Institute of Economic Studies, Faculty of Social Sciences
Charles University in Prague

Impact of Institutions on Cross-Border Price Dispersion

Jiří Schwarz

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Institute of Economic Studies,
Faculty of Social Sciences,
Charles University in Prague

[UK FSV – IES]

Opletalova 26
CZ-110 00, Prague
E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Institut ekonomických studií
Fakulta sociálních věd
Univerzita Karlova v Praze

Opletalova 26
110 00 Praha 1

E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

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Impact of Institutions on Cross-Border Price Dispersion

Jiří Schwarz*

* IES, Charles University Prague and
Czech National Bank
E-mail: jiri.schwarz@gmail.com

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Abstract:
This paper analyzes the role of institutions in price dispersion among cities in the European region in the 1996-2009 period. An overview of the literature on the border effect reveals that the role of institutions is completely neglected. Using the Worldwide Governance Indicators as explanatory variables I find that the better the institutions, the lower the predicted dispersion. The result is robust to different specifications of the regression model and it is consistent with a hypothesis that arbitrage, as an entrepreneurial activity and the main power behind the law of one price, is influenced by institutional quality.

Keywords: border effect, price dispersion, price convergence, law of one price, institutional quality

JEL: D23, E31, F41, L26

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1. INTRODUCTION

There are two major puzzles in international economics that are closely related to each other. First, there seems to be a large home bias in trade. And second, real exchange rates seem to be much more volatile, and deviations from the purchasing power parity (PPP) more persistent than justifiable by economic theory. The amount of the unexplained missing trade, size and persistence of the PPP deviations, and the factors influencing them are the subject of this text.

"How is it possible to reconcile the extremely high short-term volatility of real exchange rates with the glacial rate…at which deviations from PPP seem to die out?" (Rogoff, 1996, p. 664). The answer to this question is linked to the so-called law of one price (LOP), a disaggregated version of the PPP. The reason why the LOP should hold is that if it were possible to buy a particular good in one place, transport it to another place and still sell with profit, such arbitrages would tend to equalize the prices in both locations. It is not surprising that in a world of high transportation and other transaction costs the deviations from the LOP were large and very long-lived, as Volckart and Wolf (2006) show in their example of Medieval Europe.

However, even today the functioning of the LOP is still very slow and imperfect with long-lasting price dispersion between states. A vast literature deals with this paradox, calling the unexplained part of price differentials a "border effect", i.e. the impact of the existence of national borders on trade. The general conclusion is that there isn't nearly as much international trade as the standard models suggest there should be, while the formal barriers such as various tariffs are too low to explain the revealed missing trade (J. E. Anderson, 2000, p. 115). The first wave of studies in the second half of the 1990s only addressed the size of this border effect (Engel & Rogers, 1996; McCallum, 1995). Only recently have authors started to explain it, i.e. look for other explanatory variables in addition to transportation costs and reduce the extent of the unexplained residuum.

Many authors estimate the size of the border effect and explain the role of various factors influencing cross-border price dispersion (Bergin & Glick, 2007; Parsley & Wei, 2007; Wolszczak-Derlacz, 2008a). The underlying idea in their studies is that arbitrage is a process which should automatically equalize the prices in different places once we remove the influence of these factors. However, arbitrage is an entrepreneurial activity and as such should be influenced by institutional quality. The reason is that low-quality institutions can impose prohibitive costs to arbitrage in the same way as large distances between cities or high tariffs. And contrary to, e.g. distance or language differences, the institutional quality is improvable making it potentially subject to economic policy. However, the role of institutions is completely neglected by existing literature on the border effect. The main hypothesis of this paper is that institutional quality significantly influences the extent of the price dispersion.

First, I provide an overview of the existing literature and various approaches to border-effect analysis and present the existing results. Then, I propose a theoretical explanation of the role of institutions in the functioning of the LOP. And finally, in the last section of this text I carry out a regression analysis to empirically assess the impact of several factors, including institutional quality on the cross-border price dispersion.

2. REVIEW OF RELATED LITERATURE

TRADE APPROACH

Formally, research takes on two distinct ways of estimating and explaining the border effect. The first stream of authors, starting with McCallum (1995), try to explore how borders affect trade by looking at the difference between intra- and international trade after controlling for distance and some other variables. First studies found that the trade inside countries is, controlling for distance, more than twenty times larger than trade with a foreign country (Helliwell, 1996; McCallum, 1995). With more consistent data the border effect on trade is lowered to about one half using the same model specification (M. A. Anderson & Smith, 1999), controlling for the remoteness of trading partners further lowers the unexplained portion of missing trade (Helliwell, 1997; Wei, 1996).

A serious problem with the gravity model specification used is that it estimates significant border effects also at the subnational level between individual US states (H. C. Wolf, 2000). But, using more theoretically grounded measures of effective internal distance, the border effect among US states drops significantly to about a half of its former value (Head & Mayer, 2002). The separation of wholesale and manufacturing shipments together with the use of actual distances of shipments lowers the border effect, i.e. the ratio of actual to predicted trade flows inside the US, to 1.5 (Hillberry & Hummels, 2003). The border effect in the EU decreases with the use of effective distance measures from about 20 to 4.2 (Head & Mayer, 2002). Technical barriers to trade and currency barriers also have a sizable impact on the magnitude of the border effect (Chen, 2004; de Sousa & Lochard, 2005).

To sum up, the missing trade stemming from the gravity model is to a large degree caused by incorrect internal distance data. The correct internal distance measure and suitable data on trade flows leads to a reasonably small border effect, which has its source mainly in various trade barriers.

PRICE APPROACH

Another way of measuring the border effect was introduced by Engel and Rogers (1996) who showed that the standard deviation of relative prices in US and Canadian cities is systematically higher for cross-border city pairs than for city pairs within the same country. According to their estimates, the US-Canada border adds a variability equivalent of 75,000 miles of distance. The big advantage of this approach is that it does not suffer from the above-mentioned problems with distance measures and intranational trade – the geographical distance between two cities is easy to obtain. It has been found that short-run deviations from the purchasing power parity are strongly linked to the nominal exchange rate variability (Engel & Rogers, 2001), but the explanatory power is considerably reduced when looking at long-run deviations (Bergin & Glick, 2007; Parsley & Wei, 2001; Wolszczak-Derlacz, 2008a). Even though the fixation of exchange rates through the introduction of a common currency should evidently reduce price dispersion, empirical investigations of euro introduction lead only to mixed results (Allington, Kattuman, & Waldmann, 2005; Engel & Rogers, 2004; Wolszczak-Derlacz, 2008b).

Some parts of the border effect can be explained by various biases and arbitrage costs such as tariffs (Bergin & Glick, 2007; Parsley & Wei, 2007), transportation costs per unit of distance (Bergin & Glick, 2007; Parsley & Wei, 2001), or language, tax, and income differences in respec-

tive countries (Wolszczak-Derlacz, 2008a). Also, it has been found that the aggregation of prices tends to bias the estimated border effect upwards (Broda & Weinstein, 2008; Imbs, Mumtaz, Ravn, & Rey, 2005), but when comparing the results obtained using disaggregated price data and official price indexes, the differences are relatively minor (Crucini & Shintani, 2008). Controlling for the share of non-traded inputs decreases the border effect significantly (Crucini & Shintani, 2008; Crucini, Telmer, & Zachariadis, 2005). Introducing sticky prices and sticky information into the model can further decrease the unexplained part of the price dispersion credited to the existence of national borders (Crucini, Shintani, & Tsuruga, 2008).

Gorodnichenko and Tesar (2009) point out that cross-country heterogeneity in price dispersion can bias the border effect upwards due to the incorrect identification of the effect in the used models. However, a significant border effect between the US and Canada is also found using the regression discontinuity approach, which is immune to this identification problem (Gopinath, Gourinchas, Hsieh, & Li, 2009), as well as by countries that have very similar within-country price dispersion patterns (Horváth, Rátfai, & Döme, 2008).

To conclude the literature review, there is a consensus that the border effect exists and is substantial even after controlling for many potential sources of this excess price variability.

3. THE ROLE OF INSTITUTIONAL QUALITY

The studies introduced in the previous section use a number of factors to explain the observed dispersion of prices between cross-border city pairs. The underlying idea is that after we control for the most important sources of distortions, the prices in different places should equalize as a consequence of arbitrage existence. However, arbitrage is not an automatic equilibrating process, it is an entrepreneurial activity. As Kirzner (1997, p. 70) points out, "each market is characterized by opportunities for pure entrepreneurial profit. The…entrepreneur…buys where prices are 'too low' and sells where prices are 'too high'. In this way…price discrepancies are narrowed in the equilibrative direction."

In a similar manner, Baumol, Litan, and Schramm (2007, p. 3) understand an entrepreneur to be "any entity, new or existing, that provides a new product or service or that develops and uses new methods to produce or deliver existing goods and services at lower cost". The goods do not travel from where they are cheaper to where they are more expensive by themselves; the prices do not automatically equalize. It is a process run by the entrepreneurs who have to discover profit opportunities. The profitability of arbitrage is then influenced by a number of different costs, such as tariffs or transportation costs. However, it is not the lack of entrepreneurship that leads to deviations from the LOP. Building on Schumpeter and Kirzner, Baumol (1990, p. 894, emphasis in the original) notes that, "Entrepreneurs are always with us and always play *some* substantial role. But…some of those roles do not follow the constructive and innovative script that is conventionally attributed to that person.…How the entrepreneur acts at a given time and place depends heavily on the rules of the game – the reward structure in the economy – that happen to prevail."

In other words, if the institutional framework induces prohibitive costs to engage in innovative or arbitrage activities, the entrepreneurs will direct their efforts to other activities, often unproductive, such as rent seeking. As a consequence, in addition to the already-introduced costs of arbitrage such as those caused by the distance between cities, language differences, or trade

barriers, the quality of institutions should also influence the attractiveness of arbitrage activities. But its role in the existing literature on the border effect is almost completely ignored.

Due to the unavailability of suitable data, I will not test the direct link from institutions to entrepreneurship and price dispersion, but only indirectly from institutions to price dispersion. It is, therefore, possible that the institutional quality influences the price differentials through some other channel. Research on the topic of entrepreneurial productivity, however, suggests that the link between institutional quality and the activities of entrepreneurs indeed exists. Baumol (1990) provides several examples of various historical periods and shows how changing institutional frameworks through the allocation of resources between the productive and unproductive affected the innovativeness and spread of technological discoveries.

Aidis and Estrin (2006) address the relationship of institutions and productive entrepreneurship in today's Russia. Even though they do so very informally, they emphasize several interesting differences between Russian and Chinese self-help institutions based on social networks. While in China this system has evolved into a tool used to overcome the absence of well-defined property rights and contract enforcement, this was not the case in Russia, where the network is primarily used as a means for corruption (Hsu, 2005; Wu & Huang, 2006). Aidis and Estrin find that the entry rates of new firms in Russia are deep below the rates commonly observed both in developed and developing countries.

A more formal test of the link between institutional quality and the productivity of entrepreneurship is provided by Sobel (2008). He uses the Economic Freedom of North America index as a measure of institutional quality and several proxies for productive and unproductive entrepreneurship. As proxies for the productive, Sobel uses venture capital investments per capita, patents per capita, the growth rate of self-employment activity, the establishment birth rate, and the large firm establishment birth rate. To proxy for unproductive entrepreneurship, he uses three different measures of the number of political and lobbying organizations in each state's capital and an index measuring judicial quality, where states scoring poorly have generally significant levels of legal fraud and abuse. As expected, institutional quality is positively correlated with measures of productive entrepreneurship, and negatively with measures of unproductive entrepreneurship, no matter what measure is used.

In this text I use the theory of productive and unproductive entrepreneurship to argue that institutional quality may be one of the determinants of the size of the border effect. In order to test this hypothesis, I will express the quality of institutions as one of the factors influencing the total costs of arbitrage by including various measures of institutional quality into the set of variables used to explain price dispersion. The theoretical prediction is that the better the institutions, the smaller the deviations from the LOP.

4. DATA

In the analysis I use data on actual retail prices, not price indexes. The information on prices comes from the Worldwide Cost of Living surveys conducted twice a year by the Economist Intelligence Unit (EIU). The main target market for the data source is managers who use it to compare the costs of living in different world cities and estimate compensation for relocating employees. Even though the goods included in the survey to some degree reflect this target, the sample overlaps sufficiently with a typical urban consumption basket. Generally, the use of ac-

tual prices could be problematic mainly because a) the price data are collected from a small number of stores compared to the number of outlets surveyed by national statistical agencies when constructing various indexes, b) the price data come only from large cities which do not have to be fully representative of whole countries, and c) the list of tracked items does not represent the whole consumption basket (Engel & Rogers, 2004; Wolszczak-Derlacz, 2008b).

In order to test the reliability of the EIU data, Crucini and Shintani (2008) compare the half-lives of aggregated EIU prices with official CPI statistics and find that both datasets are practically identical. Similarly, Rogers (2002) finds out that a) price indexes constructed from the EIU data share important characteristics with the Penn World Tables and OECD intersectoral data sets, and b) the correlation between EIU price changes and the annual official CPI inflation rate is positive and large. Moreover, PPP rates resulting from EIU prices are comparable to the PPP rates reported by the OECD. It seems, therefore, that it is possible to use the EIU dataset without inducing any type of bias into the results.

The major advantage of using actual prices compared to the use of price indexes is the possibility to construct a measure of the average dispersion of the individual prices between two places in one time period. Price indexes also have the disadvantage of including both traded- and non-traded goods and lack important pieces of information due to the aggregation – price deviations with opposite signs can cancel each other out.

The survey covers 140 cities in 93 countries and consists of local prices for more than 160 individual goods. Among the goods are products such as "white bread (1 kg)", "paperback novel (at bookstore)", and "women's cardigan sweater" or services like "man's haircut (tips included)". The prices of many goods in the survey are collected from two types of outlets: supermarkets and mid-priced stores. In this paper, only prices from the supermarket or lower-price outlets are used, since they are more likely to be comparable across different regions. The data are annual and collected since 1990, but due to limitations of institutional quality data only the 1996-2009 period is used in the analysis. All prices are expressed in euros.

Forty cities from 31 countries in the European region are chosen, together with 134 goods (listed in Appendix Table A1, Table A2, and Table A3).[1] The choice of cities is based on the availability of both price data and institutional quality data. Products and services are grouped into eight different categories to allow for a more detailed overview of price development. The distinction between traded and non-traded goods is a common sense one and follows the classification used by other authors (Bergin & Glick, 2007; Engel & Rogers, 2004).

In order to study the impact of institutional quality, data from the Worldwide Governance Indicators project (WGI) are used. They cover six dimensions of governance over the 1996-2009 period: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. The first two dimensions capture the processes by which governments are selected, monitored, and replaced. Government effectiveness and regulatory quality assess the capacity of governments to effectively formulate and implement sound policies. The last two indicators measure the respect of both citizens and the state for the institu-

[1] Some of the available items were not included: Prices of cigarettes, tobacco, electricity, gas, water, heating oil, road tax and automobile registration fees are often regulated and therefore cannot be expected to converge. The second group of excluded items consists of goods and services which are not very suitable for international comparison because their quality can vary significantly: cars, office and residential rents, insurance, and prices of schools, healthcare, and sports.

tions that govern economic and social interactions between them (Kaufmann, Kraay, & Mastruzzi, 2010, p. 4).

The WGI gets the data from 31 different sources of four kinds: commercial business information providers, surveys of firms and households, non-governmental organizations, and public sector data providers. Altogether, more than 400 variables are used to compute the indicators. This should lead to greater precision of data compared to any individual data source.

5. MEASURING PRICE DISPERSION

My goal is to measure the scope of deviations from the LOP across cities in different markets and its development over time. Moreover, I want to estimate the influence of various city- and country-specific factors on the size of the deviations. In order to do so, following the other studies (Bergin & Glick, 2007; Engel, Rogers, & Wang, 2003; Horváth et al., 2008), relative log prices between all available city pairs are formed. To be more specific, let $P_{i,t}^k$ be the price of good k in city i at time t expressed in euros. For a given pair of cities (i, j), the relative price for a given good and time is:

$$q_{ij,t}^k = p_{i,t}^k - p_{j,t}^k \tag{1}$$

where the lower case denotes logs.

In order to capture the costs of arbitrage, a price dispersion measure is constructed. Existing papers generally use two types of average dispersion measures. I decided to use both as a robustness check and find out if the choice of dispersion measure affects the final results. The first measure is a standard deviation of $q_{ij,t}^k$ across all products k:

$$SD_{ij,t} = \left(\sum_{k \in K} \left(q_{ij,t}^k - q_{ij,t}^{\bar{k}} \right)^2 / K_N \right)^{1/2} \tag{2}$$

where K is the set of products, K_N is the number of products, and $q_{ij,t}^{\bar{k}}$ is the average relative price over all the products from the set for city pair ij.

The second measure is a mean square error of $q_{ij,t}^k$ across all products k:

$$MSE_{ij,t} = \sum_{k \in K} \left(q_{ij,t}^k \right)^2 / K_N \tag{3}$$

where K is, again, the set of products and K_N is the number of products. The only difference between the SD and MSE is that the SD removes the city-pair fixed effects. That is, the MSE not only measures dispersion, but also the average distance of relative prices from zero. Potentially, there are 820 city pairs, each with up to 20 yearly observations. This gives us a sample of a maximum of 16,400 observations. After the exclusion of missing observations, 13,004 observations of price dispersion are left. Appendix Table A4 provides a brief statistical summary of both measures – there is, obviously, enough variance in the sample.

Some studies directly use the relative log price as a measure of price dispersion between the two cities (Engel et al., 2003). However, this approach is not consistent with the theory behind the LOP. Deviations from an equilibrium price level of a good exist because for some reason the

forces of arbitrage are not functioning. Whatever the sources of arbitrage failure may be, it is possible to represent them by a band of no-arbitrage, within which the differences in the price of one good between two places are too small to enable arbitrage with profit (Parsley & Wei, 2001).

As a simple example, we can imagine a world where there are only two barriers to trade: transportation costs and tariffs. These two costs give rise to a band, or interval, where the prices of a particular product in two distinct cities are too close to each other, i.e. the relative price is too close to zero, to allow for a profit-making arbitrage. Arbitrage would start to work only after the relative price leaves this band. In a world of no other obstacles to trade, the correction of an excess price difference would be instantaneously bringing the relative price back into the band where no further profitable arbitrage would be possible. The situation is illustrated in Figure 1. However, the band's width does not have to be constant all the time. Suppose, for example, that in 1994 the tariff is lowered. As a consequence, arbitrage would be profitable with the lower absolute values of relative prices, i.e. with a smaller price difference. The band of no-arbitrage can also widen, for example due to higher oil prices that then increase transportation costs.

Figure 1: Relative prices in the band of no-arbitrage (example)

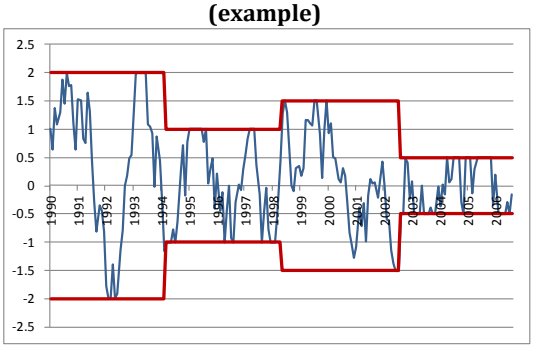
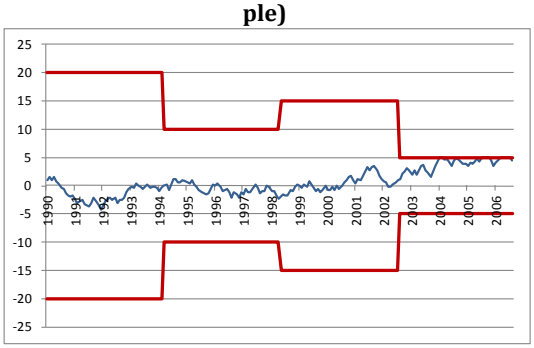


Figure 2: No-arbitrage band unidentifiable (example)



The relative price inside the band of no-arbitrage follows a random walk process. As long as it is inside the band, the price difference can move in any direction regardless of the arbitrage constraints symbolized by the band's width. Using the absolute value of the relative price itself as a measure of dispersion is, therefore, not appropriate because we are not able to observe the width of the no-arbitrage band and distinguish between the random movement of the relative price inside the band and the change of the width of the band. But, only the second case is a phenomenon that could be explained by changes in external factors.

It is possible to estimate the width of the no-arbitrage band by observing the many realizations of relative prices between two cities and calculating their dispersion. There is, of course, an implicit assumption that the relative price fluctuations use the whole band width. In other words, if due to any reason the prices move in a band narrower than the no-arbitrage band both before and after the change of external factors influencing the costs of arbitrage, as illustrated in Figure 2, then even this method fails. Such a situation is, however, very improbable given the level of world market integration as would happen only in the case of immense trade barriers. Both measures of dispersion are formed for ten different product sets: 1) perishable food and non-alcoholic beverages, 2) non-perishable food and non-alcoholic beverages, 3) clothing and footwear, 4) alcoholic beverages, 5) recreational products, 6) personal care products, and 7) household supplies together with a few other items form the group of 8) traded goods which, together with 9) non-traded goods and one other item, form group 10) all items.

Figure 3: SD

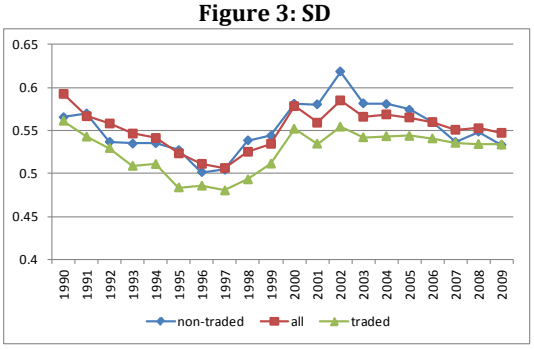


Figure 4: MSE

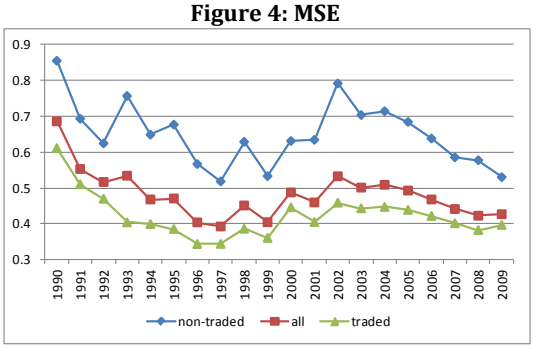


Figure 5: SD for different categories

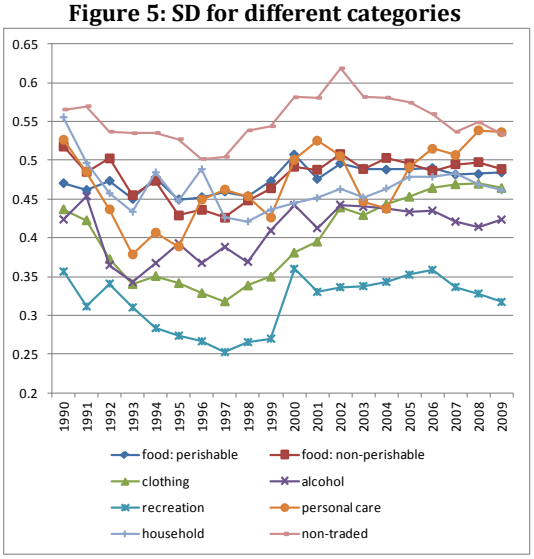


Figure 6: MSE for different categories

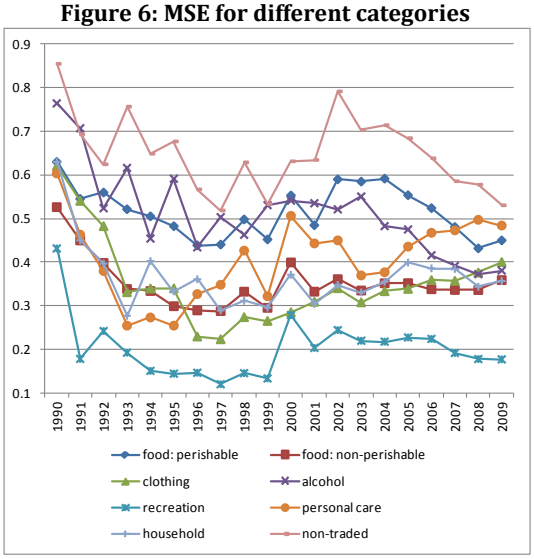


Figure 3 and Figure 4 present both dispersion measures averaged over all city pairs, i.e.:

$$SD_{\overline{ij},t} = \sum_{ij \in C} SD_{ij,t}/C_N$$
$$MSE_{\overline{ij},t} = \sum_{ij \in C} MSE_{ij,t}/C_N \qquad (4)$$

where C is the set of city pairs, and C_N is the number of available city pairs in time t. A U-pattern is evident for both dispersion measures during the 1990-2002 period, which corresponds to the findings of other authors using micro-data (Bergin & Glick, 2007; Engel & Rogers, 2004; Wolszczak-Derlacz, 2008a). Bergin and Glick (2007) find it especially surprising given the rise of Internet usage and the continuous integration of markets leading to higher price transparency. However, as I have explained above, the known existence of a non-zero relative price is only a necessary, but not a sufficient condition for arbitrage to take place. The evidence merely suggests that after a period of arbitrage-costs decrease, since 1997 the zone of no-arbitrage has widened again.

Figure 5 and Figure 6 show that the rough pattern is also present when disaggregating to individual product groups. Not surprisingly, the highest dispersion over the whole observed period is shown in the group of non-traded goods. On the other hand, the lowest variation in relative prices belongs to the group of recreational products, which is also expected given the items included (Time magazine, paperback novel, or color television).

There is one interesting difference between the two used dispersion measures. At the beginning of the 1990s, a sharp decline in MSE is documented which is not mirrored in the SD. The rest of the series development is very similar for both measures. As I mentioned before, the only difference between the MSE and SD is that the SD ignores the mean, i.e. the city-pair fixed effect. Because we averaged across all city pairs, a decline in the MSE which is not accompanied by a decline in the SD signals that, on average, the no-arbitrage band moved closer to zero without changing its width.

Given the time period, one hypothesis suggests itself: Price levels in countries that opened their markets by the fall of Socialism at the end of 1980s should converge with a higher pace to price levels in other economies. Suppose, for example, that in 1990 all prices in West Germany were higher than in the Czech Republic. If between 1990 and 1991 all prices in the Czech Republic (expressed in ECU) increase by approximately the same proportion, the standard deviation of the relative prices would remain intact but the mean square error would decrease substantially. And, indeed, the data seem to provide support for this hypothesis. Table 1 shows city pairs with the highest differences between the 1993 and 1990 dispersion measured as mean square error. The first 61 positions are occupied by pairs where one of the cities is Warsaw, Prague, or Budapest. No such pattern is observable using the standard deviation.

Table 1: Top MSE differences between 1993 and 1990

#	City 1	City 2	Δ MSE	#	City 1	City 2	Δ MSE
1.	Helsinki	Warsaw	2.534066	11.	Barcelona	Warsaw	1.678679
2.	Helsinki	Prague	2.464104	12.	Paris	Warsaw	1.622458
3.	Prague	Stockholm	2.256737		…	…	…
4.	Stockholm	Warsaw	2.236346	40.	Budapest	Helsinki	1.254125
5.	Oslo	Warsaw	2.007358		…	…	…
6.	Warsaw	Zurich	1.997984	48.	Budapest	Stockholm	1.072657
7.	Oslo	Prague	1.979630		…	…	…
8.	London	Warsaw	1.835583	62.	Moscow	Zurich	0.654976
9.	Dublin	Warsaw	1.729069		…	…	…
10.	Prague	Zurich	1.711344	66.	Helsinki	Lisbon	0.602652

6. EXPLAINING PRICE DISPERSION

Authors of existing studies came up with a large number of different variables to explain the excessive cross-border price dispersion. Distance as a proxy for transportation costs is included in all of them. The nominal exchange rate volatility also proved to be positively correlated with price dispersion (Bergin & Glick, 2007; Engel & Rogers, 2001; Parsley & Wei, 2001, 2007; Wolszczak-Derlacz, 2008a). Other factors explaining some part of the border effect are a common language in cities, taxes and income levels in respective countries, as well as the trade intensity between them (Wolszczak-Derlacz, 2008a).

Tariff rates significantly correlate with price dispersion (Bergin & Glick, 2007; Parsley & Wei, 2007). Furthermore, the consideration of inputs tradability allows a more precise classification of products, revealing that a part of the dispersion attributed to the existence of borders may be explained by the existence of non-traded inputs, even to highly tradable goods (Crucini & Shintani, 2008; Crucini et al., 2005). Last but not least, distance is not an ideal proxy for transportation costs because the real costs per unit of distance do not have to be constant in time. The in-

clusion of a measure of unit transportation costs also explains part of the cross-border price dispersion (Bergin & Glick, 2007; Parsley & Wei, 2001).

I will focus on the neglected role of institutions influencing the business environment, as explained in Section 3, and will control for the usual variable – the distance between cities. As a robustness check, I will control for potential non-institutional sources of the variation in the institutional quality measure.

The distance between cities is used as a proxy variable for transportation costs, which are expected to influence the width of the no-arbitrage zone. I calculate the distance between cities using the great circle formula. The problem of distance as a proxy for transportation costs is not only the absence of unit costs, but also the fact that types of transport, as well as the quality of infrastructure can drastically vary case to case. Some kind of effective distance measure would be more appropriate. However, due to data limitations, simple geographical distance is used.

All six available measures of institutional quality from the WGI project are highly correlated, with the lowest correlation coefficient over 88%. Based on the theory presented in Section 3, the regulatory quality measure should best represent the analyzed institutional quality. According to Kaufmann, Kraay, and Mastruzzi (2010, p. 4), it captures "perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development". In order to test this hypothesis, I ran the regression (5) with the standard deviation as the dependent variable and with each of the six institutional measures in place of the institutional explanatory variable. Appendix Table A5 shows that the regulatory quality measure is indeed able to explain the largest part of the variation in the price dispersion. The regulatory quality measure also has the largest estimated coefficient, even after rescaling all of the institutional measures to [0-1] variables.

The regulatory quality from the WGI project is therefore used as an institutional quality measure. Until 2002 the indexes were calculated only every other year. The values in 1997, 1999, and 2001 are averages of the value in the previous and the following year. For each city pair, the institutional measure is constructed as a plain sum of levels attributed to the countries in which the cities are located. The higher value of institutional measure indicates better institutional quality. A better quality of institutions is expected to be correlated with a lower dispersion because good regulations lower the expected costs of entrepreneurial activity, making the costs of arbitrage smaller.

The standard deviation and mean square error of traded goods are used as dependent variables:

$$X_{ij,t} = \alpha_0 + \alpha_1 \ln(distance)_{ij} + \alpha_2 border_{ij} + \alpha_3 institutions_{ij,t} + \sum_{t=1997}^{2009} \beta_t Y_t + \varepsilon_{ij,t} \quad (5)$$

where $X_{ij,t}$ is either $SD_{ij,t}$, or $MSE_{ij,t}$ and Y_t are year fixed effects to capture the time-varying factors influencing all city pairs. Variance is clustered on the country-pair level to allow for intra-group correlation. All estimates are done using the OLS estimator.

Table 2: Regression results

Dependent variable:	(1) Standard deviation	(2) Mean square error	(3) Standard deviation	(4) Standard deviation	(5) Mean square error	(6) Standard deviation	(7) Mean square error	(8) Standard deviation	(9) Standard deviation	(10) Mean square error
Regulatory quality	-0.051***	-0.093***	-0.051***	0.015	0.004			-0.048***	-0.045***	-0.076***
	(0.003)	(0.008)	(0.003)	(0.010)	(0.010)			(0.005)	(0.006)	(0.014)
Border*reg. quality				-0.067***	-0.098***					
				(0.010)	(0.012)					
Diff. in regulatory quality						0.080***	0.155***			
						(0.005)	(0.013)			
Border	0.105**	0.107**	0.105**	0.275***	0.355***	0.078**	0.055*	0.105**	0.088***	0.034
	(0.044)	(0.050)	(0.043)	(0.028)	(0.035)	(0.032)	(0.029)	(0.043)	(0.028)	(0.027)
Log distance	0.047***	0.074***	0.047***	0.047***	0.073***	0.040***	0.056***	0.047***	0.069***	0.123***
	(0.006)	(0.013)	(0.006)	(0.006)	(0.013)	(0.005)	(0.012)	(0.006)	(0.006)	(0.014)
Year			3.841***							
			(0.332)							
Year^2			-0.001***							
			(0.000)							
GDP per capita								-0.222		
								(0.264)		
City fixed effects									✓	✓
Observations	10088	10088	10088	10088	10088	10088	10088	9955	10088	10088
Adjusted R^2	0.527	0.321	0.522	0.534	0.324	0.548	0.356	0.526	0.696	0.561

Notes: Robust standard errors in parentheses; variance is clustered at the country-pair level. All specifications but (3) include year fixed effects. Year effects are plotted in Figure 7 and Figure 8. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2 presents the regressions results. Column 1 shows a regression with the SD as the price dispersion measure, Column 2 shows results when using the MSE. In both cases the coefficients are highly significant and have expected signs. Cities further apart and those separated by a national border have a higher price dispersion. The institutions effect is not only statistically significant but also economically relevant. Only the change of the regulatory quality variable in 2009 when switching from the Prague-St. Petersburg to Prague-Stockholm pair induces a decrease in the price dispersion measured as the SD by 0.108, which is almost one standard deviation of the measure. This result confirms the hypothesis formulated in Section 3.

I plot the coefficients for year dummies to see whether the used explanatory variables are sufficient to model the pattern observed in the price dispersion measures. Figure 7 and Figure 8 show that the pattern is still observable. To formally test it, I replace the year dummies with a quadratic time trend.

Figure 7: Year fixed effects (incl. 95% conf. intervals), specification (1)

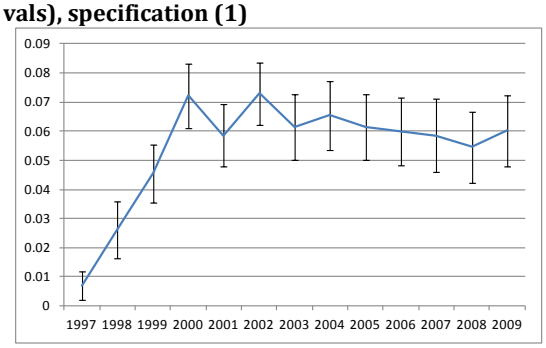
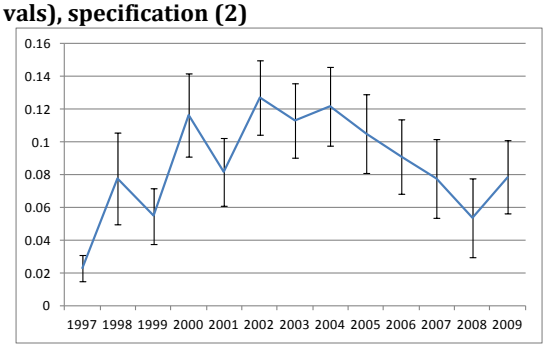


Figure 8: Year fixed effects (incl. 95% conf. intervals), specification (2)



Column 3 of Table 2 reports that the time trend is statistically significant and forms a parabola opened down with its peak in 2004. Qualitatively the same results are obtained when using the MSE as the dispersion measure, and are, therefore, not reported.

Theoretically, the role of institutions should be more important in the case of cross-border city pairs. No special permission in most cases is needed to trade among cities inside one country. It is, therefore, not necessary to communicate with the regulatory authorities in such cases. Moreover, existing retailers already buy their goods from some wholesalers in their countries. Switching to a different wholesaler or arbitrage from another retailer in the case of lower prices and, as a consequence, higher profit margins shouldn't be a complicated process dependent on institutional quality.

On the other hand, trade across borders is connected with significantly larger risks. The arbitrageurs have to deal with people they don't know, often with completely dissimilar cultural backgrounds. They cannot use the social networks they use in their domestic country. They have to be familiarized with unknown regulations and deal with customs and tax officers. In a nutshell, when trading across national borders, institutional quality should become much more important. To test this hypothesis, I add an interaction term *border*regulatory quality* among the explanatory variables. Columns 4 and 5 in Table 2 present the results of this amended regression. The interaction term is significant and negative for both specifications, which is consistent with the theoretical expectation. However, it has to be kept in mind that the number of city pairs

within one country is very small (222) compared to the number of cross-border city pairs, which can also cause the loss of significance of the original regulatory quality explanatory variable.

7. ROBUSTNESS CHECKS

Appendix Table A6 reports the results for individual product categories. All of them show the significant impact of border and institutional quality on price dispersion. Distance is also significant in all but two cases. However, certain categories have a very low R-squared which indicates that the model used to explain the extent of price dispersion is not very suitable for these categories. A low goodness of fit can have two sources: First, the width of the no-arbitrage band may be incorrectly identified, since the number of included items is very limited in categories other than perishable and non-perishable food, clothing, and non-traded goods. And second, some categories of products may have a specific process of price setting which is not captured by the model. This could be the case of alcoholic beverages which have, together with personal care products, a larger estimated border effect than non-traded goods.

Many authors include city fixed effects to their regressions. Results with city fixed effects are in Columns 9 and 10 in Table 2. The impact of institutional quality is still statistically significant for both dispersion measures, but the border loses its explanatory power when using the MSE measure. Given the fact that the only difference between the measures is that the MSE includes city-pair fixed effects, the city fixed effects probably are able to explain a large part of them and take on the explanatory power of the border.

The robustness of the proposed model is also checked by including the GDP per capita as a measure of the respective country's wealth. The reason is that the model could suffer from endogeneity – the wealth of the country could influence both the price dispersion and the quality of institutions. It is true that the GDP per capita and the quality of institutions are highly correlated; their correlation coefficient is above 0.73. However, the GDP per capita is able to explain only 54.3 % of the variation in the quality of institutions. And as Column 8 in Table 2 shows, including the GDP per capita doesn't remove the explanatory power of the institutional quality.

As described above, the regulatory quality measure for each city pair is constructed as a sum of both cities' indicators. The reason for this is that we expect city pairs with better institutions, conditional on their distance, to be more arbitrage-friendly, thereby with lower differences in the prices of traded products. One other approach of estimating the role of institutions is, however, also possible: we can, instead of sums, look at differences in institutional quality. The larger the difference, the more dispersed the prices should be.

To illustrate this idea in an example, suppose we choose two cities, e.g. Dublin and Moscow. If there are better quality institutions in Dublin, then the deviations from the LOP should be smaller there than in Moscow, where the institutional quality is lower, because Dublin is easily accessible for arbitrage activities. As a consequence, relative prices should be more dispersed between these two cities, conditional on distance and other factors, than between e.g. Dublin and Berlin.

Columns 6 and 7 in Table 2 report the results for the regression where for each city pair the sum of institutional indicators is replaced with their absolute-value difference. Regardless of the dispersion measure used, the impact of differences in institutional quality is significant and of expected direction.

We might also be interested in a more detailed analysis of the various aspects of the institutional framework. In order to test the robustness of the findings, I used a number of indicators provided by the World Bank.[2] Columns 1 and 2 of Appendix Table A7 present the results of regressions with five additional explanatory variables rescaled to [0-1] to allow a comparison of the size of their impact. The tertiary school enrollment rate is chosen to test whether the used aggregate institutional quality indicator isn't only a proxy for the level of development of the economy. The other used variables capture tax and the tax administration burden, tariffs, and importation costs. Even though it is revealed that the school enrollment rate and some of the other variables do play a significant role in explaining deviations from the LOP, the regulatory quality is still statistically significant and of expected sign.

Only after adding the importation time as another independent variable, the explanatory power of the regulatory quality disappears regardless of the dispersion measure used as reported in Columns 3 and 4 of Appendix Table A7. However, importation time captures the time needed for importing a 20-ft container load of general cargo and includes the waiting time at a border or seaport, the handling of the container, customs and technical/health clearance time, and transportation to a warehouse. Therefore, it also contains an institutional aspect and it is not surprising that the time to import is able to explain the part of the LOP deviation caused by differences in institutional quality. This finding doesn't refute the fact that institutional quality matters.

8. CONCLUSION

Building on the literature on the effects of national borders on deviations from the law of one price, I formulate the hypothesis that arbitrage is not an automatic equilibrating process, but rather an entrepreneurial activity. I argue that once we understand arbitrage as a productive entrepreneurial activity, institutional quality should be one of the determinants of arbitrage attractiveness and should, therefore, influence international price dispersion.

To test this hypothesis, I express the quality of institutions as one of the factors influencing the total costs of the arbitrage. The regression analysis of the data in the 1996-2009 period proves that institutional quality explains a significant part of the observed price dispersion defined either as a standard deviation or mean square error. I find that the better are the institutions, the lower is the predicted dispersion. This shows that institutional quality explains another part of the price dispersion previously attributed solely to the existence of borders. The result is robust to changes in the specification of the estimated model.

The major disadvantage of the institutional quality measure used is its high level of aggregation, which can lead to endogeneity and misidentification problems. Nevertheless, the fact that the regulatory quality indicator is able to explain more of the variation in the price dispersion than any of the other Worldwide Governance Indicators is consistent with the central hypothesis of this paper introduced in Section 3. Furthermore, the effect of the regulatory quality on the price dispersion is robust to the addition of variables explaining the general level of the development of the economy, and also stays significant when the tax and tax administration burden, tariffs and importation costs are included as explanatory variables.

[2] All variables used are described in Appendix Table A4.

The hypothesis that institutional quality influences the extent of the deviations from the LOP through the costs of arbitrage is further confirmed by the fact that the explanatory power of regulatory quality is lost only when the importation time is added to the set of explanatory variables. The reason is that this variable incorporates, for example, customs and technical/health clearance time which is expected to be correlated with the overall institutional quality of the respective country. On the other hand, it has to be admitted that due to data availability limitations it was not possible to directly verify the link through entrepreneurship even though the obtained results are consistent not only with the existence of such a link, but also with the empirical literature on entrepreneurship confirming the impact of institutions on entrepreneurial activity.

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APPENDIX

Table A1: Traded items in sample

Food and non-alcoholic beverages: perishable	Olive oil (1 l)	Scotch whisky, 6 y old (700 ml)
White bread (1 kg)	Peanut or corn oil (1 l)	Gin, Gilbey's or equiv. (700 ml)
Butter (500 g)	Peas, canned (250 g)	Vermouth, Martini & Rossi (1 l)
Margarine (500 g)	Tomatoes, canned (250 g)	Cognac, French VSOP (700 ml)
Spaghetti (1 kg)	Peaches, canned (500 g)	Liqueur, Cointreau (700 ml)
Flour, white (1 kg)	Sliced pineapples, can (500 g)	
Sugar, white (1 kg)	Chicken: frozen (1 kg)	***Recreation***
Cheese, imported (500 g)	Frozen fish fingers (1 kg)	Compact disc album
Cornflakes (375 g)	Instant coffee (125 g)	Television, colour (66 cm)
Milk, pasteurised (1 l)	Ground coffee (500 g)	Kodak colour film (36 expos)
Potatoes (2 kg)	Tea bags (25 bags)	International foreign daily newspaper
Onions (1 kg)	Cocoa (250 g)	International weekly news magazine (Time)
Tomatoes (1 kg)	Drinking chocolate (500 g)	Paperback novel (at bookstore)
Carrots (1 kg)	Coca-Cola (1 l)	
Oranges (1 kg)	Tonic water (200 ml)	***Personal care***
Apples (1 kg)	Mineral water (1 l)	Aspirins (100 tablets)
Lemons (1 kg)		Razor blades (five pieces)
Bananas (1 kg)	***Clothing and footwear***	Toothpaste with fluor. (120 g)
Lettuce (one)	Business suit, two piece, medium weight	Facial tissues (box of 100)
Eggs (12)	Business shirt, white	Hand lotion (125 ml)
Beef: filet mignon (1 kg)	Men's shoes, business wear	Lipstick (deluxe type)
Beef: steak, entrecote (1 kg)	Men's raincoat, Burberry type	
Beef: stewing, shoulder (1 kg)	Socks, wool mixture	***Household supplies***
Beef: roast (1 kg)	Dress, ready to wear, daytime	Soap (100 g)
Beef: ground or minced (1 kg)	Women's shoes, town	Laundry detergent (3 l)
Veal: chops (1 kg)	Women's cardigan sweater	Toilet tissue (two rolls)
Veal: fillet (1 kg)	Women's raincoat, Burberry type	Dishwashing liquid (750 ml)
Veal: roast (1 kg)	Tights, panty hose	Insect-killer spray (330 g)
Lamb: leg (1 kg)	Child's jeans	Light bulbs (two, 60 watts)
Lamb: chops (1 kg)	Child's shoes, dresswear	Batteries (two, size D/LR20)
Lamb: stewing (1 kg)	Child's shoes, sportswear	Frying pan (Teflon or good equivalent)
Pork: chops (1 kg)	Girl's dress	Electric toaster (for two slices)
Pork: loin (1 kg)	Boy's jacket, smart	
Ham: whole (1 kg)	Boy's dress trousers	
Bacon (1 kg)		***Not included in any category***
Chicken: fresh (1 kg)	***Alcoholic beverages***	Yoghurt, natural (150 g)
Fresh fish (1 kg)	Wine, common table (1 l)	Mushrooms (1 kg)
Orange juice (1 l)	Wine, superior quality (700 ml)	Shampoo & conditioner in one (400 ml)
	Wine, fine quality (700 ml)	
Food and non-alcoholic beverages: non-perishable	Beer, local brand (1 l)	
White rice (1 kg)	Beer, top quality (330 ml)	

Table A2: Non-traded items in sample

Non-traded	Moderate hotel, single room, one night including breakfast	Taxi: initial meter charge
Laundry (one shirt)	Babysitter's rate per hour	Taxi rate per additional kilometre
Dry cleaning, man's suit	Cost of developing 36 colour pictures	One drink at bar of first class hotel
Dry cleaning, woman's dress	Daily local newspaper	Two-course meal for two people
Dry cleaning, trousers	Three-course dinner for four people	Simple meal for one person
Man's haircut (tips included)	Four best seats at theatre or concert	Fast food snack: hamburger, fries and drink
Woman's cut & blow dry (tips included)	Four best seats at cinema	Hire car, weekly rate for lowest price classification
Telephone and line, monthly rental	Cost of a tune-up (but no major repairs) (low)	Hire car, weekly rate for moderate price classification
Hourly rate for domestic cleaning help	Cost of a tune-up (but no major repairs) (high)	***Not included in the category***
Maid's monthly wages (full time)	Regular unleaded petrol (1 l)	Telephone, charge per local call from home (3 mins)
Business trip, typical daily cost		
Hilton-type hotel, single room, one night including breakfast		

Table A3: Cities in sample

Almaty	*Kazakhstan*	Geneva	*Switzerland*	Moscow	*Russia*
Amsterdam	*Netherlands*	Hamburg	*Germany*	Oslo	*Norway*
Athens	*Greece*	Helsinki	*Finland*	Prague	*Czech Rep.*
Baku	*Azerbaijan*	Istanbul	*Turkey*	Paris	*France*
Barcelona	*Spain*	Copenhagen	*Denmark*	Rome	*Italy*
Berlin	*Germany*	Kiev	*Ukraine*	Reykjavik	*Iceland*
Belgrade	*Serbia*	London	*UK*	Sofia	*Bulgaria*
Bratislava	*Slovakia*	Lisbon	*Portugal*	St. Petersburg	*Russia*
Brussels	*Belgium*	Luxembourg	*Luxembourg*	Stockholm	*Sweden*
Bucharest	*Romania*	Lyon	*France*	Tashkent	*Uzbekistan*
Budapest	*Hungary*	Madrid	*Spain*	Vienna	*Austria*
Dublin	*Ireland*	Manchester	*UK*	Warsaw	*Poland*
Düsseldorf	*Germany*	Milan	*Italy*	Zurich	*Switzerland*
Frankfurt	*Germany*	Munich	*Germany*		

Table A4: Description of used variables

Variable	Description	N	Mean	Std. Dev.
SD	Standard deviation of relative log prices across all traded products for a given pair of cities. Source: EIU	13004	0.528752	0.12081
MSE	Means square error of relative log prices across all traded products for a given pair of cities. Source: EIU	13004	0.421107	0.297707
Distance	Geographical distance between cities.	13004	7.120744	0.709327
Voice and accountability	Dimension of governance from the WGI. Captures to which extent a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. For each city pair the sum of levels attributed to the respective countries is calculated. Source: WGI	10088	1.83972	1.1752

Political stability	Dimension of governance from the WGI. Captures likelihood that the government will be destabilized or overthrown by unconstitutional or violent means. For each city pair the sum of levels attributed to the respective countries is calculated. Source: WGI	10088	1.24321	1.066992
Government effectiveness	Dimension of governance from the WGI. Captures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. For each city pair the sum of levels attributed to the respective countries is calculated. Source: WGI	10088	2.217464	1.317888
Control of corruption	Dimension of governance from the WGI. Captures the ability of the government to control corruption. For each city pair the sum of levels attributed to the respective countries is calculated. Source: WGI	10088	2.115712	1.534505
Rule of law	Dimension of governance from the WGI. Captures the quality of contract enforcement, the police, the courts, and the likelihood of crime and violence. For each city pair the sum of levels attributed to the respective countries is calculated. Source: WGI	10088	1.960842	1.348987
Regulatory quality	Dimension of governance from the WGI. Captures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. For each city pair the sum of levels attributed to the respective countries is calculated. Source: WGI	10088	1.935048	1.129872
Diff. in reg. quality	See above. For each city pair an absolute-value difference of levels attributed to the respective countries is calculated. Source: WGI	10088	0.841026	0.792292
School enrollment, tertiary	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level. For each city pair the sum of levels attributed to the respective countries is calculated. Source: UNESCO Institute for Statistics	9015	96.37729	27.77875
Total tax rate	Total tax rate measures the amount of taxes and mandatory contributions payable by businesses after accounting for allowable deductions and exemptions as a share of commercial profits. Taxes withheld (such as personal income tax) or collected and remitted to the tax authorities (such as value added taxes, sales taxes or goods and service taxes) are excluded. For each city pair the sum of levels attributed to the respective countries is calculated.	3981	97.19673	20.2592

	Source: World Bank			
Time to prepare and pay taxes	Time to prepare and pay taxes is the time, in hours per year, it takes to prepare, file, and pay (or withhold) three major types of taxes: the corporate income tax, the value added or sales tax, and labor taxes, including payroll taxes and social security contributions. For each city pair the sum of levels attributed to the respective countries is calculated. Source: World Bank	3981	561.2457	400.4576
Tariff rate	Simple mean applied tariff is the unweighted average of the effectively applied rates for all products subject to tariffs calculated for all traded goods. For each city pair the sum of levels attributed to the respective countries is calculated. Source: World Bank	10056	7.417708	3.217913
Importation costs	Cost measures the fees levied on a 20-foot container in U.S. dollars. All the fees associated with completing the procedures to export or import the goods are included. These include costs for documents, administrative fees for customs clearance and technical control, customs broker fees, terminal handling charges and inland transport. The cost measure does not include tariffs or trade taxes. Only official costs are recorded. For each city pair the sum of levels attributed to the respective countries is calculated. Source: World Bank	3981	2552.818	977.3354
Importation time	Time is recorded in calendar days. The time calculation for a procedure starts from the moment it is initiated and runs until it is completed. If a procedure can be accelerated for an additional cost, the fastest legal procedure is chosen. It is assumed that neither the exporter nor the importer wastes time and that each commits to completing each remaining procedure without delay. Procedures that can be completed in parallel are measured as simultaneous. The waiting time between procedures – for example, during the unloading of cargo – is included in the measure. For each city pair the sum of levels attributed to the respective countries is calculated. Source: World Bank	3981	37.71314	26.69093
GDP per capita	PPP GDP per capita in current international dollar. Source: IMF	9955	49062.32	18255.91
SD of food: perishable	Standard deviation of relative log prices across perishable food items for a given pair of cities. Source: EIU	13004	0.477965	0.124553
SD of food: non-perishable	Standard deviation of relative log prices across non-perishable food items for a given pair of cities. Source: EIU	13004	0.481621	0.126029
SD of clothing	Standard deviation of relative log prices across clothing and footwear items for a given pair of cities. Source: EIU	12886	0.408302	0.120075

SD of alcohol	Standard deviation of relative log prices across alcoholic beverages for a given pair of cities. Source: EIU	12973	0.414298	0.162324
SD of recreation	Standard deviation of relative log prices across recreation products for a given pair of cities. Source: EIU	13004	0.320432	0.177225
SD of personal	Standard deviation of relative log prices across personal care products for a given pair of cities. Source: EIU	12973	0.477303	0.232974
SD of household	Standard deviation of relative log prices across household supplies items for a given pair of cities. Source: EIU	13004	0.464138	0.143282
SD of non-traded	Standard deviation of relative log prices across non-traded items for a given pair of cities. Source: EIU	13004	0.555712	0.186385
SD of all	Standard deviation of relative log prices across all items for a given pair of cities. Source: EIU	13004	0.553605	0.140432

Table A5: Worldwide Governance Indicators' explanatory power

Dependent variable: Standard deviation	(1)	(2)	(3)	(4)	(5)	(6)
Control of corruption	-0.032***					
	(0.002)					
Rule of law		-0.038***				
		(0.003)				
Regulatory quality			-0.051***			
			(0.003)			
Government effectiveness				-0.042***		
				(0.003)		
Political stability					-0.042***	
					(0.003)	
Voice and accountability						-0.049***
						(0.003)
Border	0.092**	0.098**	0.105**	0.098**	0.105**	0.110**
	(0.046)	(0.044)	(0.044)	(0.043)	(0.043)	(0.043)
Log distance	0.058***	0.054***	0.047***	0.052***	0.060***	0.045***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
Observations	10088	10088	10088	10088	10088	10088
Adjusted R^2	0.489	0.500	0.527	0.520	0.462	0.523

Notes: Robust standard errors in parentheses; variance is clustered at the country-pair level. All specifications include year fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Robustness checks: Individual product categories

Dependent variable:	(1) SD of food: perishable	(2) SD of food non-perishable	(3) SD of cloth-ing	(4) SD of alco-hol	(5) SD of recreation	(6) SD of per-sonal	(7) SD of household	(8) SD of non-traded	(9) SD of all
Regulatory quality	0.022**	0.014**	-0.033***	0.013*	-0.002	0.038***	0.051***	0.006	0.013
	(0.010)	(0.007)	(0.007)	(0.007)	(0.008)	(0.013)	(0.016)	(0.004)	(0.009)
Border*reg. quality	-0.068***	-0.052***	0.001	-0.080***	-0.083***	-0.112***	-0.058***	-0.076***	-0.076***
	(0.010)	(0.008)	(0.008)	(0.008)	(0.009)	(0.015)	(0.016)	(0.006)	(0.010)
Border	0.235***	0.250***	0.083***	0.336***	0.265***	0.387***	0.256***	0.321***	0.305***
	(0.028)	(0.029)	(0.025)	(0.028)	(0.026)	(0.041)	(0.026)	(0.024)	(0.026)
Log distance	0.057***	0.041***	-0.001	0.008	0.040***	0.036***	0.021***	0.067***	0.052***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.013)	(0.007)	(0.008)	(0.006)
Observations	10088	10088	9970	10088	10088	10088	10088	10088	10088
Adjusted R^2	0.441	0.317	0.287	0.284	0.474	0.199	0.069	0.399	0.552

Notes: Robust standard errors in parentheses; variance is clustered at the country-pair level. All specifications include year fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Robustness checks: Various aspects of the institutional framework

Dependent variable:	(1) Standard deviation	(2) Mean square error	(3) Standard deviation	(4) Mean square error
Regulatory quality	-0.021***	-0.052***	0.008	-0.002
	(0.006)	(0.013)	(0.008)	(0.019)
School enrollment, tertiary (% gross)	-0.294***	-0.400***	-0.291***	-0.394***
	(0.030)	(0.070)	(0.029)	(0.066)
Total tax rate (% of commercial profits)	0.093**	0.046	0.069	0.003
	(0.046)	(0.100)	(0.042)	(0.094)
Time to prepare and pay taxes (hours)	0.110***	0.083	0.099***	0.063
	(0.032)	(0.067)	(0.033)	(0.070)
Tariff rate, applied, simple mean, all products (%)	0.028	-0.244**	0.049	-0.207*
	(0.051)	(0.111)	(0.051)	(0.112)
Importation costs (US$ per container)	-0.063	0.241*	-0.344***	-0.251
	(0.054)	(0.130)	(0.064)	(0.153)
Importation time (days)			0.447***	0.784***
			(0.074)	(0.174)
Border	0.189***	0.180***	0.183***	0.168***
	(0.051)	(0.044)	(0.048)	(0.038)
Log distance	0.035***	0.063***	0.029***	0.053***
	(0.007)	(0.014)	(0.007)	(0.013)
Observations	1896	1896	1896	1896
Adjusted R^2	0.493	0.349	0.532	0.377

Notes: Robust standard errors in parentheses; variance is clustered at the country-pair level. All specifications include year fixed effects. All explanatory variables but regulatory quality, border, and distance re-calculated to [0-1]. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Univerzita Karlova v Praze, Fakulta sociálních věd
Institut ekonomických studií [UK FSV – IES] Praha 1, Opletalova 26
E-mail : ies@fsv.cuni.cz http://ies.fsv.cuni.cz