	80.86
Abrasives	4.32	2.32	3.15	Cork and brushes	19.3	17.9	21.04
Machinery - textile	4.33	3.33	2.64	Plastics	20.35	209.38	74.74
Toys and sports	4.38	1.13	4.73	Motor vehicles - bodies	21.43	2160.35	287.08
Machinery - agricult.	4.41	6.75	6.07	Confectionery	22.06	3232.41	712.41
Machinery n.e.s.	4.45	3.57	4.99	Shipbuilding	22.91	0.79	1.72
Floor coverings	4.79	2.92	4.95	Oils and fats	23.91	14.71	2.21
Iron and steel	4.81	11.06	66.2	Clothing	25.11	109.64	196.5
Asbestos	4.82	2.4	2.06	Pharmaceuticals	25.28	141.07	37.64
Transmission eq.	4.84	10.62	16.86	Used tyres	25.68	37.89	25.68
Furs	5.03	127.55	44.01	Textiles - households	27.85	226.76	78.27
Electrical apps. - home	5.3	4.93	14.63	Wood - processed	29.38	2447.84	23.19
Office machinery	5.52	11.97	9.51	Railway	30.18	63.25	22.4
Ceramics	5.75	0.67	4.76	Wooden furniture	30.8	91.44	121.76
Household chem. n.e.s.	5.77	13.61	32.87	Foundries	31.21	25.73	44.81
Cycles	6.23	0.99	7.72	Paint and ink	31.37	17.18	11.43
Leather - products	6.77	5.32	18.62	Metals transformation	35.61	10.91	9.25
Precision instr.	6.89	8.96	8.05	Dairy	40.13	8937.64	2965.67
Musical instr.	7.1	2.61	12.45	Food n.e.s.	43.11	1838.3	697.06
Footwear - mass	7.46	41.18	17.16	Structural metal	44.61	881.27	83.41
Non-ferrous metals prod.	7.61	94.75	25.1	Graphic labs	50.54	50.54	50.54
Knitting	8.3	124.12	200.47	Pasta	51.34	715.12	2651.51
Steel - preprocess	8.3	87.96	78.25	Grain milling	55.94	690.27	17.28
Clocks	8.72	73.36	318.74	Wires	62.47	193.4	91.46
Glass	8.77	4.91	10.22	Metal containers	65.78	246.82	72.91
Pulp and paper	8.87	68.24	6.27	Poultry	66.53	298.96	39.5
Lighting eq.	9.49	23.32	57.89	Printing	67.42	322.11	67.42
Transport eq. n.e.s.	9.64	12.05	7.44	Forging	72.51	680.32	116.32
Meat	9.9	220.67	6.81	Bread	84.36	542.28	1672.74
Machinery-food, chem	10.57	35.79	30.46	Tobacco	86.73	881.07	47.99
Industrial chem. n.e.s.	10.68	62.21	22.63	Sugar	101.91	863.75	270.12
Rubber	11.16	62.76	102.11	Oil refining	109.34	167.74	4.21
Stone	11.41	3.51	6.94	Beer	127.64	1173.34	1013.31
Motor veh. - ass and eng	11.43	140.71	3675.35	Concrete	134.21	4124.43	300.81
Electrical apps. - indl.	11.67	5.27	12.49	Clay	153.3	1269.59	2007.2
Medical eq.	12.22	11.66	12.02	Wood - sawing	153.64	3881.25	33.21
Receivers - TV and radio	12.73	108.94	217.65	Distilling	155.32	288681.6	1905.27
Machine-tools	12.95	53.15	66.1	Soft drinks	167.15	2097.1	1737.22
Machinery - engineering	12.99	82.47	61.43	Carpentry	233.72	11500.94	1244.24
Motor vehicles - parts	13.14	9106.8	2895.63	Wine	259.29	66770.45	3986.76
Telecoms	13.37	1.04	1.73	Wooden containers	303.62	2107.59	344.69
Starch	13.84	95.35	0.58	Cement	385.06	7548.77	3188.06

Source: Head and Mayer (2001).

A.2 - Minimum driving distances between economic centers

Table A.2.1. Nitsch's measure of average internal distance = square root of the country area times 0.564 (which is $1/\sqrt{\pi}$).

	Prague **Czech**	*Budapest* **Hungary**	*Warsaw* **Poland**	*Bratislava* **Slovakia**	*Vienna* **Austria**	*Frankfurt* **Germany**
Czech	158.4	570	625	355	315	515
Hungary		172.1	710	215	255	985
Poland			320.8	640	670	1140
Slovakia				124.9	75	800
Austria					163.4	730
Germany						337.0

Table A.2.2. Lower internal distance

= square root of the country area times 0.376 (which is $2/3\sqrt{\pi}$).

Dist Nitsch	*Prague* **Czech**	*Budapest* **Hungary**	*Warsaw* **Poland**	*Bratislava* **Slovakia**	*Vienna* **Austria**	*Frankfurt* **Germany**
Czech	105.6	570	625	355	315	515
Hungary		114.7	710	215	255	985
Poland			213.8	640	670	1140
Slovakia				83.3	75	800
Austria					108.9	730
Germany						224.6

Table A.2.3. Economic centers geographically shifted and lowered internal distance

	Prague **Czech**	*Budapest* **Hungary**	*Warsaw* **Poland**	*Banska Bystrica* **Slovakia**	*St. Polten* **Austria**	*Frankfurt* **Germany**
Czech	105.6	570	625	446	371	515
Hungary		114.7	710	175	321	985
Poland			213.8	509	736	1140
Slovakia				83.3	328	960
Austria					108.9	664
Germany						224.6

Table A 3 Method of estimation = Ordinary Least Squares

Dependent variable: X1
Current sample: 1 to 324
Number of observations: 324

Mean of dep. var. = 7.98372	LM het. test = .888317 [.346]
Std. dev. of dep. var. = 1.99341	Durbin-Watson = 1.92863 [<.611]
Sum of squared residuals = 79.3888	Jarque-Bera test = 5.20418 [.074]
Variance of residuals = .256093	Ramsey's RESET2 = 9.06905 [.003]
Std. error of regression = .506056	F (zero slopes) = 361.683 [.000]
R-squared = .938147	Schwarz B.I.C. = 272.367
Adjusted R-squared = .935553	Log likelihood = -231.902

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C93	-5.22542	0.323495	-16.1530	[.000]
C94	-5.15691	0.316668	-16.2849	[.000]
C95	-5.09334	0.311164	-16.3686	[.000]
C96	-5.02601	0.307877	-16.3247	[.000]
C97	-4.93051	0.303200	-16.2616	[.000]
C98	-4.87513	0.300495	-16.2237	[.000]
C99	-4.85537	0.298767	-16.2513	[.000]
C00	-4.77156	0.301494	-15.8264	[.000]
C01	-4.74682	0.301580	-15.7398	[.000]
HOME	2.25204	0.140576	16.0201	[.000]
Y1	0.562466	0.017191	32.7180	[.000]
Y2	0.571691	0.020209	28.2894	[.000]
DIST	-0.166897	0.044253	-3.77145	[.000]
LANG	1.47734	0.123566	11.9559	[.000]

Standard Errors are heteroskedastic-consistent (HCTYPE=2).

Table A.4 Estimation using instrumental variables

Dependent variable: X1
Endogenous variables: Y1 Y2
Included exogenous variables: C93 C94 C95 C96 C97 C98 C99 C00 C01 HOME DIST LANG
Excluded exogenous variables: POPI POPJ
Current sample: 1 to 324
Number of observations: 324

Mean of dep. var. = 7.98372 R-squared = .937465
Std. dev. of dep. var. = 1.99341 Adjusted R-squared = .934843
Sum of squared residuals = 80.5092 Durbin-Watson = 1.90562 [<.530]
Variance of residuals = .259707 F (zero slopes) = 23668.1 [.000]
Std. error of regression = .509615 E'PZ*E = 0.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C93	-5.52160	0.318188	-17.3533	[.000]
C94	-5.45751	0.313117	-17.4296	[.000]
C95	-5.40328	0.308749	-17.5005	[.000]
C96	-5.33804	0.306662	-17.4069	[.000]
C97	-5.24033	0.301999	-17.3522	[.000]
C98	-5.18731	0.299826	-17.3011	[.000]
C99	-5.16603	0.298527	-17.3051	[.000]
C00	-5.07956	0.300309	-16.9144	[.000]
C01	-5.05787	0.300298	-16.8428	[.000]
HOME	2.19989	0.149367	14.7281	[.000]
Y1	0.572774	0.021481	26.6641	[.000]
Y2	0.613295	0.025121	24.4134	[.000]
DIST	-0.214345	0.050628	-4.23373	[.000]
LANG	1.46676	0.129715	11.3075	[.000]

Standard Errors are heteroskedastic-consistent
H = 1.10238

Table A.5. Dynamic Analysis

Dependent Variable: X1
Method: Least Squares
Date: 04/24/04 Time: 18:27
Sample: 1 324
Included observations: 324
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C93	-5.313260	0.324184	-16.38965	0.0000
C94	-5.226328	0.315308	-16.57529	0.0000
C95	-5.141936	0.307848	-16.70284	0.0000
C96	-5.054340	0.304533	-16.59703	0.0000
C97	-4.928784	0.298890	-16.49028	0.0000
C98	-4.848486	0.295120	-16.42889	0.0000
C99	-4.819662	0.292393	-16.48351	0.0000
C00	-4.691198	0.291300	-16.10433	0.0000
C01	-4.657076	0.289952	-16.06152	0.0000
Home93	2.779106	0.191045	14.54685	0.0000
Home94	2.668523	0.176858	15.08853	0.0000
Home95	2.543631	0.171329	14.84646	0.0000
Home96	2.422013	0.170303	14.22175	0.0000
Home97	2.241687	0.169832	13.19944	0.0000
Home98	2.092192	0.174885	11.96324	0.0000
Home99	2.037774	0.177243	11.49706	0.0000
Home00	1.769883	0.198615	8.911111	0.0000
Home01	1.713584	0.196548	8.718404	0.0000
Y1	0.562466	0.016529	34.02961	0.0000
Y2	0.571691	0.019659	29.08008	0.0000
DIST	-0.166898	0.043052	-3.876640	0.0001
LANG	1.477340	0.127385	11.59743	0.0000

R-squared	0.942662	Mean dependent var	7.983723
Adjusted R-squared	0.938675	S.D. dependent var	1.993415
S.E. of regression	0.493645	Akaike info criterion	1.491487
Sum squared resid	73.59305	Schwarz criterion	1.748204
Log likelihood	-219.6208	F-statistic	236.4313
Durbin-Watson stat	1.891162	Prob(F-statistic)	0.000000