ONE EUROPE, ONE PRODUCT, TWO PRICES

– THE PRICE DISPARITY IN THE EU

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Abstract: This article examines the price dispersion in the European Union in the last fifteen years (1990-2005). The analysis of price convergence is examined on aggregate and disaggregate levels. The macro approach is based on Comparative Price Level index calculated as the ratio between PPPs and exchange rate. The disaggregate analysis utilizes actual prices of 148 individual products sold in the 15 capital cities of the EU. The calculations comprise of sigma and beta convergence adopted from the real growth literature. The different results of the speed of convergence are obtained according to the different econometric methods. Moreover the gravity model is tested to measure the contribution of different factors in explaining the observed convergence pattern.

Key words: price convergence, international price dispersion, law of one price,

Jel classification: E31, F36, F41

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1. Introduction

According to the traditional definitions (Marshall 1947, Cournot 1971) a market is an area where identical products have the same prices. These definitions are based on The Law of One Price (LOOP) which states that, regardless of the location, at a given moment of time prices of the same products should be equal when converted to a common currency because of the process of arbitrage. Consequently, the spatial price dispersion means that the market does not act efficiently. Price convergence can be treated as a measure of market integration. Moreover the reduction in price dispersion may yield significant GDP gains[1].

On the other hand, it is clear now that completely equalized prices among member states are hard to be achieved. Still, the slow speed of convergence documented on international markets remains a puzzle[2], especially if we take into account the efforts of strengthening integration by the Internal Market Programme (1990) which removed trade barriers and implemented four freedoms. But we think that the bigger puzzle is the different results of price convergence rate reported by the researchers. An extensive overview of this literature gives inconclusive results with the half-lives of price shocks from 9 to 282 months. Of course, results of the empirical studies depend largery on different modeling approaches (cross-section analysis-standard growth regression, time series analysis, panel data models), sample time, area covered and last but not least the source and characteristic of the data.

In fact the data used consist on price indexes or on actual prices of different products. There are supporters of each of them. Engel and Rogers (2004) state that the indexes cannot be compared directly across countries to investigate differences in price levels. On the other hand Allington et al. (2004) opt for indexes as being more

[1] HM Treasury (2003), Prices and EMU, pp. 53.
[2] E.g. Rogers (2001), Parsley and Wei (2001), Goldberg and Verboven (2001), Crucini (2002), Wolf (2003)

representative. The problem with the price indexes is that they can underline the real price dispersion. They are usually obtained through complicated process of collecting data, estimation, recalculation etc. To show the problem let's consider very simple example with just two countries: A and B. There are two products sold in each of them: X and Y. The product X costs in country A 5 euro and in country B 10 euro, while the product Y costs in country A 10 euro and in country B only 5. The values of the baskets of these two goods in country A and B are equal 15 euro each, but does it mean thet there is no price dispersion in these two countries?

To see what effects applying different kind of data have on the result we conduct the price convergence analysis first using the price index then actual prices of a bulk number of products. Moreover, we compare the results of applying different econometric methods for dynamic panel data models.

In our analysis we follow the literature of real growth rates and use the idea of sigma and beta convergence. Sigma convergence is understood here as the reduction of price dispersion measured by standard deviation. Beta convergence means the negative relation between the average growth rate of prices (inflation) and initial price level. The article examines the price dispersion in the European Union in the last fifteen years together with the basic factors that explain price divergence. The paper is organised in the following way:

- section 2 is dedicated to the law of one price
- section 3 examines the price convergence at aggreagate level (based on price index)
- section 4 examins the price convergence at dissagreagate level
- section 5 tests the gravity model

Finally, the conclusion is drawn together with suggestions for future studies.

2. The Law of One Price and its limtations.

The Law of One Price (LOOP) states that when there are no impediments to international trade and no transport costs, prices of the same product should be equal when converted to a common currency regardless of the location. It can be written with a formula:

$$P_A^i = E_{A/B} \times P_B^i \tag{1}$$

where: P_A^i - price of the good *i* sold in country A in currency A, P_B^i - price of the same good *i* sold in country B in currency B and $E_{A/B}$ - exchange rate between country A nad B

This law is a part of a basic economic principle and in practice has been used since trade was introduced. If the homogenous good has different prices in two locations it would be profitable to buy it where it is cheaper and after transportation to sell it on the more expensive market. In consequence, there is a flow of products from cheaper regions to more expensive ones and the process will continue till the price is equalised on both markets and there is no more motivation for arbitrage transactions. The equation (1) is relevant only for one good but it can be derived intuitively that if LOOP holds for different goods, it should be true for the whole aggregate of goods. In this way we derived the hypothesis of Purchasing Power Parity (PPP).

Both LOOP and following it PPP hold only in strict circumstances**.** These are**:** perfect competition, no transport costs, no trade barriers. Naturally, all of them are violated in the real world. As far as countries of different currencies are concerned the final price of the good depends on exchange rate and exchange rate risk. In practice the prices do not have to adjust instantly to the nominal exchange rate. Both exporters and importers can leave the prices at the same level and adjust their mark-ups to the new exchange rates. If the change of the price is conected with huge additional costs, stickiness of prices can occur. The next

factors that raise the final price of the good in relation to its price on the orginal market, are information costs which can depend not only on quantities sold but also on using differenet languages; different legislation, especially the labour law;, the advertising law; and different fiscal systems (especially VAT).

All of these costs are called arbitrage costs, the costs that have to be undertaken by the one who wants to sell the same good in different geographical markets. The arbitrage process is only profitable when prices differ between countries and this difference is higher than the arbitrage costs. Taking into account the arbitrage costs we can redefine the LOOP: *The price difference of the same product sold at two locations should not exceed the arbitrage costs.*

If (AC) stands for arbtrage costs we get the following equation:

$$P^{i}{}_{A} - E_{A/B} P^{i}{}_{B} \leq AC \tag{2}$$

Where arbitrage costs are the sum of transport cost (TC), exchange rate costs (EC), information costs (IC), trade restrictions costs (TRC) and other costs (OC):

$$AC = TC + EC + IC + TRC + OC \tag{3}$$

The next arguments against the law of one price are due to the structure of price that is created during a multi stage process. The final price can be decomposed into fabric, warehouse and detail price. In each of these stages there are potential elements that can affect the price dispersion.

We should point out that the law of one price holds only for tradable goods which undergo international exchange and whose prices are set on international markets. The prices of non-tradable goods are determined by national demand and supply. First of all tradable goods consist in certain measure of elements produced in non-tradable sectors. In fact the division between tradable and non-tradable goods is strictly conventional.

Table 1 summarizes the basic factors against the law of one price and consequently against the convergence of prices.

Tabel 1 The factors against the price convergence

Natural	Structural	Political
▪ **Transport costs** ▪ **clients' taste and culture** ▪ **climate** ▪ **type of good**	▪ **market segmentation** ▪ **concentration/internationalization** ▪ **diversification of market by firms (control of distribution channels, pricing to market etc.)**	▪ **trade and non-trade barriers.** ▪ **Different fiscal systems** ▪ **Different labour law and advertising and promotion law** ▪ **Non-harmonised Common Law of EU/problems with implemetation of EU's law**

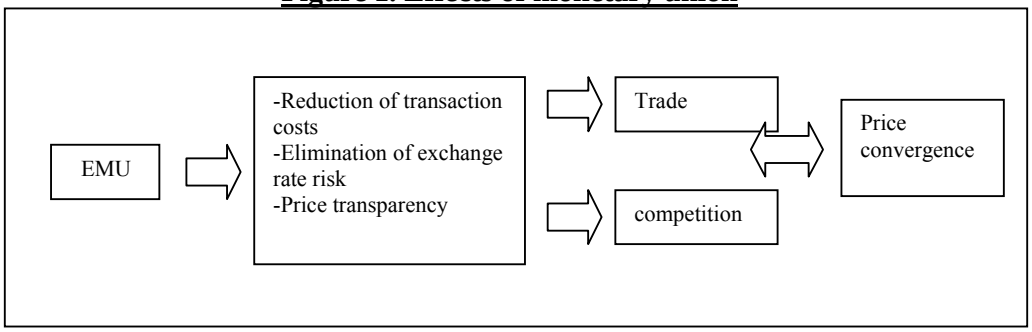
Source: author's own

We divided the elements into three groups: natural, structural and political. The transport costs, clients' taste, culture and type of the good in natural way cause the price dispersion. Structural factors are connected with market segmentations and marketing strategies of the firms resulting in price discrimination. Finally there are the factors caused by the different political sytems such as trade and non-trade barriers, different regulation of fiscal system, labour law and still the low degree of harmonisation between member countries' laws.

On the other hand, there are also factors that speed the spatial price convergence. The basic ones are the market integration and e-commerce. As far as the European Union is concerned, the removal of trade barriers and realization of four freedoms (the freedom of movement of goods, labour, capital and services) should cause more competition between firms, better allocation of capital, higher production efficiency and these will lead prices to converge at the level: "better argumented in view of economic and technical effectiveness"[3] (figure 1).

[3] Price competition and price convergence, The Single Market Review Series , June 1996,

Figure 1. Effects of monetary union



Source: author's own

In theory, internationalization of the markets due to higher trade whether due to the introduction of international firms should cause price dispersion to decline.[4]

The hypothesis that a single currency would have the effect of narrowing price dispersion in Europe was shown for the first time in the publication from 1990 "One Market One money". The European Commission argued that only EMU can lower the degree of price dispersion among members countries by removing transition costs, exchange rate risk and by introducing higher price transparency.[5] Reduction of currency costs, exchange risk and introduction of price transparency should in theory boost trade activity and competition, putting some stress on prices to converge (figure 1).

The EU Commission's studies claims that reduction of transaction costs should bring savings of 0.4% of GDP, and for countries with advanced banking systems of 0.1%.[6] The consumers' ability to compare prices directly due to price transparency was supposed to lead them to buy in the places where the goods are the cheapest. This is justified for durable goods such as cars and in situations when transport costs are low compared to the value of the goods. In contrast, it is not the case for basic goods, non-tradable services and perishable goods. On the other hand, higher price transparency has an impact on suppliers as well. The easier monitoring of competitors' prices can lead to collusion or the

[4] Price competition and price convergence pp.140
[5] European Commission (1990) One market, one money: an evaluation of the potential benefits and costs of forming an economic and monetary union, European Economy, no. 44
[6] Prices and EMU, pp. 12.

establishment of new techniques of price segmentation; e.g not issuing a European price list or allowing terms and conditions to vary from country to country.[7]

Moreover, the exchange rate costs are mostly barriers to the trade of small and medium sized enterprises than for the large firms for which they were less important with the rise of transaction value. There is a consensus that price convergence is going to be strengthened rather by big retailers than small ones.[8] Additionally, EMU cannot reduce other barriers of trade such as transport costs by itself, yet they can be of a greater importance to the price convergence than the common currency.[9]

Another aspect is whether enough time elapsed from the establishment of EMU to materialise the effects on price convegrence- effects that in fact are called long term ones. Taking into consideration the establishment of EMU in 1999 when the euro come to non-cash circulation should reveal some evidence of additional pressure on price convergence due to the monetary union. The only obstacle can be the slow uptake of the euro. According to the Commission survey from the end of 2000, fewer than 1.5% of business had switched over to the euro accounting and just 5.8% of volume terms of national payments made by business were in euros.[10] This is an argument for expecting the euro effects not from 1999 but from the introduction of euro notes and coins.

Despite the preceding discussion most of the channels, except for the price transparency on the potential for coordination between producers, suggest that introducing the euro should reduce price dispersion.

Table 2 Summarised the effect of intoducing euro on price dispersion.

Direct effect	Consequence	Price dispersion
Elimination cost of transaction	Increase market access	↓
Reduce consumer search costs	Producer less able to segment	↓

[7] European Economy No7 – July 2001, Supplement A, pp. 5.
[8] Prices and EMU, pp. 9.
[9] Lutz M. (2003), Price Convergence under EMU? First Estimates, Mimeo, University of St. Gallen, pp.15.
[10] COM (2001) 190 final, pp.17-19.

Less consumer price uncertainty	Producer less able to segment	↓
Reduction of risk	Greater incentives for arbitrage	↓
Increase for transparency	More arbitrage	↓
	Consumers better informed	↓
	More information on competitors	↑

Source: European Economy; European integration and the functioning of product markets, European Commission Special report No2/2002, pp.50.

Reviewing the latest studies of price convergence due to EMU does not provide a clear picture Lutz's (2003) and Engel and Rogers (2004) studies oppose the impact of EMU on price convergence. Lutz applies difference-in-difference (DD) methodology to the four set of data: Big Macs, The Economist, different models of cars and13 categories of goods collected by UBS. The results reject the euro effect. Engel and Rogers (2004) come to the same conclusion in their econometric analysis of city price data. On the other hand, Parsley and Wei (2001) and Isgut (2002) provide a significant reduction in price dispersion due to the introduction of common currency using the same data source as Engel. Isgut finds that EMU reduces price dispersion by 5%. Allington et al. (2004) apply the DD method to the aggregated data of 115 categories of goods (prices expressed in comparative price levels indices as opposed to the retail prices). They suggest that the euro has a robust integrating effect, but the results are no longer significant when only tradable goods are considered. Goldberg and Verboven (2004) analyze the European car market. They conclude that the monetary union reduced price dispersion by a small but significant percentage (about 1.5%) between 1999 and 2001. However, the euro does not speed convergence process after 2002.

The next factor that can speed the price dispersion is the development of the internet market and the process of buying goods over internet. According to common sense[11] internet markets are more efficient than traditional ones. In comparison to traditional markets, virtual ones are characterized by large numbers of buyers and sellers, low entry barriers to the market and low information costs.

As far as the e-commerce is considered in relation to the price dispersion two different questions have to be answered:

- What is the price dispersion among goods sold through the internet?
- What effects do (lower) internet prices have on price dispersion? Does the development of internet market result in increasing price convergence in the whole market?

Price comparison through the internet is much easier. In the network there are different kind of transaction agents such as shopbots which provide the products with their prices from different distributors, and there are no rigid frameworks governing shops opening hours or localization. Bearing this in mind, we might suppose that price dispersion is small in the internet. On the contrary, though, empirical studies claim that the prices of products offered on-line differ significantly and continuously (Brynjolfsson and Smith (1999) Clemens et al. (1998)).

Moreover, there is no agreement whether this price dispersion is stable over time. Baylis and Perloff (2002) who were comparing prices of digital cameras and scanners for longer than one year got stable values of deviations from LOOP through whole period. On the other hand Brynjolfsson and Smith (1999) argue that price dispersion means that internet market is not mature yet. Brown and Goolsbee (2002) demonstrated that at the

[11] E.g.: "Internet is almost the perfect market, because the information is continuous, buyers can compare the offers from whole the word. The result is: strong price competition, decreasing differentiation of the products." Kuttner R., in Business Week, May 11 1998, "All of this (internet) make us closer to the effective market" MacAvoy R., Business Week, 4 May 1998 to see more check: Rajiv Lal, Miklos Sarvary, When and How is the Internet Likely to Decrease Price Competition.

beginning the prices on the internet tend to differ so much because not many people are buying through the network, but that as the number of clients rises the effects of higher competition and price convergence occur. The following factors explain the existing price dispersion of products sold through the internet [12]:

- The different standard of service.
- Client's attachment to the Brand.
- Confidence and security more important than the price.
- The cost of changing the distributor ("switching cost" here new web side).
- Price discrimination e.g.: different prices for "informed" clients.
- "Information overflow"- too much information or incorrect information makes it difficult to find the best deal.

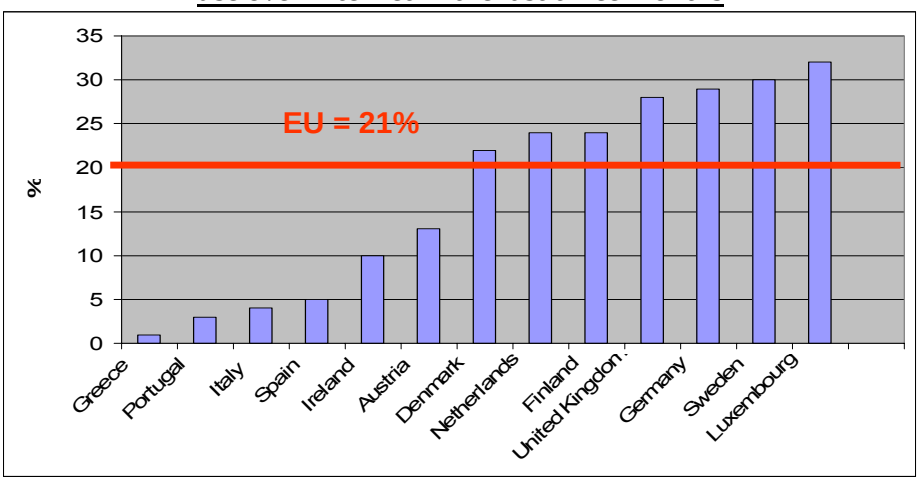
The next question is what effects (lower) internet prices have on price dispersion? First of all we make an assumption that the products sold through the internet are cheaper than those offered through traditional trade channels.[13] The effect depends on the number of clients. When a limited number of people buy on-line, only this group will feel the advantages of lower prices, while on the whole market the price dispersion can be enhanced. Nowadays in Member Countries almost half of households have the access to the Internet (45%) but two–thirds of them never (64%) buy anything online. Figure 2 shows the share of individuals having ordered/bought goods or services for private use over the internet in the last three months (Eurostat, 2004). The mean value for the whole

[12] Based on Nowacka K., The law of one price in e-commerce in: Electronic Commerce, Gdańsk University of Technology 2002.

[13] In the first empirical studies concerning comparison of goods sold through internet the conclusion was that products sold online are more expensive eg.: Lee (1997), but in recent studies the opposed relation was showed eg.: Brynjolfsson E. i Smith M.D. (1999) the prices sold by internet are lower by 9-16% than the same products sold in traditional way., Friberg, Ganslandt i Sandstrom (2000) estimated that prices of books and CDs sold online in Sweden are cheaper by 15% (by 10% after including transport costs) than sold on traditional markets. The same tendency was shown in the English economy where within most of 21 sectors a drop in prices was observed due to the introduction of online sales. To see more: e-Commerce and firm performance, Luxembourg 2004 and Price levels and price dispersion in the EU, Supplement A No7-July 2001.

EU is 21% Greece, Portugal and Italy are well below the average. Moreover, in the EU only 2% (2005) of the whole sum of expenses from retail trade comes from e-commerce. This problem can be underlined from the fact that people are cautious about buying online due to the lack of confidence and security.

Figure 2. Share of individuals having ordered/bought goods or services for private use over internet in the last three months



Source: Eurostat 2005

The last aspect is whether lower internet prices have an influence on the level of prices of goods sold in traditional ways. In contrary to most studies where the prices offline are treated as exogenous, Brown and Golsbee (2002) conducted the research of the life insurance and showed that the rise of internet clients by 10% causes the decrease of prices of the same product sold off-line by 5%.

The above arguments for and against price convergence show the complexity of the matter.

3. Price convergence at aggregate level

3.1 Comparative price level

In studies concerning prices, the method used to calculate price levels is very important because it is possibble to aggregate them in space and in time. The careful selection of price indexes is needed. The measures used most frequently are: CPI -

Consumer Price Index, PPI - Producer Price Index and WPI - Wholesale Price Index. They can be an adequate tool to compare prices in time but when spatial comparison is needed they become useless. An internationally comparable aggregation can be obtained by using exchange rate calculation, but it could result in over or under valuation, because exchange rates are also determined by other factors than price fluctuations. These drawbacks can be avoided by using Purchasing Power Parity (PPP) and relating it with to Comparative Price Level (CPL). The index is obtained by dividing the purchasing power parity (PPP - the third column in table 3) by the official exchange rate to the euro for each country (E_{euro} - the second column) and can be expressed by the following formula .

$$CPL = \frac{PPP}{E_{euro}} \times 100 \qquad (4)$$

Table 3. Purchasing Power Parities and relative price level in 2004.

Country	Exchange rate to the EUR [E_{euro}]	Purchasing power parity (1PPS = ...national currency units)	Comparative price level [CPL]
Austria	1	0.996	99.6
Belgium	1	1.003	100.3
Denmark	7.4399	9.798348	131.7
Finland	1	1.182	118.2
France	1	1.038	103.8
Greece	1	0.818	81.8
Spain	1	0.840	84
Netherlands	1	1.012	101.2
Ireland	1	1.184	118.4
Luxemburg	1	0.997	102
Germany	1	1.040	102.5
Portugal	1	0,735	82,4
Sweden	9.1243	10.62069	116.4
United Kingdom	0.67866	0.68884	101.5
Italy	1	0.945	98.7
UE -15	:	1	100

Source: Eurostat

Purchasing power parity of a given country means how many national currency units equals the standard unit (PPS - Purchasing Power Stanndard). One PPS buys the same amount of goods and services in all countries, whereas different numbers of national currency units are needed to buy this volume of goods and services depending on the

national price level. In Eurostat calculations 1 PPS equals 1EUR. CPLs give also the pictire of under or over-valuation of a given currency. Although common currency was introduced in the euro-area and the prices can be compared directly, the euro has a different purchasing power in the different euro-zone countries and PPPs still have to be constructed[14]. For example in 2004 one PPS in Ireland was equal 1.184 EUR while in Greece only 0.818 (table 3).

The comparative price level make it possible to compare prices in relation to the EU average (EU=100). An index higher than 100 means that the country is relatively expensive in comparision with the EU average;an index lower than 100 means that the country is cheap.

For example in 2004 the price level in Ireland was 18.4 % above the EU average, while in Greece it was 18.2 % below.

In all statistical papers concerning PPPs methodology and technical aspects complicate the calculations.Consequently, the interpretation of the CPL should be carried out very carefully. Moreover Eurostat reminds us that PPPs and related economic indicators are constructed primarily for a spatial comparison and not for a comparison over time. Therefore any comparison of results of different years must keep this in mind.

3.2 The overall view on price disparity in the EU (1991-2004)

Accoding to the values of Comparative Price Levels EU countries have been divided into three groups: relatively expensive, countries with average price levels and relatively cheap countries. The criterion of identity was one EU average plus/minus one standard deviation. Table 4 shows the exact division.

Group 1 – relatively expensive countries with price level >114% of the EU average: Denmark, Finland, Ireland, Sweden

[14] Statistics in Focus, Theme 2 – 42/2002 Prices and Purchasing Power Parities, pp. 7.

Group 2 – countries around the EU average which price level is between 86% and 114% of EU average: United Kingdom, Germany, Netherlands, Austria, France, Luxemburg, Belgium, Italy

Group 3 – relatively cheap countries with price level < 86% of EU average: Spain, Greece, Portugal

It is worth noting that a price difference follows the geographical distribution with Northern countries (group 1) being the most expensive and Southern EU countries (group 3) below EU average. Moreover, more than half of the countries (group 2) are concentrated around the EU average. They exhibit a very tight level of price convergence not only towards the EU average but also among themselves (standard deviation across them equals 1.6).

Table 4 The division of countries according to the value of CPL in 2004.

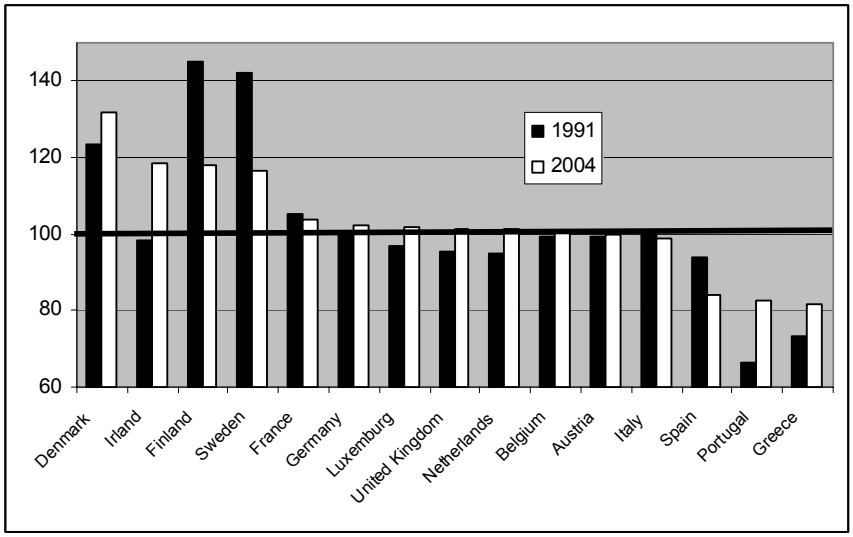
Group 1	Group 2	Group 3
Relatively expensive countries CPL > 114	Countries around the EU average 114 > CPL > 86	Relatively cheap countries CPL < 86
Denmark, Finland, Ireland, Sweden	France, Germany, Luxemburg, UK, Netherlands, Belgium, Austria, Italy	Spain, Greece, Portugal

Source: own based on data from Eurostat

The movement of CPLs between 1991 and 2004 is shown in figure 3. They show a relatively stable pattern: countries that were considered to be expensive in the early 90s are still in the same group. The same applies to the second and the third group. Countries that changed group category are the minority. Only Ireland changed its grouping significantly; in early 90s it was among the below EU15 average. Ireland's impressive growth –which put pressure on prices – explains the shift in its profile.[15]

[15] Report from the Commission, COM(2002) 743 final, Brussels 2002, pp.10.

Figure 3 Cmparative Price Level for 1991 ad 2004

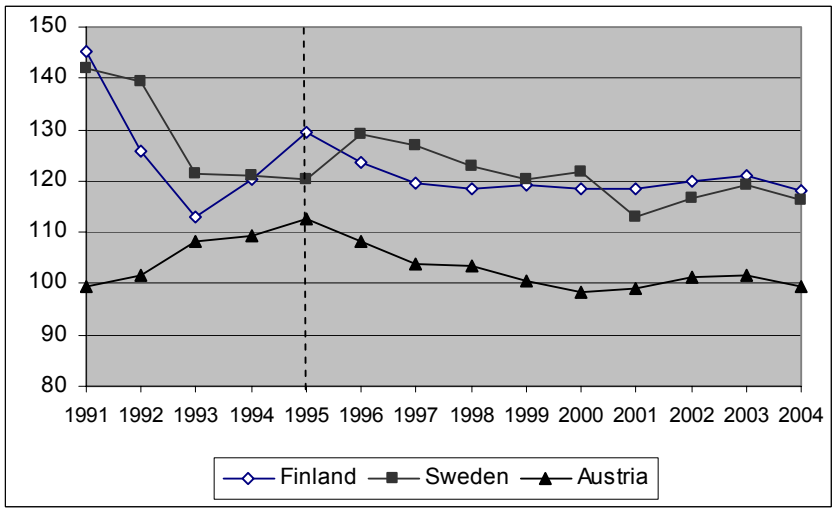


Source: own based on data from Eurostat

Some of the member states have moved closer to the EU average: for Portugal and Greece this means a rise in prices, while for Sweden and Finland moving closer to the EU average means becoming less expensive. On the other hand, there are countries such as Denmark, Ireland and Italy which have moved further away from the EU average.

In Figure 4 we can see the CPLs for countries that became the members of the EU in 1995.

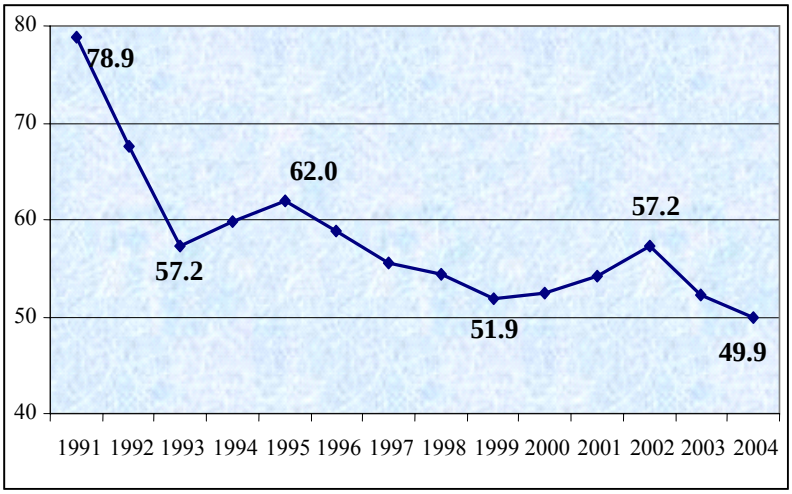
Figure 4.CPLs for Austria, Finland and Sweden



Source: own based on data from Eurostat

In the case of Finland and Sweden, their CPLs in 1991 were considerable higher than the EU average. The large fall in their comparative price levels may have resulted from opening up to intenational competition and integration with the EU. The Austrian data demostrate a different historical trend. Since the early 90s Austria's CPL rose away from the EU average, but since 1995 it started to declineThe absolute price dispersion measured as the difference between the maximum comparative price level and the minimum is shown in Figure 5.

Figure 5. The absolute price dispersion (max CPL-min CPL)



Source: author's own

The figure indicates some increase of price convergence with the fall of absolute dispersion from 78.9 in 1991 to 49.9 in 2004. In 2004 the absolute price dispersion was between the cheapest Greece (CPL=81.8) and the most expensive Denmark (CPL =131.7)

In the next section we will conduct detailed statistical analysis of CPLs convergence

3.3 Sigma convergence

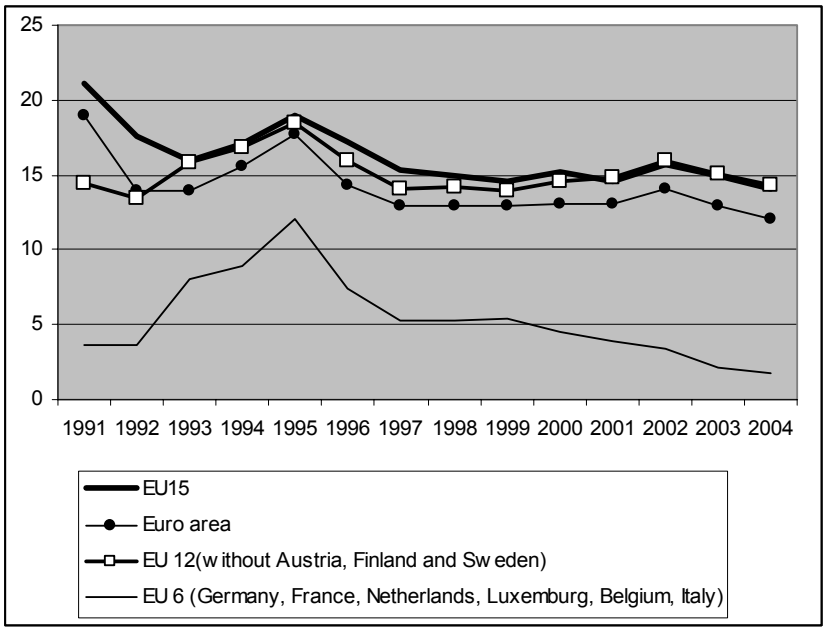
The concept of sigma convergence is derived from the literature of real convergence (Barro, Sala-i-Martin 1992) and originally concerns cross-sectional dispersion of income. In our context, sigma convergence occurs if the dispersion of prices – measured

by standard deviation declines over time. To assess the extent to which there has been sigma convergence across EU countries we calculated the unweighted standard deviation for CPLs from 1991 to 2004. In our opinion, although the weight deviation might be recommended because larger member states have more significant impact on the price convergence than smaller ones due to the bigger share of transaction within the EU, it cannot be accepted because it reshapes the price dispersion within EU.

It is worth noting that in case of EU15 our measure of price dispersion is identical to the coefficient of variation (because the EU average equals 100) used by Eurostat to analyze the price dispersion in the EU.

Figure 6 shows price dispersion measured as a standard deviation of CPLs across economies.

Figure 6 Standard deviation for CPLs across EU15, Euro area, EU12 and EU 6.



Source: author's own

Over the whole period of time price convergence resulting in the fall of the deviation from 21.1 in 1991 to 14.0 in 2004 is observed. However the trend of price convergence was especially distinctive at the beginning of the 90s. Between 1993 and 1995 the divergence of prices was observed. The rise in dispersion was reversed at the

mid-1990s and dispersion fell through 1999. The deviation between 1999 and 2001 has not fluctuated more than by 1.5. Since 2002 a gentle decrease of price dispersion is observed again.

Figure 6 shows that 1995 is the turning point. The logical reason for this is the accession of three new members to the EU. Two of them- Sweden and Finland - had CPLs well above the EU average. To check this hypothesis, in Figure 6 a separate line was drawn representing the price dispersion across EU12 (without Sweden, Finland and Austria). It is noticeable that since 1993 the lines for EU12 and EU15 are almost identical. This contradicts the argument that the price dispersion of the whole EU was raised by the entry of new member states.

It is interesting to compare the pattern of price convergence in EU countries as a whole to the Eurozone. The price disperion is lower in EMU countries than in the whole EU. However, the tendency is constant from the early 90s, so monetary union does not seem to explain the lower price dispersion. The last line in Figure 6 represents the dispersion across EU6 - core countries (Germany, France, Netherlands, Luxemburg, Belgium and Italy). It confirms the higher price convergence among them, although the general trend over time for EU 6 and EU 15 is similar.

It is worth checking whether the decline in the standard deviation was statistically significant. The classical F test was performed to check the difference between variance in 1991 and 2004. The calculated F-values (for each of the groups) were below the critical values so the null hypothesis of equality of variance was not rejected. We conclude that although the price dispersion decreased over the entire sample period, 1991-2004, the decline in the dispersion was statistically insignificant. As a result, we cannot draw the conclusion that sigma convergence across EU countries has occurred.

3.4 Beta convergence

Our measure of international price dispersion is the absolute value of log-difference in the CPLs in country *i* relative to the country *j* and is computed for all possible pairs of countries (15*14/2 = 105).

We again follow the classical approach to measuring beta convergence; we estimate so called Barro's regression which we adopt for our purpose and we replace the income levels with price differentials. We want to check the relation between the price gap (the difference of price levels in one country versus the CPL in the other country) with the previous period's price gap. The equation we wish to estimate has the following form:

$$\Delta p_{ij,t} = \alpha - \beta p_{ij,t-1} + \eta_{ij} + v_t + \xi_{ij,t} \tag{5}$$

with:

$p_{ij,t}$ - the absolute log-difference in the price levels of countries *i* and *j* in period *t.*

η_{ij} - individual effect for pair of countries: *i* and *j*

v_t - time effect

$\xi_{ij,t}$ - error term

Clearly the above model can be written equivalently as:

$$p_{ij,t} = \alpha + (1-\beta) p_{ij,t-1} + \eta_{ij} + v_t + u_{ij,t} \tag{6}$$

The estimated coefficient on the lagged gap is the indicator of convergence process. The speed of convergence is calculated as: $\lambda = -ln(1-\beta)$ and the half-life of price shocks according to the formula: $t^* = -\frac{ln 0{,}5}{\lambda}$.

In our model, the explanatory variable is the lagged value of our measure of price dispersion so it is a dynamic model. Therefore the standard panel data estimators - OLS levels (pooled), Within Groups (Fixed Effects) - cannot be used. Nevertheless, it may still be useful to compare those results to those obtained by GMM.

Our results for the model (6) are reported in Table 5.

Table 5 The estimations of beta convergence for CPLs

	OLS LEVELS	WITHIN GROUPS	2SLS	DIF-GMM	SYS-GMM
$p_{ij,t}$	0.8976 (0.00957)	0.6425 (0.02413)	0.8999 (0.04498)	0.5685 (0.02637)	0.8759 (0.01439)
speed of convergence (λ)	0.1081	0.4423	0.1054	0.5646	0.1325
half-life (t*)	**6.41**	**1.57**	**6.58**	**1.23**	**5.23**
observations	1365	1365	1260	1260	1365
Hansen test				0.31	0.132
AR(1) test				0.00	0.000
AR(2) test				0.956	0.990

Notes: All computation done using XTABOND2 for StataSE 9.0
Year dummies included in all models
Robust standard errors in parentheses, 2SLS – Two Stage Least Squares, DIF-GMM first-differenced estimator, SYS-GMM system estimator, Results are reported for two-step GMM estimator, The figures reported for Hansen test and Arellano-Bond test are the p-values.

The first two columns report OLS and Within Groups estimates. It is well known that OLS levels give an estimates of autoregressive parameter that is biased upwards and Within Groups give an estimate that is biased downwards (Blundell, Bond 1998, Bond 2002). In our case it means that speed of convergence of OLS is biased downwards and of Within Groups biased upwards. The third column reports Two Stage Least Squares estimator (known also as Anderson and Hsiao estimator) for the equation in first differences that use $p_{ij,t-2}$ as the instrumental variable. This gives the parameter above the OLS and cannot be accepted. The forth column reports a two-stage first-differenced GMM estimator using full set of instruments. The DIF-GMM appears to give downwards-biased estimate of the coefficient on the lagged dependent variable that is consistent with the finite sample biases expected in the case of highly persistent series (Bond 2002).

The final column reports the system GMM estimator which use lagged levels and lagged first-differences as instruments. The system GMM parameter estimates appear to be

reasonable. Interpretation of the values of Hansen and correlation tests gives no evidence of misspecification of the model. The Hansen test indicates that the null hypothesis cannot be rejected at any conventional significance level so instruments used in the estimation are not correlated with the error terms and over-identifying restrictions are justified. Moreover, the autocorrelation tests AR(1) and AR(2) suggest the first-ordered correlation and the lack of second-ordered correlation in the differenced residuals. The estimated autoregressive parameter of 0.8759 implies an average speed of price convergence of 13% per year and consequently a half-life of 5.23 years.

4. The price convergence – disaggregate level

4.1 Sigma convergence

The data used in this part of our studies comes from the Economist Intelligence Unit (EIU). The dataset is composed of actual prices of 173 products for 15 capital cities of member countries The product list consists of tightly specified items such as: "bread ", "coca-cola" and a variety of services such as "laundry one shirt", "cost of developing 36 colour pictures" etc. The prices are expressed in euros with actual market exchange rates used in calculations, the pre-1999 ECU exchange rate was used. The data are annual from 1990 to 2005. The price list is not free of missing observations. In these case, CPI was used to provide the extrapolation. Some items were excluded from the data as naturally "difficult to be compared across cities" e.g.: taxi ride from the airport to the city centre. After these exclusions and adjustments the final sample of goods was reduced to148 products; 107 of them are traded and 41 non-traded. There are lists all of the goods in appendix A. The classification for tradable and non-tradable goods follows common sense and it is not based on any formal assumptions[16]. Moreover, the tradable goods are grouped into 8 categories following the EIU's definition: food perishable (34 items), food

[16] The tradability of a good can be calculated as the ratio of the total trade among the countries in a particular industry divided by total output of the industry across the same countries.

nonperishable (15 items), alcoholic beverages (13 items), clothing and footwear (16 items), household supplies (6 items), personal care (8 items), recreation (6 items), cars and petrol (9 items.)

To provide a first impression of the price dispersion, Table 6 presents the goods and services with highest and lowest price dispersion in 2005.

Table 6: Price comparison across goods: 2005

Lowest price dispersion	C.V	Highest price dispersion	C.V
International weekly news magazine (Time)	6.1	Hourly rate for domestic cleaning help	63.4
Lipstick (deluxe type)	12.4	Telephone, charge per local call (3 mins)	61.5
International foreign daily newspaper	12.9	**Lemons (1 kg) (supermarket)**	58.9
Regular unleaded petrol (1 l)	13.5	**Frying pan (Teflon or good equivalent)**	58.1
Compact disc album	14.1	Dry cleaning, woman's dress	54.4
Simple meal for one person	14.6	Taxi rate per additional kilometre (average)	54.2
Toothpaste with fluoride (120 g)	14.9	Furnished residential apartment: 2 bedroom	53.7
Television, colour (66 cm)	15.9	**Pork: loin (1 kg)**	53.3
Business trip, typical daily cost	17.9	Unfurnished residential apartment: 4 rooms	52.9
Boy's dress trousers (chain store)	18.2	Annual premium for car insurance (low)	49.3

source: EIU and own calculations

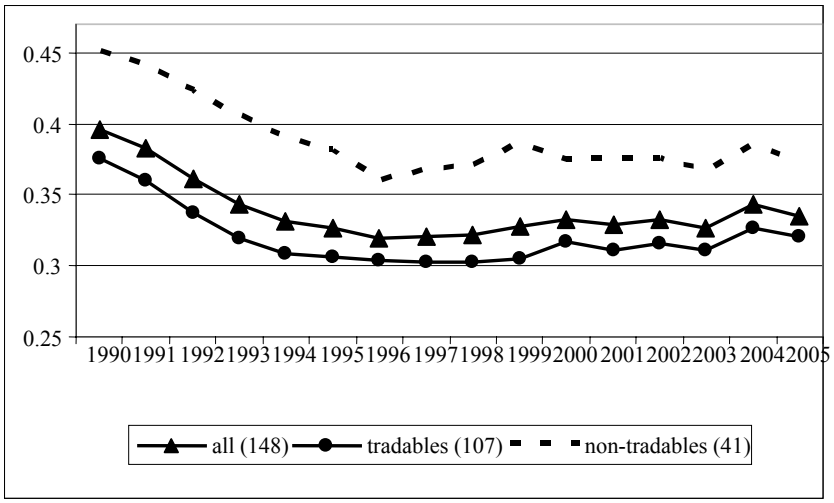
The price dispersion is measured here as coefficient of variation for each item across 15 cities.

The maximum price difference is observed for "hourly rate for domestic cleaning help", totalling 63% with the enormous value of 37 euro in Stockholm and only 5 euro in Lisbon. The lowest coefficient of variation - 6.1% - is for international weekly news magazines such as Time. Not surprisingly, eight out of ten goods with the lowest price dispersion are tradable while seven of ten with the highest dispersion are non-tradable. The price dispersion for all product measured as the mean coefficient of variation is 34.08%; for tradable 31.56% and non-tradable 39.08%.

We start the statistical analysis from the sigma convergence which is in fact the comparison of standard deviations over time. In calculating the mean standard deviation we do not use any weights for different products, our measure is just a simple arithmetic

mean. Figure 7 plots the average price dispersion (mean standard deviation) for each year between 1990 and 2005.

Figure 7 The price dispersion, 1990-2005 for all, tradable and non-tradable goods

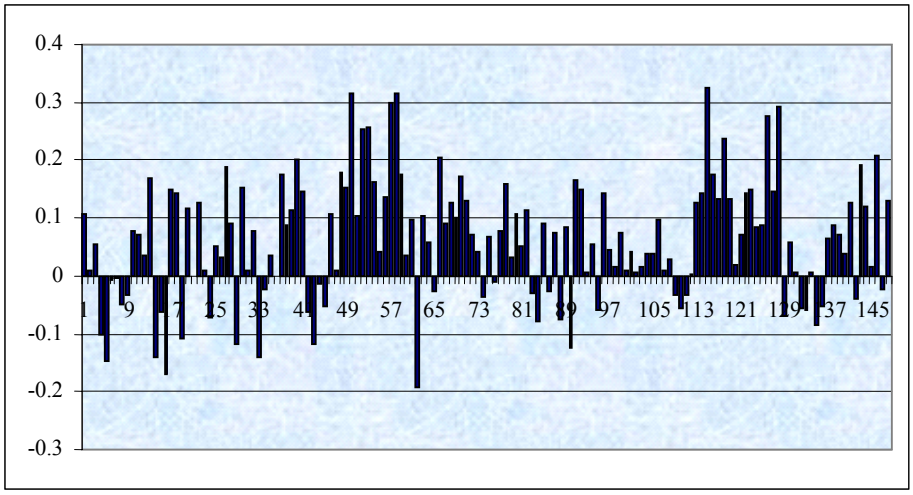


*the mean standard deviation for each of the product group
Source: own calculations

There are three lines representing, respectively: the average for all 148 goods, for 107 tradable goods and the average for 41 non-tradable goods. First of all the price dispersion is higher for non-tradable goods while the plot for all goods is in the middle. But the tendency for all groups is the same. At the beginning of the 90s, there was a significant decline in the price dispersion (between 1990 and 1996 the decrease of standard deviation for all products by 19%) Since 1996 a slight increase in price dispersion took place. Over the entire sample period, 1990-2005 the price dispersion has been reduced by 15.4% for all goods, by 14.5% for tradable and by 17.2% for nontradables. The decline in the dispersion for each of the groups of products was not statistically significant so the sigma convergence is again rejected.

When we look more closely at each individual good, we note that 110 out of 148 goods underwent price convergence during last fifteen years (39 statistically significant). Figure 8 shows the differences of the price dispersion between 1990 and 2005. The positive value indicates the decline in the price dispersion.

Figure 8. Price dispersion 1990 vs 2005– all goods

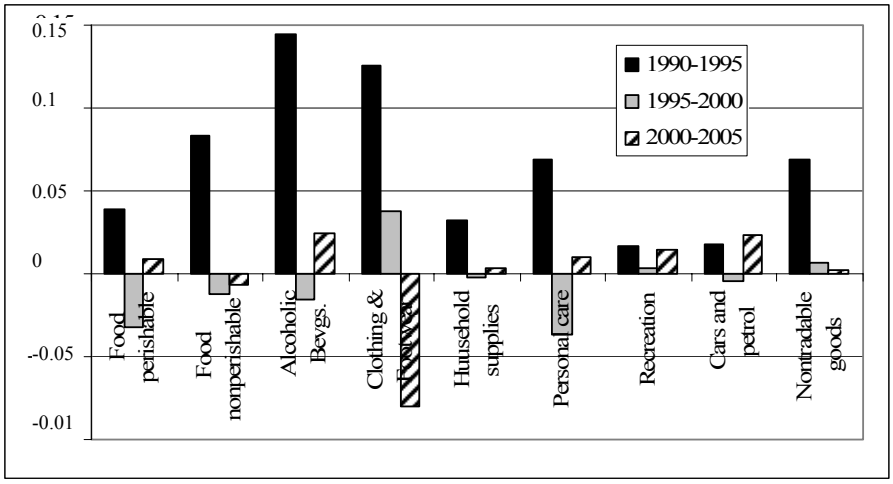


* The difference between the standard deviation from 1990 and 2005, the positive value means the convergence

Source: own calculations

Figure 9 plots the change in the price dispersion for 8 defined product categories of tradable goods for three sub-periods: 1990-1995, 1995-2000 and 2000-2005. The positive bar in the chart reports the decline in the price dispersion and the negative bar represents the increase.

Figure 9 Change in the price dispersion by the product categories



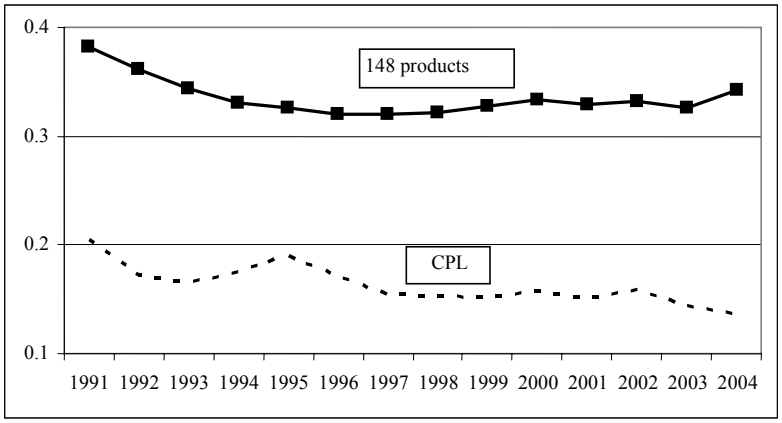
Source: own calculations

We see that during the earliest sub-period the price dispersion for each category declined. The strongest decline was for alcoholic beverages. In the 1995-2000 period only clothing and recreation prices show a decline in dispersion. For the last sub-period except

nonperishable food and clothing all categories underwent a decrease in price dispersion. Again the differences in variances were not proven by statistical tests.

It is interesting to compare two measures of price dispersion. The first one is based on the aggregate data: standard deviation of CPLs and the second one is the mean standard deviation across all 148 products. The conclusion from Figure 10 is obvious. The aggregate measure might underestimate the price dispersion.

Figure 10 Standard deviation of CPLs and mean standard deviation of 148 products



Source: own calculations

4.2 Beta convergence

We repeat the estimation of model (6) with the dependent variable now being a measure of price dispersion across pairs of cities for each of 148 products:

$$p^k_{i,j,t} = ln P^k_{i,t} - ln P^k_{j,t} \tag{7}$$

$P^k_{i,,t}$ - price of the product k in country i at time t

$P^k_{j,t}$ - price of the product k in country j at time t

All prices are in logs so the difference is expressed in percentage terms. The measure was computed for all possible pairs of cities (15*14/2 = 105). The differences can have a positive or negative sign. When the measure is negative its rise means the price convergence, while for a positive value of price differences, its rise implies price divergence. To avoid confusion in interpretation we adopt the absolute deviation:

$$\left| p_{i,j,t}^{k} \right| = \left| \ln P_{i,t}^{k} - \ln P_{j,t}^{k} \right| \tag{8}$$

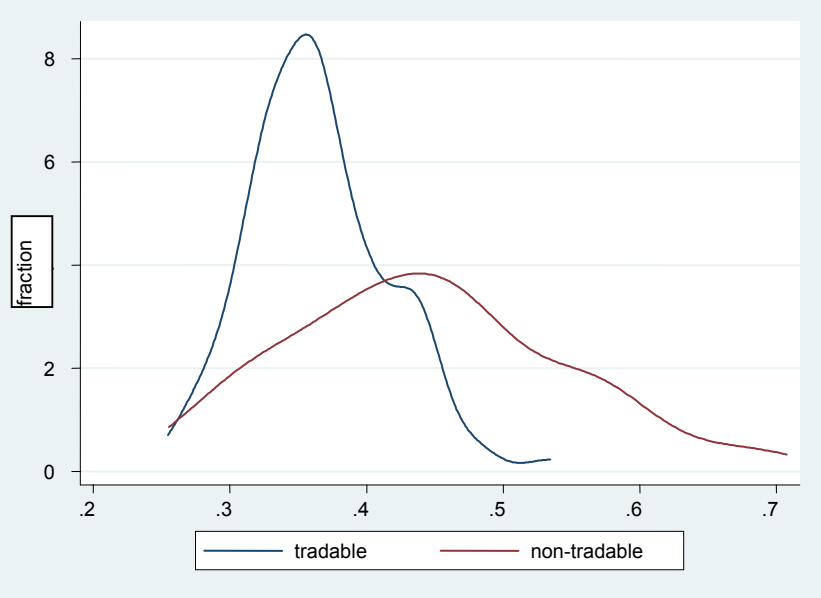
To eliminate the individual effects of different products we computed the price dispersion measure as a mean separately for all goods- tradable and no-tradable - according to the formula;

$$\overline{\left| p_{i,j,t} \right|} = \frac{\sum_{k=1}^{k} \left| p_{i,j,t}^{k} \right|}{k} \tag{9}$$

where *k* is the number of goods (148 – all goods, 107 tradable, 41 non-tradable)

Figure 11 presents the distribution of price differences pooling all goods and locations in 2005.

Figure 11. Distribution of price differences for tradable and non-tradable goods in 2005.

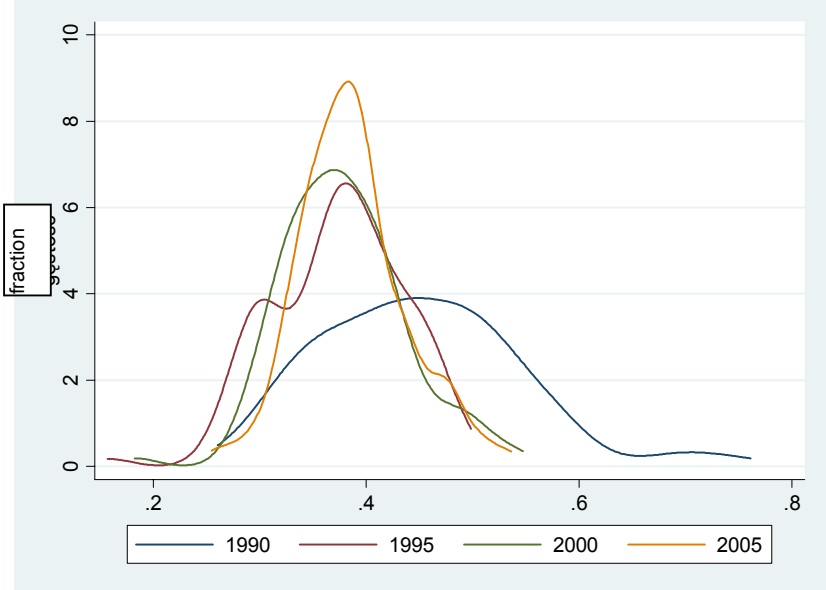


Source: own calculations

The densities are estimated using Gaussian kernal. The lower the price difference, the closer the distribution's mass to zero. Figure 11 plots two lines presenting distribution for tradable and non-tradable goods respectively. The greater dispersion of prices for non-

tradable goods is clear. In addition the figure 12 plots the distribution for all good for 1990, 1995, 2000 and 2005.

Figure 12. Distribution of price differences for all goods for 1990,1995,2000 and 2005.



Source: own calculations

Figure 12 suggests a decline in price dispersal between 1990 and 1995 (displacement of the distribution to the left). The distributions have not moved considerably since then, so the deviation of prices is quite stable.

Table 7 reports the results obtained by different estimation methods for model (6) starting from OLS pooled estimator. The interpretation of the estimates is in line with the results obtained for CPLs. Recall that the OLS estimates is likely to be biased upwards (half-life biased downwards) and Within Group is likely to be biased downwards (half-life upwards). The parameter of 2SLS is again out of the possible range. In opposition to the previous panel data estimations, both DIF GMM and system GMM give the accepted values. DIF GMM gives an estimate of 0.7702 that is similar to the system GMM estimate of 0.7484 with an asymptotic standard error of 0.0384. Both estimators are consistent and efficient. Our final result for the half-life based on the system GMM estimator equals 2.3 years and is less than half of the one computed when CPLs were used.

Table 7 The estimations of beta convergence - dependent variable: mean absolute value of log-price difference

	OLS *pooled*	FE *within*	2SLS	DIF-GMM	SYS GMM
(1 - β)	0.8512 (0.0125)	0.7017 (0.0183)	0.8596 (0.0454)	0.7702 (0.0232)	0.7484 (0.0384)
speed of convergence (λ)	0.1610	0.3542	0.1513	0.2612	0.2898
half-life (t*)	**4.3029**	**1.9568**	**4.5813**	**2.6541**	**2.3921**
Observations	1575	1575	1475	1475	1575
Hansen test				[0.382]	[0.899]
AR(1) test				[0.000]	[0.000]
AR(2) test				[0.324]	[0.321]

Notes: All computation done using XTABOND2 for StataSE 9.0
Year dummies included in all models
Robust standard errors in parentheses, 2SLS – Two Stage Least Squares, DIF-GMM first-differenced estimator, SYS-GMM system estimator, Results are reported for two-step GMM estimator, The figures reported for Hansen test and Arellano-Bond test are the p-values.

Table 8 presents the estimates of the regression (6) with the dependent variable counted as mean absolute differences across all goods, tradable and non-tradable respectively.

Table 8.The estimates of beta convergence for all goods, tradable and non-tradable.

	All goods	Tradable goods	Non-tradable
(1 - β)	0.7484 (0.0384)	0.7027 (0.0411)	0.8511 (0.0377)
speed of convergence (λ)	0.2898	0.3528	0.1612
half-life (t*)	**2.3921**	**1.9646**	**4.2993**
observations	1575	1575	1575
Hansen test	[0.899]	[0.940]	[0.877]
AR(1) test	[0.899]	[0.000]	[0.000]
AR(2) test	[0.000]	[0.823]	[0.606]

Notes: the same comments as to the Table 7.

The time needed for difference in prices to diminish by half is twice as much for non-tradable goods as for tradable ones. Although the half-life for non-tradable items is longer, the beta convergence has been confirmed.

5. The gravity model explaining the price dispersion

In this section we want to evaluate the factors that cause price dispersion. We adopt the gravity model which is deduced from the "standard" gravity model used to estimate bilateral trade.

5.1 Determinants of price dispersion – the choice of the variables

The previous sections show that the price disparity in the EU is still big. There is a complex set of factors explaining the price disparity at the spatial level (see Table 1). Of course a complete decomposition of price dispersion into all possible driving factors is not technically possible. The choice of the independent variables is determined not only by theoretical framework but also by the possibility of getting the needed data. The price dispersion defined by price differences between the city pairs as in formula (9) will be explained by the following variables (see Annexe B for precise definition and source of data): distance between cities, differences in income levels and labour costs, differences in VAT rates, volatility of bilateral exchange rate, measure of trade importance and dummy variables representing a common land border, common currency and common language.

First of all, the prices vary from location to location because of the costs of transporting the product. Transportation costs increase the final price of the product in a natural way. The higher the transportation costs, the higher the price disparity. In the analysis, the measure of transportation costs is proxy by distances between locations and it isassumed that price differences increase with the distance. Of course, we are aware of the simplicity of this proxy and problem that transportation costs do not have to be proportional to the distance because of different kinds of transport or different geographical conditions. The distances between countries are measured as the distances between capital cities using the great circle formula[17].

[17] Great circle formula taken from www.indo.com/cgi-bin/dist

The next analysed factor is the GDP per capita. There is a theoretical framework that suggests that relative prices are determined by income level. We make an assumption that rich countries are expensive ones. The variable is calculated as absolute log diffeences in GDP per capita between country pairs. Additionally, the alternative variable of income inequalties is introduced; the ratio between the maximum and the mean per capita GDP of the countries where the pair of cities are located. The measure ranges from 1 to 2, where 1 indicates the lack of differences in income. The greater income differences, the higher price disparity. The sign of the parameter should be positive.

The third examined factor is labour cost. This is included in the analysis because of the importance of local factors such as local wages and rents in creating retail prices and also because of the Balassa-Samuelson effect. The variable is constructed analogusly to the previous one, either computed as absolute difference in log wages or as the ratio between maximum and mean wage.

The volatility of bilateral exchange rates is the next independent variable. It is computed as the standard deviation of monthly log differences in the nominal bilateral exchange rate between January and December of a given year. In theory it can be assumed that the influence of exchange volatility on price dispersion is positive but the value of the parameter depends on price stickiness.

The next factor is the trade intensity. We assume the negative link between price differences and trade. For each pair of countries, we computed the following measure of trade importance:

$$T_{ij} = 0{,}5\left[\frac{X_{ij}}{X_i} + \frac{X_{ji}}{X_j}\right] \tag{10}$$

where X_{ij} represents exports of country i to j and X_i total exports of country i. If the index is low, it means that the countries are unimportant to each other as trade partners.

As a measure of country's tax level, the standard value added tax rate is taken. The differences in taxes between countries are calculated as absolute differences in standard VAT rates. We expect the positive sign of the parameter: the higher differences in VAT, the higher price dispersion. Because of the lack of a complete data set, the variable is computed only for 2003 and treated as time-invariant.

Finally, the dummy variables are introduced to control for other characteristics that might reduce the volatility of prices across city pairs. There are variables indicating common language, common border and common currency. We expect that cities located in the neighbouring countries (sharing land borders) would have less dispersed prices. The same is expected for cities sharing the same main language and being a part of Eurozone. The last variable is intended to evaluate the effect of introducing the euro. We split the euro effect into two phases and consequently into two dummy variables: 1st: 1999-2001 when the euro was introduced into non-cash circulation and 2nd starting in 2002 with official adoption of the euro as a national currency.

According to the above analysis the signs of the relations between the price differences and independent variables are as follows:

$$p_{ij,t} = f(\overset{(+)}{dist_{ij}}, \overset{(+)}{PKB_{ij}}, \overset{(+)}{w_{ij}}, s(\overset{(+)}{evol_{ij}}), \overset{(+)}{T_{ij}}, \overset{(+)}{VAT_{ij}}, \overset{(-)}{euro_{ij}}, \overset{(-)}{border_{ij}}, \overset{(-)}{language_{ij}})$$

and the final version of the regression model has the form:

$$\begin{aligned} p_{ij,t} &= \beta_1 \ln(dist_{ij}) + \beta_2 \ln(GDP_{ij,t}) + \beta_3 GDP_{ij,t}2 + \beta_4 \ln(w_{ij,t}) + \\ &+ \beta_5 w_{ij,t}2 + \beta_6 s(evol_{ij,t}) + \beta_7 T_{ij,t} + \beta_8 VAT_{ij} + \beta_9 euro_{ij,t} + \\ &+ \beta_{10} euro2002_{ij,t} + \beta_{11} border_{ij} + \beta_{12} language_{ij} + \xi_{ij,t} \end{aligned} \tag{11}$$

where:

$p_{ij,t}$ - mean of the absolute log price differences between city i and city j according to the formula (9).

$dist_{ij}$ -the distance between cities i and j in kilometers.

PKB_{ij} - the absolute difference in GDP per capita between country *i* and country *j*.

$PKB_{ij}2$ - the index of income inequalities.

w_{ij} - the absolute wage difference between country *i* and country *j*.

$w_{ij}2$ - the index of wage inequalities.

$s(evol_{ij})$ - exchange rate volatility.

T_{ij} - index of trade intensity between country *i* and country *j*

VAT_{ij} - the absolute difference in standard VAT rate between country *i* and country *j* in2003.

$euro_{ij}$ - dummy that equals 1 for years t > 1998 and if country *i* and country *j* are in the Eurozone, zero otherwise.

$euro2002_{ij}$ - dummy that equals 1 for years t > 2001 and if country *i* and country *j* are in the Eurozone, zero otherwise.

$border_{ij}$ - dummy that equals 1 if country *i* and country *j* have a common border, zero otherwise.

$language_{ij}$ - dummy that equals 1 if country *i* and country *j* have the same language, zero otherwise.

$\xi_{ij,t}$ - the error term (where $\xi_{ij,t} \sim$ i.i.d).

The estimation method was OLS with time fixed effects. Moreover, we used the Huber-White sandwich estimator of variance permitting autocorrelation in observations within city pairs. Because not all the data cover the whole sample period and for two variables there is lack of data for Luxembourg (see Annexe B) the different versions of equation (11) were tested. Furthermore, we cannot include all variables in one model (e.g. correlation between GDP and wage). Since the estimates of different models were

almost identical, to save space in table 9 we report only the results for two basic specifications.

Table 9. The estimates of gravity model with dependent variable absolute mean of the log price differences between a pair of cities.

Variables	I	II
$ln(dist_{ij})$	0.0164*** (0.0033)	0.0240*** (0.0033)
$ln(GDP_{ij})$	0.0555 *** (0.0057)	-
$ln(w_{ij})$	-	0.0245*** (0.0042)
T_{ij}	-0.0785*** (0.0281)	-0.1046*** (0.0291)
$s(evol_{ij,t})$	1.4640*** (0.1748)	1.3696*** (0.1763)
VAT_{ij}	0.52*** (0.07)	0.60*** (0.07)
$euro_{ij}$	-0,0113* (0,0064)	-0,0193*** (0,0068)
$euro_{ij}2002$	0.0081 (0,0077)	0.0124 (0,0081)
$border_{ij}$	-0.0220*** (0.0061)	-0.0178*** (0.0061)
$language_{ij}$	0.0112 (0.0071)	0.0136 * (0.007)
Observations	1365	1365
R^2	0.9846	0.9839
F statistic	4233.95***	3968.16***
Individual effect	Yes	Yes

*** Significant at 99% confidence level; ** at 95% confidence level;
* significant at 90% confidence level. Year dummies included in all models.
Robust standard errors in parentheses.

For all models goodness-of fit measures are very high. Moreover, most of the parameter estimates are statistically significant and of the expected sign.

Prices differences are greater between cities that are further apart, but although the relation is statistically significant, at 99% confidence level its economical significance is negligible. It is predicted that doubling the distance between city pairs will raise the price difference by between 1.6 and 2.4 percentage points. As for the effects on income and wage inequalities, a one percent rise in income/wage difference causes the increase of price dispersion of 0.055 and 0.024 % respectively. The wage impact on prices is about half of GDP impact. The estimated coefficient on trade index indicates that its rise of one percent

leads price difference to fall by around 0,1 percent. The fall in exchange rate volatility of 1 percent causes the reduction of price dispersion of about 1.4 %.

Moreover, the positive relation between tax difference and price difference was confirmed with the parameter of around 0.5. Country-pairs with the same currency have price differentials that are between 1.1 and 1.9 [$(e^{1,113} - 1) * 100\%$] percent lower than differentials between other countries. The similar effect of common borders was estimated. The effect of common language in most models is statistically indistinguishable from zero, although in specification II it is significant but at 90% confidence level. Surprisingly in this case use of a common language is associated with more price dispersion. It has to be pointed out that in our analysis the common language was defined as the official language, not the business or most commonly used language. This can affect the final results.

Finally, Table 10 reports the results for the estimates when the dependent variable was computed separately for tradable and non-tradable goods respectively. As far as non-tradable goods are considered, the major differences are the increase in magnitude of the parameter on exchange rates, the euro effect and the lost significance of trade index. Moreover the significance of the language parameter is opposite depending on the type of good. The loss of statistical significance of parameters on trade index for non-tradable items is understandable. However, we have no explanation for the other, seemingly anomalous, results. We can only suppose that this is connected with the heterogeneity of non-tradable goods. Because of that we believe that parameter estimates for non-tradable is questionable and should be taken with caution.

Table 9. The estimates of gravity model with dependent variable computed separately for tradable and non-tradable goods

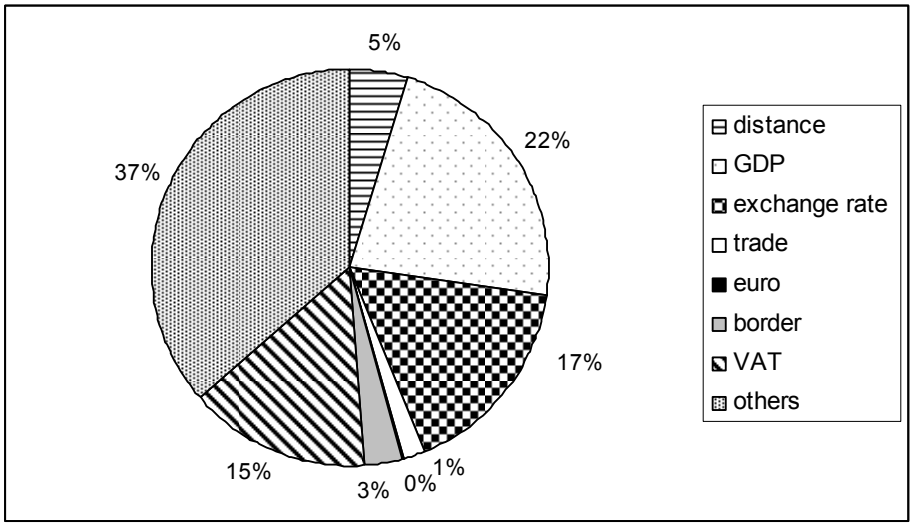
Variable	Tradable goods	Non-tradable goods
$ln(dist_{ij})$	0.0030*** (0.0035)	0.0513*** (0.0070)
$ln(PKB_{ij})$	0.0631*** (0.0057)	0.0358*** (0.0114)

T_{ij}	-0.1388*** (0.0298)	0.0787 (0.0562)
$s(evol_{ij,t})$	0.7710*** (0.1837)	30.27*** (0.3488)
VAT_{ij}	0.0059*** (0.0007)	0.0031*** (0.0013)
$euro_{ij}$	-0.0019 (0.0068)	-0.0360** (0.0145)
$euro_{ij}2002$	0.0106 (0.0079)	0.0015 (0.0166)
$border_{ij}$	-0.0193** (0,0060)	-0.0292** (0,0106)
$language_{ij}$	-0.0225** (0.0102)	0.0998*** (0.0147)
Observations R^2 F statistic Individual effect	1365 0.9810 3706.07 Yes	1365 0.9578 1348.10 Yes

*** Significant at 99% confidence level; ** at 95% confidence level;
* significant at 90% confidence level. Year dummies included in all models.
Robust standard errors in parentheses

To summarize, all variables except for the common language appear to affect price differentials significantly. Nevertheless, the independent variables are of different units with the distinct range values so the interpretation of estimated effects does not give a clear view on the relative importance of the various explanatory factors. To examine the relative contribution of each of the independent variables to explaining price dispersion we performed a variance decomposition. The results are presented in Figure 13.

Figure 13 Relative contribution of each of the variables to explaining price differentials.



The figures refer to the relative contribution of the particular variable to explaining price differentials. They are based on semipartial correlation coefficients of model I.

Source: own calculations

Each pie segment reflects the percentage contribution of the particular variable to explaining the price differentials.

More than thirty percent of variations of price differences are unexplained by our regression. Nevertheless, most of the explanatory power comes from the differences in GDP, exchange rate volatility and differences in taxes. They constitute more than half the explanatory power. It is worth noting that the euro effect is negligible now. We can conclude that although statistically significant, the euro effect is economically insignificant.

6. Conclusion

In this paper we investigated the price dispersion in the EU between 1990 and 2005. The analysis attepmts to evaluate the effect of last fifteen years of European integration on price dispersion.

Up to now, most of the empirical research has been either micro or macro based. In contrast, we conducted the complex analysis utilizing both aggregate and disaggregate price data.

However the price dispersion was shown to be large no matter whether caulations were based on price indexes or actual prices of individual products. For this general conclusion it does not matter whether we use the aggregate or disaggregate level of our data.

Nevertheless, as far as disaggregated data are concerned, the magnitude of the price dispersion is bigger in comparision to the aggregate data. This is probably connected with the aggregation bias that washes out the part of the price dispersion during the process of constructing the indexes.

On the other hand in our analysis the sigma convergence concerning cross-sectional dispersion of prices was rejected both when based on standard deviations of CPLs and when based on actual prices across economies.

Beta convergence was proven to occur, but the results of the speed of price convergence and consequently of the half lives of price shocks were estimated with considerably different values. Recall that the half-life estimated by system GMM for CPLs equals 5.2 years while when computed on the base of actual prices though by the same estimator is half of that value 2.4. In view of these facts the inconsistency of the results obtained by different studies which use not only different data sets but also different estimation methods is not surprising.

Finally, we estimated the gravity model explaining the price dispersion. Of course we utilized only a limited number of independent variables, though in our opinion we have chosen the most important ones. It was shown that most of the relations between indepndent variables and price differentials were as predicted by the theory. The exception is the influence of common language which turned out to be either not statistically significant or positively correlated with price dispersion. This can mean that language diversity is not a problem in the EU. Moreover, the different parameter estimates were obtained for tradable and non-tradable goods respectively. But the latter should be treated with caution as the group of non-tradable items was very incoherent.

Our analysis confirms the importance of employing a proper estimation and modelling tools. Additionally, in future studies we want to focus on nonlinear panel data estimators and panel time series.

In our analysis we focused only on 15 countries, so the natural step is the extension of these studies to include new members of the EU where the price convergence problem is at the top of public agenda.

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Annexe A Product list

Tradeables			Household supplies (6)
	Food and bevgs., perishable (34)	79	Laundry detergent (3 l) (supermarket)
1	White bread, 1 kg (supermarket)	80	Dishwashing liquid (750 ml) (supermarket)
2	Butter, 500 g (supermarket)	81	Light bulbs (two, 60 watts) (supermarket)
3	Margarine, 500g (supermarket)	82	Batteries (two, size D/LR20) (supermarket)
4	Spaghetti (1 kg) (supermarket)	83	Frying pan (Teflon or good equivalent) (supermarket)
5	Flour, white (1 kg) (supermarket)	84	Electric toaster (for two slices) (supermarket)
6	Sugar, white (1 kg) (supermarket)		Personal Care (8)
7	Cheese, imported (500 g) (supermarket)	85	Toilet tissue (two rolls) (supermarket)
8	Cornflakes (375 g) (supermarket)	86	Soap (100 g) (supermarket)
9	Milk, pasteurised (1 l) (supermarket)	87	Aspirins (100 tablets) (supermarket)
10	Potatoes (2 kg) (supermarket)	88	Razor blades (five pieces) (supermarket)
11	Onions (1 kg) (supermarket)	89	Toothpaste with fluoride (120 g) (supermarket)
12	Tomatoes (1 kg) (supermarket)	90	Facial tissues (box of 100) (supermarket)
13	Carrots (1 kg) (supermarket)	91	Hand lotion (125 ml) (supermarket)
14	Oranges (1 kg) (supermarket)	92	Lipstick (deluxe type) (supermarket)
15	Apples (1 kg) (supermarket)		Recreation (6)
16	Lemons (1 kg) (supermarket)	93	Compact disc album (average)
17	Bananas (1 kg) (supermarket)	94	Television, colour (66 cm) (average)
18	Lettuce (one) (supermarket)	95	Kodak colour film (36 exposures) (average)
19	Eggs (12) (supermarket)	96	International foreign daily newspaper (average)
20	Beef: filet mignon (1 kg) (supermarket)	97	International weekly news magazine (Time) (average)
21	Beef: steak, entrecote (1 kg) (supermarket)	98	Paperback novel (at bookstore) (average)
22	Beef: stewing, shoulder (1 kg) (supermarket)		Cars and petrol (9)
23	Beef: roast (1 kg) (supermarket)	99	Low priced car (900-1299 cc) (low)
24	Beef: ground or minced (1 kg) (supermarket)	100	Low priced car (900-1299 cc) (high)
25	Lamb: leg (1 kg) (supermarket)	101	Compact car (1300-1799 cc) (low)
26	Lamb: chops (1 kg) (supermarket)	102	Compact car (1300-1799 cc) (high)
27	Lamb: Stewing (1 kg) (supermarket)	103	Family car (1800-2499 cc) (low)
28	Pork: chops (1 kg) (supermarket)	104	Family car (1800-2499 cc) (high)
29	Pork: loin (1 kg) (supermarket)	105	Deluxe car (2500 cc upwards) (low)
30	Ham: whole (1 kg) (supermarket)	106	Deluxe car (2500 cc upwards) (high)
31	Bacon (1 kg) (supermarket)	107	Regular unleaded petrol (1 l) (average)
32	Chicken: fresh (1 kg) (supermarket)		**Non-tradables (41**)
33	Fresh fish (1 kg) (supermarket)	108	Laundry (one shirt) (standard high-street outlet)
34	Orange juice (1 l) (supermarket)	109	Dry cleaning, man's suit (standard high-street outlet)
	Food and bevgs., non-perishable (15)	110	Dry cleaning, woman's dress
35	White rice, 1 kg (supermarket)	111	Dry cleaning, trousers (standard high-street outlet)
36	Olive oil (1 l) (supermarket)	112	Man's haircut (tips included) (average)
37	Peanut or corn oil (1 l) (supermarket)	113	Woman's cut & blow dry (tips included) (average)
38	Peas, canned (250 g) (supermarket)	114	Telephone and line, monthly rental (average)
39	Peaches, canned (500 g) (supermarket)	115	Telephone, charge per local call from home (3 mins) (average)
40	Sliced pineapples, canned (500 g) (supermarket)	116	Electricity, monthly bill (average)
41	Frozen fish fingers (1 kg) (supermarket)	117	Hourly rate for domestic cleaning help (average)
42	Instant coffee (125 g) (supermarket)	118	Babysitter's rate per hour (average)
43	Ground coffee (500 g) (supermarket)	119	Cost of developing 36 colour pictures (average)
44	Tea bags (25 bags) (supermarket)	120	Daily local newspaper (average)
45	Cocoa (250 g) (supermarket)	121	Three course dinner for four people (average)
46	Drinking chocolate (500 g) (supermarket)	122	Four best seats at theatre or concert (average)
47	Coca-Cola (1 l) (supermarket)	123	Four best seats at cinema (average)
48	Tonic water (200 ml) (supermarket)	124	Cost of a tune up (but no major repairs) (low)
49	Mineral water (1 l) (supermarket)	125	Cost of a tune up (but no major repairs) (high)
	Alcoholic beverages (13)	126	Annual premium for car insurance (low)
50	Wine, common table (1 l) (supermarket)	127	Annual premium for car insurance (high)
51	Wine, superior quality (700 ml) (supermarket)	128	Taxi: initial meter charge (average)
52	Wine, fine quality (700 ml) (supermarket)	129	Taxi rate per additional kilometre (average)
53	Beer, local brand (1 l) (supermarket)	130	Furnished residential apartment: 1 bedroom (high)
54	Beer, top quality (330 ml) (supermarket)	131	Furnished residential apartment: 2 bedroom (high)
55	Scotch whisky, six years old (700 ml) (supermarket)	132	Unfurnished residential apartment: 2 bedrooms (moderate)
56	Gin, Gilbey's or equivalent (700 ml) (supermarket)	133	Unfurnished residential apartment: 2 bedrooms (high)
57	Vermouth, Martini & Rossi (1 l) (supermarket)	134	Unfurnished residential apartment: 3 bedrooms

			(moderate)
58	Cognac, French VSOP (700 ml) (supermarket)	135	Unfurnished residential apartment: 3 bedrooms (high)
59	Liqueur, Cointreau (700 ml) (supermarket)	136	Unfurnished residential apartment: 4 bedrooms (moderate)
60	Cigarettes, Marlboro (pack of 20) (supermarket)	137	Unfurnished residential house: 3 bedrooms (moderate)
61	Cigarettes, local brand (pack of 20) (supermarket)	138	Unfurnished residential house: 3 bedrooms (high)
62	Pipe tobacco (50 g) (average)	139	Unfurnished residential house: 4 bedrooms (moderate)
	Clothing and footwear (16)	140	Business trip, typical daily cost
63	Business suit, two piece, medium weight (chain store)	141	Business trip, typical daily cost
64	Business shirt, white (chain store)	142	Hilton-type hotel, single room, one night including breakfast (average)
65	Men's shoes, business wear (chain store)	143	Moderate hotel, single room, one night including breakfast (average)
66	Mens raincoat, Burberry type (chain store)	144	One drink at bar of first class hotel (average)
67	Socks, wool mixture (chain store)	145	Two-course meal for two people (average)
68	Dress, ready to wear, daytime (chain store)	146	Simple meal for one person (average)
69	Women's shoes, town (chain store)	147	Hire car, weekly rate for lowest price classification (average)
70	Women's cardigan sweater (chain store)	148	Hire car, weekly rate for moderate price classification (average)
71	Women's raincoat, Burberry type (chain store)		
72	Tights, panty hose (chain store)		
73	Child's jeans (chain store)		
74	Child's shoes, dresswear (chain store)		
75	Child's shoes, sportswear (chain store)		
76	Girl's dress (chain store)		
77	Boy's jacket, smart (chain store)		
78	Boy's dress trousers (chain store)		

Source: EIU, City Data

Annexe B Descripion of data set

Variables	Number of observ.	Mean	Standard Deviation	Coefficient of Variation (%)	Min value	Max value	Sample period	Source
p_{ij}	1680	0.387	0.068	17.75	0.148	0.761	1990-2005	Economist Intelligence Unit, City Data
$ln(dist_{ij})$	1680	7.043	0.640	9.09	5.1416	8.1202	-	www.indo.com/distance
$ln(GDP_{ij})$	1575	0.406	0.336	82.73	0.000	1.528	1990-2004	World Bank, World Development Indicator (2005),
$GDP_{ij}2$	1575	1.194	0.154	12.92	1.000	1.643	1990-2004	World Bank, World Development Indicator (2005),
$ln(w_{ij})$	1456	0.486	0.423	87.04	0	1.755	1990-2005 (no data for Luxembourg)	Economist Intelligence Unit
$w_{ij}2$	1456	1.226	0.183	14.918	1	1.705	1990-2005 (no data for Luxembourg)	Economist Intelligence Unit
$s(evol_{ij,t})$	1680	0.01	0.011	112.46	0	0.051	1990-2005	Eurostat.
T_{ij}	1365	0.077	0.069	89.49	0.004	0.352	1990-2004 (no data for Luxembourg)	IMF, Direction of Trade Statistics, (September 2005).
VAT_{ij}	1680	3.425	2.422	70.71	0	10	2003	Economist Intelligence Unit, for Luksemburga - Eurostat.

Source: own calculation