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Abstract

Price levels differ considerably between the member states of the EU. This paper examines what causes these price differences. Disaggregated price level indexes for 13 capital cities in the EU are used in order to investigate differences in relative prices during the 1990s. It is found that such variables as physical distance, tax levels, participation in the EMU and income levels explain differences in price levels.

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1 Introduction

During the 1990s the process of integration and economic cooperation between the member states of the European Union (EU) was mainly influenced by two crucial developments: the start of the Single Market Programme and the European Monetary Union (EMU). After many years of discussions and several agreements the Single Market Programme came into force on the 1st of January 1993. The main idea behind the common market was to eliminate trade barriers between the member states and increase competition by means of free movement of capital, people, goods and services inside the union. As a natural consequence monetary cooperation started on the 1st of January 1999, when 12 of the 15 member states step-by-step replaced their national currencies with a common currency. During the debate on the creation of the EMU, proponents often argued that easier price comparison was one of the positive effects of the single currency, and that increased competition and price transparency would force price levels to converge within the union. Convergence implies that differences in price levels diminish

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either through decreasing prices in countries with higher price levels or through increasing prices in countries with lower price levels. According to the European Commission (2001 a) price differences in the union have declined and the Commission suggests that this is due to the Single Market Programme.

Since the beginning of 2002 the euro has been used in all transactions in the member states of the EMU. Due to the common currency, interest in price issues in the member states has risen and further convergence of prices is expected. In the first year it was argued that retail prices increased in the member states of the EMU. This price increase was considered to be temporary and was explained by the fact that prices were revised upwards when national currencies were converted to the common currency. Further price increases in poorer economies inside the union are anticipated, as economies with lower GDP per capita are catching-up (European Commission (2001 a)). Even if there has been a general convergence in price levels there still exist substantial differences. For example, average price levels in Sweden have converged to the EU's average level, but are still 21 percent higher (Swedish Competition Authority (2000)).

According to economic theories, e.g. the Law of One Price (LOP) and the Purchasing Power Parity (PPP) theories, identical products should have the same prices measured in a common currency if there are no trade restrictions or transport costs. In the classical empirical study by Isard (1977) prices of several traded goods are compared and strong evidence is found that the LOP is violated. Recent empirical articles focusing on differences in relative prices include, among others, Engel and Rogers (1996, 2001), Parsley and Wei (1996), Crucini et al (2000). These articles concentrate on the importance of distance between locations and the effect of national borders in explaining the failure of the LOP. Engel and Rogers (1996) state the hypothesis that price volatility is positively related to distance and, holding the distance constant, volatility should be higher between two locations separated by a national border. Their regression results show that both distance and borders are significant in explaining different prices of similar goods. The effect of a border compared to the effect of distance is large. In their earlier paper Engel and Rogers examine US and Canadian price data, while European price data is analysed in the latter study. Similar results are obtained for both data sets. Parsley and Wei (1996) concentrate mainly on studying the rate of convergence to the LOP in the United States. As only one single country is studied, there are no trade barriers or exchange rate fluctuations. With the help of price data at the product level, the authors are able to classify commodities as tradables and non-tradables. Tradables are divided into two sub-categories: perishables (bread, cheese, etc.) and non-perishables (cigarettes, coffee, etc.). According to summary statistics, the variability is highest for perishables and the mean absolute deviation is highest for services. Parsley and Wei (1996) analyse the effects of transport costs and taxes on the rate of convergence. Similarly to Engel and Rogers (1996), transport costs are approximated by distance and the results confirm that price differences between cities can be explained by transport costs. Distance and variability of prices are positively related for all the sub-

categories and the effect of distance is strongest for tradables. This result remains unchanged when the price data is adjusted for explicit sales taxes. According to Parsley and Wei (1996) the effect of taxes on price differences is minimal. The results obtained by Crucini et al (2000) once again confirm the positive relationship between price dispersion and distance. Besides the effect of distance, the authors find that price differences are about 17 percent lower for traded goods compared to non-traded goods. We can conclude that in empirical studies the LOP is often rejected, and price differences between locations are explained by existing transport costs. How big are the effects of transport costs and have the effects changed over time? Are there any other factors that influence relative prices and help us to explain price dispersions? Differences in income levels, in market structures and in tax rates, exchange rate fluctuations and lack of transparency are some of the factors that can influence price levels.

The objective of this paper is to analyse the effects of several factors that can cause differences in relative prices. We study disaggregated price level indexes for the 13 capital cities of the EU member states during the 1990s, and in doing so expand earlier work done in the area in several ways. First, earlier studies examine price dispersion, i.e. how prices have diverged or converged between countries over time, while here we answer the question of what causes this dispersion in relative prices. Second, we use a panel of disaggregated price level indexes which originates from the same source (Eurostat/OECD database). The reference basket for different groups of commodities is homogenous and comparable. We can concentrate on the absolute version of the PPP, while earlier studies test the relative PPP. Many earlier studies use consumer price indexes (CPI) for long time periods, while here we can disaggregate the CPI into smaller product groups. Third, we analyse the effects of some explanatory variables, such as value added tax, corporate tax and the monetary union, that are not included in earlier studies in a similar way.

We find that differences in relative prices are positively correlated with the physical distance, i.e. transport costs influence prices. The size of the effect differs between product groups, with the effect being strongest for tradables. These results were expected and are in line with evidence found in earlier studies. The expectations that price differences should further diminish due to the monetary union are confirmed in our study. The coefficient of the EMU dummy is negative, which implies that price differences are lower in the participating countries. Our results are contrary to the ones found in Lutz (2002), who did not find evidence of less dispersed price levels in the member states of the EMU. Tax levels, particularily value added taxes (VAT), should have a direct impact on price levels. The regression results show that the effects of VAT and corporate taxes are not obvious at all. The coefficient of VAT is positive and significant for six out of ten product groups, while the effect of corporate taxes is significant for four product groups. Our results confirm earlier evidence that the effect of taxes on price level differences is not as large as expected. Countries with higher income levels are expected to have higher price levels. Our empirical analysis supports earlier evidence of the positive correlation between income and price levels.

The rest of the paper is structured as follows. Section 2 concentrates on the theoretical and empirical background of the LOP and the PPP theories. The empirical analysis and comparison to earlier results are presented in Section 3. The paper is summarized in Section 4.

2 The LOP and the PPP

In the absence of transport costs and trade barriers, identical goods, despite their geographical location, should sell for the same price if converted to a common currency. This idea is known as the Law of One Price (LOP) in the literature and can formally be stated as follows: $p_S^i = e_{SEK/DM} + p_G^i$, where e is the exchange rate, p_S^i is the price of good i in Sweden and p_G^i is the price of the same good in Germany (all variables are in logarithms). The LOP theory should work due to the perfect goods arbitrage mechanism, i.e. if prices in two locations differ, then the product is bought from the cheaper location and sold on the more expensive market. This process continues until prices are equalized between locations. The LOP applies to individual commodities, while the relationship between general price levels in different countries can be characterized by the Purchasing Power Parity (PPP) theory.[1] According to the absolute PPP relative price levels should equal exchange rates, i.e. $e_{SEK/DM} = p_S - p_G$, where p now denotes the reference basket of commodities. The relationship between changes in exchange rates and relative price levels is characterized by the relative PPP, which states that $\Delta e_{SEK/DM} = \Delta p_S - \Delta p_G$ and allows for a constant price differential between the reference baskets.

It is widely known that empirically we often reject the LOP and the PPP. Prices of similar goods vary greatly between countries and even in different locations inside a country. An overview of the reasons behind the failure of the theories can be found in European Commission (2001 a). Generally, we can say that the LOP does not hold because the necessary arbitrage mechanism does not function perfectly since in reality trade has several costs.

[1] An overview of the LOP and the PPP theories can be found in Froot and Rogoff (1995) and Sarno and Taylor (2002).

Price differences and transport costs should move together, i.e. the higher the transport cost, the larger the price difference. Some goods have such high transport costs that they are not traded at all. Typical examples of non-tradables are all kinds of services such as haircuts or medical treatments, except some financial services such as cross border lending by banks. Prices of non-tradables are defined only on domestic markets and hence it is important to make a distinction between tradables and non-tradables when making price comparisons. Non-tradables are usually included in the commodity baskets and influence the results of the tests. It is complicated to define the degree of tradability in a good, and according to some authors all tradable goods include non-tradable components such as local distribution and marketing.

Besides differences in general VAT levels between countries, governments have the possibility of applying reduced or increased rates to selected products. If tariffs exist, then prices of imported goods will be influenced. Differences in national characteristics of countries, such as language and consumer preferences, may give rise to market segmentation, in which case producers can use different pricing strategies on different markets. A crucial problem is the collection of price data in different countries, and the failure of the theories is explained by the fact that the commodity baskets of countries differ. If this is the case, making price comparisons becomes more difficult and sometimes even meaningless.

In addition to microeconomic reasons, macroeconomic factors can cause differences in relative prices. Countries with higher income levels are expected to have higher prices, differences in monetary and fiscal policies give rise to different inflation levels, asymmetric shocks may influence prices in some countries, as will exchange rate fluctuations.

The main purpose of the current study is to analyse the factors that can explain differences in relative prices. Some of the above mentioned factors, e.g. trade barriers, have been gradually eliminated due to the European Single Market Programme and trade between the member states is free, but still prices inside the EU vary a lot. Distance between the locations can be one of the factors that influences prices. Even if we can diminish transportation costs we are not able to eliminate them totally. Differences in tax levels can be another reason that gives rise to price dispersions. Despite extensive work done in order to harmonize taxes in the member states, tax levels still differ. In 2001 Sweden's and Denmark's VAT rates were 25 percent while in Luxembourg the VAT rate was 15 percent (European Commission (2001 a)). Price levels in the member states should be influenced by the preparatory process to the monetary union, as monetary and fiscal policies are coordinated through the Stability and Growth Pact issued by the European Council, as well as through the Stability and Convergence Programmes issued yearly by each country.

2.1 The Consumption-Based Price Index

To illustrate how different factors can influence relative prices we follow Obstfeld and Rogoff (1999) and derive the consumption-based price index in a dynamic Ricardian model.[2] Assume that the economy consists of two countries, Home and Foreign, which together can produce a continuum of goods indexed by $i \in [0,1]$. By defining good $i = 1$ as a numeraire we express commodity prices $p(i)$ in units of good 1. In each country there is a representative individual who maximizes utility $U_t = \sum_{s=t}^{\infty} \beta^{s-t} \log C_s$, where $C = \exp\left[\int_0^1 \log c(i)di\right]$ is a consumption index. Now we can define the consumption-based price index P in terms of the numeraire as the minimum total expenditure $I = \int_0^1 p(i)c(i)di$ such that $C = \exp\left[\int_0^1 \log c(i)di\right] = 1 \Longrightarrow \int_0^1 \log c(i)di = 0$ given $p(i)$. Minimization of expenditure I subject to the constraint $\int_0^1 \log c(i)di = 0$ gives the lowest cost of purchasing a unit of C and yields the price index[3]

$$P = \exp\left[\int_0^1 \log p(i)di\right]. \tag{1}$$

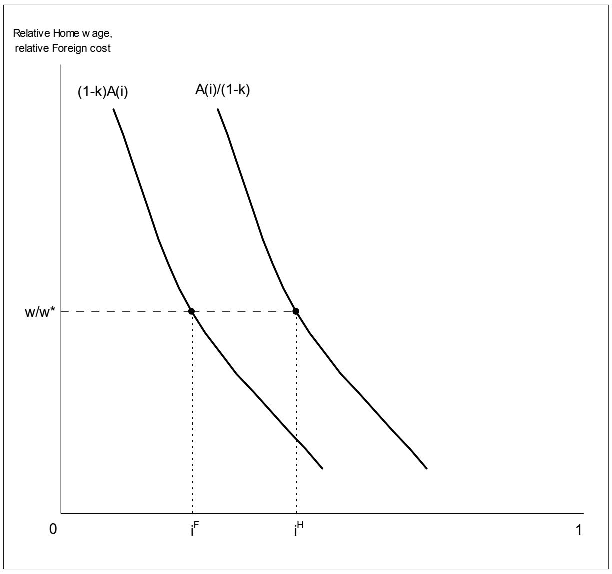
Obstfeld and Rogoff (1999) develop the model further by adding transport costs. Assume that the fraction k $(0 < k < 1)$ of transported products fades away. This implies that if Home orders one unit of good i from Foreign, then Foreign has to produce and export $\frac{1}{1-k}$ units of good i. Production of a unit of good i costs $p = wa$ and $p^* = w^*a^*$ for Home and Foreign respectively, where w denotes labour cost and a denotes the unit labour requirement in the respective countries. It costs $p^*/(1-k)$ for Home to import a good from Foreign. With given labour costs, Home produces those goods for which $p < \frac{p^*}{1-k}$ and Foreign produces goods for which $p^* < \frac{p}{1-k}$. If transport costs are added to the model, then some goods become non-tradables. This is illustrated in Figure 1, where $A(i) = \frac{a^*(i)}{a(i)}$ is the relative Home labour productivity and for a given labour cost ratio and transport costs, Home produces and exports $i \in [0, i^F]$ and Foreign produces and exports $i \in [i^H, 1]$. Goods in the range $i \in [i^F, i^H]$ are produced in both countries and are not traded internationally.

The price levels in each country are defined by the fraction of traded and nontraded

[2] Engel and Rogers (1996) solve the producer's problem in order to show how prices are influenced by different factors. The price of good i in location j is determined by $p_j^i = \beta_j^i \alpha_j^i (w_j^i)^{\gamma_i} (q_j^i)^{1-\gamma_i}$ if the good is sold by a profit-maximizing monopolist, where β_j^i denotes the mark-up over costs, α_j^i measures the total productivity of the final goods sector, w_j^i is the price of the non-traded service and q_j^i denotes the price of traded intermediate input and, γ_i is the share of non-traded good in final output. Transport costs influence prices of traded intermediate inputs, q_j^i and as a result relative price levels are influenced through the ratio of $\frac{q_j^i}{q_k^i}$. Due to differences in cost structures, $\frac{w_j^i}{w_k^i}$ and $\frac{\alpha_j^i}{\alpha_k^i}$ may vary and cause differences in relative prices.

[3] The solution to the minimization problem and the derivation of equation (1) is presented in Appendix 1.

Figure 1: Specialization with transport costs



goods and are given by

$$P = \exp\left\{\int_0^{i^H} \log\left[p(i)\right] di + \int_{i^H}^1 \log\left[\frac{p^*(i)}{1-k}\right] di\right\} \tag{2}$$

$$P^* = \exp\left\{\int_0^{i^F} \log\left[\frac{p(i)}{1-k}\right] di + \int_{i^F}^1 \log\left[p^*(i)\right] di\right\} \tag{3}$$

Relative prices follow from (2) and (3)

$$\frac{P}{P^*} = \exp\left\{\int_{i^F}^{i^H} \log\left[\frac{p(i)}{p^*(i)}\right] di + \left[i^F - (1-i^H)\right]\log(1-k)\right\}.$$

The first part of the index shows that relative prices depend on prices for non-tradables (goods from i^F to i^H are not traded). At the same time tradables and transport costs influence relative prices through the specialization pattern. If, for example, Home's import from Foreign rises, i.e. i^H decreases, then Home's price index rises as imported goods include transport costs. The model above illustrates how transport costs change trade patterns and influence relative prices between countries through the share of traded goods. In a similar way to transport costs, other factors such as differences in monetary policies or in tax rates can influence price levels.

In empirical studies transport costs are often approximated by the physical distance between the locations under study. To analyse the effects of distance and border empirically, Engel and Rogers (1996) run the following regression:

$$V(P^i_{j,k}) = \beta^i_1 r_{j,k} + \beta^i_2 B_{j,k} + \sum_{m=1}^{n} \gamma^i_m D_m + u_{j,k} \tag{4}$$

where $P^i_{j,k} = \frac{\log(P^i_j)}{\log(P^i_k)}$, $V(P^i_{j,k})$ is the volatility of $P^i_{j,k,t} - P^i_{j,k,t-2}$, $r_{j,k}$ is the log of the distance between location j and k, $B_{j,k}$ is a dummy variable for the locations in different countries and D_m is a city dummy. In our empirical analysis that follows we proceed from equation (4).

3 Empirical Analysis

As mentioned in the introduction, price levels in the member states of the EU vary a lot. In order to illustrate these differences we first plot the highest and lowest prices for each product group. Next, we investigate the effects of distance, tax rates and monetary cooperation by extending equation (4). We begin with the whole sample and after that we estimate the same equation for two subsamples in order to see whether the effects have changed over time.

3.1 Data

We use the Eurostat/OECD annual price level indexes from 13 capital cities in the EU covering the period 1990-1998. Due to lack of data, Luxembourg and Helsinki are excluded from the study. In the Eurostat/OECD database total private consumption is divided into several sub-categories of commodities and we are able to analyse different product groups. Table 1 lists the ten product groups investigated. Price level indexes include value added taxes and are computed relative to the EU average, i.e. the base used is EU-12=100 or EU-15=100. This implies that the indexes are comparative, i.e. we can directly compare price levels between countries inside one product group.[4]

Figure 2 depicts the highest and lowest price indexes for each product group. At the beginning of the 1990s prices in the cheapest countries in the EU were on average 36 percent lower than the EU level, while prices in the most expensive countries were 56 percent higher than the EU average. Between 1990 and 1998 price differences in the member states diminished and in 1998 the lowest prices were on average 24 percent under the EU level, while the highest prices were 24 percent over the average. Prices in countries with the highest price levels decreased for all the product groups. At the same time the lowest prices increased for some of the product groups, e.g. clothes and medical care, and remained quite stable for others, e.g. tobacco and fuel.

[4] More information about price surveys and computations of price level indexes can be found in Stapel (2002 a,b).

Figure 2: Highest and lowest price indexes

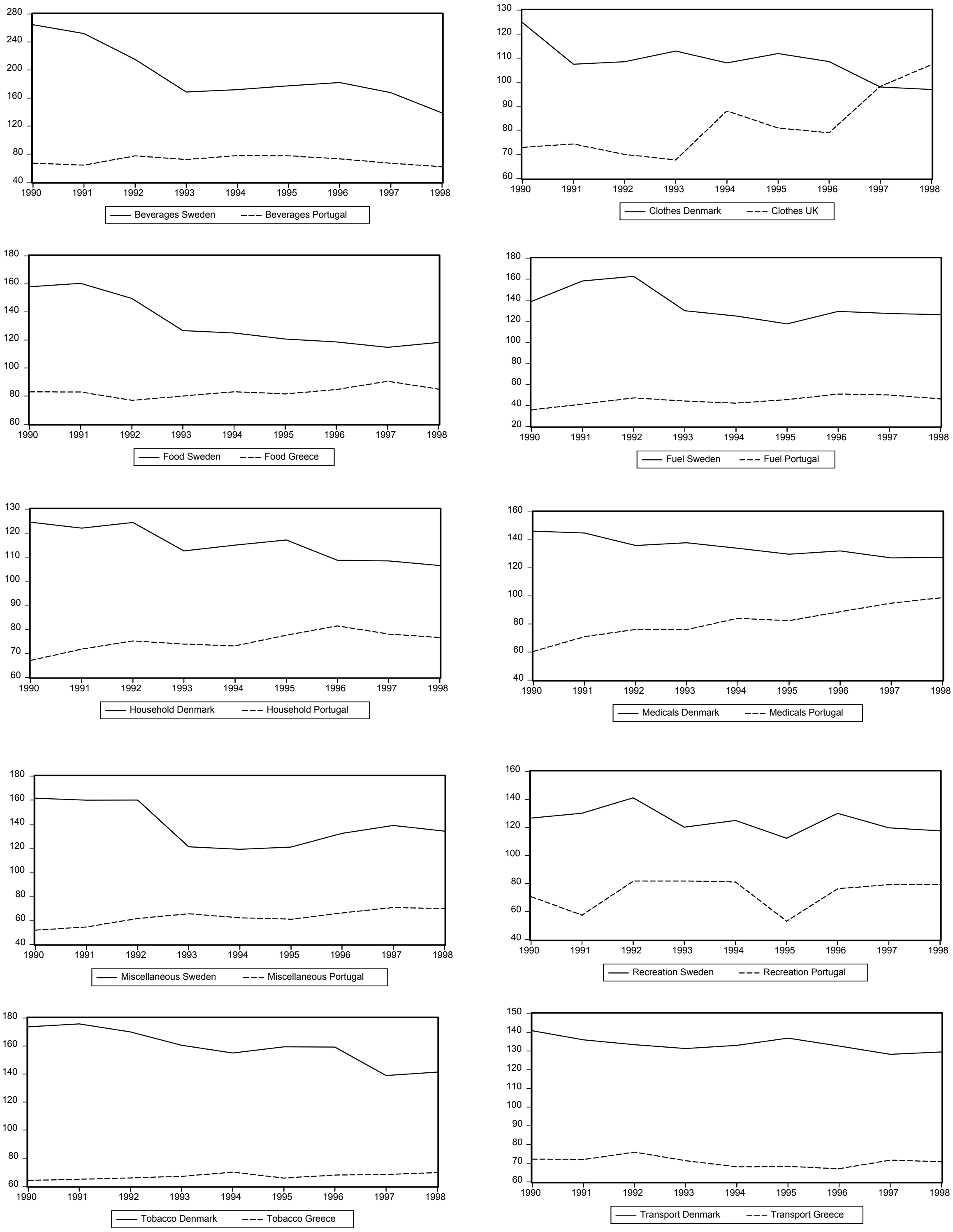


Table 1: Product groups

1.	Food (bread, meat, fish, etc.)
2.	Beverages (non-alcoholic and alcoholic)
3.	Tobacco
4.	Clothing and footwear (including repairs)
5.	Gross rents, fuel and power
6.	Household equipment and operation (including repairs)
7.	Medical and health care
8.	Transport and communication (transport equipment)
9.	Recreation, education and culture
10.	Miscellaneous goods and services (restaurants, cafés, hotels, etc.)

Note: The cities included are: Amsterdam, Athens, Berlin, Brussels, Copenhagen, Dublin, Lisbon, London, Madrid, Paris, Rome, Stockholm, Vienna

In earlier literature different methods have been used in order to construct the dependent variable. Studies that analyse price convergence mostly compute changes in bilateral relative prices and then concentrate on different measures of volatility of these changes. As the specific feature of the data set used here is comparativity, we follow Jakobsson (2001) and analyse relative prices. We construct $13 * 12/2 = 78$ bilateral relative prices per product group and per year. The bilateral relative prices are computed as follows:

$$P^i_{j,k} = |\log(\frac{P^i_j}{P^i_k})|$$

where P^i_j is the price index of good i in location j and P^i_k is the price index of good i in location k. We take the absolute value of the logged relative prices as relative prices are sensitive to the higher price being in the denominator or in the nominator. Doing so we have defined relative prices so that the higher price is always in the nominator. For each product group we stack the data by date.

3.2 Regression Results

Descriptive statistics used in the previous section indicated that relative prices in the EU deviated from the absolute PPP. To further analyse differences in relative prices we estimate the following equation for each product group i:

$$P^i_{j,k} = \beta^i_1 km_{j,k} + \beta^i_2 EMU + \beta^i_3 VAT_{j,k} + \beta^i_4 C_{j,k} + \beta^i_5 GDP_{j,k} + \sum_j \beta^i_j LD_j + \varepsilon^i \qquad (5)$$

where $km_{j,k}$ is the distance in tens of thousands of kilometers between locations j and k, EMU is a dummy variable which takes the value one if both countries are members of the EMU and zero otherwise, VAT denotes value added tax and is computed as $VAT_{j,k} = |\log(\frac{VAT_j}{VAT_k})|$, $C_{j,k}$ is the level of corporate tax and is computed similarly to value added tax. $GDP_{j,k}$ is the relative GDP per capita. To control for city specific effects we also add the city dummy LD_j to each regression. Data on GDP is taken from the OECD database. VAT rates as well as corporate tax rates originate from the European Commission (2001 b,c). This equation differs from equation (4) in several ways. First, instead of the volatility of relative prices we use the price ratio as a dependent variable. Second, our specification includes several other explanatory variables, e.g. the EMU dummy and tax rates, not studied by Engel and Rogers (1996). We are not able to control for the border effect in our analysis as all the cities under study are located in different countries.

Regression results of the estimated models are presented in Table 2. We first estimate equation (5) for a pooled data set. The coefficients of the pooled regression are the averages of the coefficients received by running the regressions separately for each of the product groups due to the identical regressors for subcategories. The coefficients of the pooled regression have expected signs and are significant. We continue by testing whether we should pool the data or use separate regressions.[5] The F-statistic takes the value 40.62, which is considerably higher than the critical value 1.197. Similarly to Engel and Rogers (1996) we reject the null hypothesis that the coefficients are the same for different sub-categories, and continue to analyse regressions of the separate product groups.

A common explanation for the empirical failure of the LOP and the PPP theories is the existence of transport costs. In the current study we approximate transport costs with the distance variable. The relationship between transport costs and distance is positive, i.e. transport costs are increasing with distance. Consequently, we expect that the coefficient of distance is positive and price differences are larger between two locations that are far away from each other. Parsley and Wei (1996) found that the effect of distance was positive for both tradables and non-tradables, and that it was strongest for nonperishable tradables. The results obtained here are similar to Parsley's and Wei's (1996). For seven of the ten goods the coefficient of distance is positive and significant. Even if the influence of distance is low compared to other variables, distance matters for price differences. The coefficient is highest for beverages (0.091) and for

[5] We use the Chow test with the test statistics given by $F = \frac{(e'e - e_1'e_1 - \ldots - e_N'e_N)/(N-1)K'}{(e_1'e_1 + \ldots + e_N'e_N)/N(T-K')}$, where e and e_i denote residuals from the restricted and unrestricted models respectively, T is the number of observations, N is the number of regressions and $K' = K + 1$, where K is the number of estimated parameters. For more information about the test, see Baltagi (2002).

Table 2: Estimated coefficients for equation (5)

Good	Distance	EMU	VAT	Corporate tax	GDP/capita	R^2
Pooled	0.036**	-0.074**	0.138**	0.038**	0.228**	0.25
	(0.003)	(0.006)	(0.02)	(0.007)	(0.01)	
Food	0.005	-0.107**	0.188**	-0.008	0.266**	0.65
	(-0.005)	(-0.009)	(0.03)	(0.007)	(0.015)	
Beverages	0.091**	-0.214**	0.563**	0.27**	0.002	0.58
	(0.01)	(0.017)	(0.061)	(0.021)	(0.027)	
Tobacco	0.064**	-0.178**	0.294**	0.14**	0.213**	0.51
	(0.012)	(0.018)	(0.064)	(0.022)	(0.035)	
Clothing	-0.022**	-0.059**	-0.152**	0.03**	0.098**	0.17
	(0.006)	(0.011)	(0.031)	(0.008)	(0.017)	
Fuel	0.057**	0.051**	-0.054	0.023	0.584**	0.61
	(0.013)	(0.015)	(0.051)	(0.021)	(0.039)	
Household	0.024**	0.002	0.056	-0.028*	0.147**	0.26
	(0.007)	(0.011)	(0.035)	(0.011)	(0.023)	
Medicals	0.06**	-0.093**	0.14**	-0.016	0.173**	0.46
	(0.008)	(0.014)	(0.047)	(0.011)	(0.028)	
Transport	0.037**	-0.055**	0.039	-0.009	0.169**	0.59
	(0.005)	(0.008)	(0.026)	(0.009)	(0.018)	
Recreation	-0.002	-0.037**	0.101**	0.043**	0.306**	0.40
	(0.007)	(0.01)	(0.038)	(0.011)	(0.024)	
Miscellaneous	0.05**	-0.055**	0.203**	-0.062**	0.321**	0.62
	(0.009)	(0.011)	(0.041)	(0.01)	(0.024)	

Note: '**' and '*' denote significance at the 1 and 5 percent levels respectively. White's heteroskedasticity consistent standard errors are in parenthesis.

tobacco (0.064). These two product groups can be classified as tradables. For non-tradables, e.g. miscellaneous goods and services, the coefficients are marginally lower and for recreation and education the coefficient of distance is not significant. This can be explained by the fact that if we are not able to transport some product, then the price of this product is independent of the transport costs. In the current study the classification of product groups into tradables and non-tradables is complicated as all groups include non-tradables to varying degrees. We assume that food, beverages, and tobacco can be treated as tradables, while recreation and miscellaneous goods are considered to be non-tradables. The rest of the sub-categories fall between the two alternatives as repairs are included in the price indexes.

Price stability and transparent prices have been arguments for joining the EMU. In the 1990s members of the EU prepared the introduction of the common currency. Is there any difference between price developments in the EMU countries and the three countries outside the monetary union? If the expectations about the effects of a common currency are fulfilled, then price differences should be lower in the countries participating in the monetary cooperation. Hence the coefficient of the EMU dummy should be negative. Our regressions show that the coefficient of the EMU dummy is negative and significant for eight of the ten product groups. This means that countries participating in the monetary union have less dispersed price levels. The effect is strongest for tradables, e.g. beverages, tobacco and food. The results obtained in earlier studies are contradictory. Parsley and Wei (2001) argue that exchange rate stability should reduce price variability. The results obtained here confirm their finding that a common currency has decreased price dispersion. The effect, however, is much higher, 7.4 percent, compared to the 3.42 percent obtained by Parsley and Wei (2001). Lutz (2002) does not find clear evidence that price differences have been lower in the EMU countries compared to countries not participating in the monetary union. Possible explanations for contradictory results can be differences in methodology used as well as differences in data sets.

One of the reasons why prices of identical products differ between countries is different tax levels. There is no consensus in the literature on whether PPP should hold on a pre-tax basis or on a tax-adjusted basis (Parsley and Wei (1996)). The price level indexes used here include VAT as consumers are assumed to be interested in prices including tax. In this study we analyse the effect of value added tax (VAT) and corporate tax.[6] Countries with higher tax levels should have higher prices. The sign of the tax coefficients should be positive, i.e. the higher the tax differences between two countries the higher the differences in relative prices. Our regression results show that tax effects are ambiguous for different product groups. The coefficients of VAT are positive and significant for six out of ten product categories and the effect is highest for beverages. Otherwise the effect seems to be more equal between tradables, e.g. food and tobacco, and non-tradables, e.g. recreation and miscellaneous goods and services. For several product groups the coefficients are insignificant or have the wrong sign. In studying price convergence in the EU, the European Commission (2001 a) adjusted price levels for tax rates and found that the dispersion was slightly lower. The Commission ranked the member states before and after tax adjustments. As the differences in rankings were not significant, they concluded that consumer taxes were not the main explanation for differences in relative price levels.

Corporate taxes in the EU vary from 10 percent in Ireland up to 52.35 percent in Germany. In most of the member states the corporate tax level is approximately 30-40

[6] Inside one country different VAT rates may be applied to different products. Effects of selective purchase taxes and reduced tax rates are out of the scope of this study. We investigate the effect of standard VAT rates for all the member states and product groups.

percent. The effect on relative prices is positive and significant only for four product groups. This result indicates that corporate taxes have no direct influence on differences in relative prices.

In the economic literature it is generally stated that countries with higher income levels have higher prices. This positive correlation between price levels and GDP per capita is explained by the Balassa-Samuelson model (see Obstfeld and Rogoff (1999)). The results obtained here confirm the Balassa-Samuelson effect. Coefficients of GDP per capita are positive and significant for nine product groups. Except for beverages, the effect of income is strong relative to other explanatory variables for both tradables and non-tradables.

3.3 Sub-periods

In the previous section we studied the effects of several variables throughout the 1990s, during which several steps were taken in order to deepen the integration process in Europe and as a consequence prices were expected to converge. Changes in price differences raise an interesting question: have the effects of our explanatory variables changed over time? To answer this question we divide our data into two sub-periods: the first period covers 1990-1992 and the second period covers 1993-1998. The start year of the Single Market Programme was chosen as a breakpoint. One way to measure convergence is to compare the standard deviation, σ, of relative prices during different periods. If prices converge, then the standard deviation decreases over time, i.e. $\sigma_t > \sigma_{t+1}$. In Table 3 we test for differences in standard deviations for the two sub-periods.[7] We reject the null hypothesis of constant variance for six product groups. For these product groups standard deviations decreased during the second period, which implies that differences in relative prices diminished and prices converged.

Next, we use equation (5) and construct the regression system with one equation for each sub-period

$$P^l_{j,k} = \beta^l_1 km^l_{j,k} + \beta^l_2 EMU^l + \beta^l_3 VAT^l_{j,k} + \beta^l_4 C^l_{j,k} + \beta^l_5 GDP_{j,k} + \sum_j \beta^l_j LD^l_j + \varepsilon^l$$

where $l = 1, 2$ denotes the period. We use the SUR method to estimate the system for each product group. Obtained coefficients for sub-periods are presented in Table 4 as are the test results showing that the coefficients of the sub-periods are equal. Note that only product groups with the correct sign and significant coefficients are presented in order to simplify interpretation of Table 4.

[7] As we have two subgroups we use the following F-statistic to test for differences between standard deviations: $F = \frac{s_1^2}{s_2^2} \sim F_{n_1-1,n_2-1}$, where n_1 and n_2 denote the subgroups and s_i^2, $i = 1, 2$, denotes the variance for the respective sub-periods (see Freund's (1999)).

Table 3: Standard deviations for sub-periods and variance equality test

	1990-1992 σ_1	1993-1998 σ_2	$H_0 : \sigma_1 = \sigma_2$	Probability
Food	0.159	0.124	1.65	0.000
Beverages	0.305	0.238	1.64	0.000
Tobacco	0.245	0.241	1.03	0.782
Clothing	0.118	0.096	1.51	0.000
Fuel	0.306	0.275	1.24	0.062
Household	0.139	0.101	1.88	0.000
Medicals	0.201	0.184	1.19	0.132
Transport	0.133	0.139	1.08	0.455
Recreation	0.162	0.142	1.31	0.020
Miscellaneous	0.244	0.169	2.08	0.000

As the distance between two cities is constant, the effect of distance on price differences should be the same during the sub-periods. Only if transport costs change can the effect of distance change. Regression results showed that the effect of distance was the same for five of the seven product groups as we were not able to reject the null hypothesis of a constant effect. If the distance variable is a good approximation for transport costs, then we can conclude that transport costs did not change considerably during the 1990s.

Preparations for the monetary cooperation should have influenced price levels through the Stability and Convergence Programmes and we expected that price dispersions would be lower in the participating 12 countries compared to the countries outside the EMU. The effects of the cooperation and coordination of economic policies should have been stronger during the second period after the implementation of the Single Market Programme. This implies that the coefficients should have been more negative during the second period. The results obtained here are ambiguous and unexpected. We reject the null hypothesis of an unchanged effect during the two sub-periods for five of the nine product groups. For those product groups the coefficient of EMU became less negative during the latter period. Consequently the effect of monetary cooperation on price convergence was not as strong as we expected during the second period.

Harmonization of tax levels in the member states is still an ongoing process. If tax levels have become more homogenous in the EU, then tax effects on price differences should have diminished during the second period. Coefficients for both relative VAT rates and corporate taxes turned out to be insignificant for most of the goods and we are not able to make any conclusions about how the effects changed over time.

Income effects are significant for seven subcategories and we reject the null hypoth-

Table 4: Regression results for the sub-periods

Distance				
	90-92	93-98	Wald test	Probability
Beverages	0.101	0.08	1.128	0.288
Tobacco	0.076	0.043	3.67	0.055
Fuel	0.081	0.036	7.81	0.005
Household	0.017	0.0132	0.29	0.587
Medicals	0.069	0.048	1.944	0.163
Transport	0.048	0.029	4.529	0.033
Miscellaneous	0.045	0.041	0.078	0.779

EMU				
	90-92	93-98	Wald test	Probability
Food	-0.18	-0.06	56.06	0.000
Beverages	-0.295	-0.179	12.3	0.000
Tobacco	-0.194	-0.201	0.07	0.786
Clothing	-0.08	-0.04	4.11	0.042
Household	-0.041	-0.01	3.722	0.053
Medicals	-0.105	-0.009	0.323	0.569
Transport	-0.093	-0.046	9.46	0.002
Recreation	-0.032	-0.036	0.029	0.862
Miscellaneous	-0.107	-0.031	11.13	0.000

VAT				
	90-92	93-98	Wald test	Probability
Food	0.128	0.237	4.166	0.041
Beverages	0.679	0.528	1.735	0.187
Tobacco	0.266	0.348	0.647	0.421
Miscellaneous	0.245	0.198	0.352	0.552

Corp. Tax				
	90-92	93-98	Wald test	Probability
Beverages	0.245	0.290	1.540	0.214
Tobacco	0.184	0.140	1.876	0.170

GDP per capita				
	90-92	93-98	Wald test	Probability
Food	0.295	0.255	1.557	0.211
Clothing	0.199	0.070	13.287	0.000
Fuel	0.731	0.556	9.971	0.001
Household	0.342	0.221	16.743	0.000
Medicals	0.251	0.169	2.516	0.112
Recreation	0.527	0.270	33.383	0.000
Miscellaneous	0.536	0.277	30.525	0.000

esis of constant effect for five of the seven groups. For these five product categories the effect of income decreased during the second period. This could be explained by the convergence of income levels in the union. Unfortunately we have to reject this explanation as our data set does not support diminished income differences inside the union. The European Commission (2001 a) has found that income differences explain about 60 percent of differences in aggregated price levels. According to the Commission this effect has been stable over time. A further analysis of income effects on aggregated versus disaggregated price data is necessary in order to explain the contradicting results.

4 Conclusions

In economic theory prices of similar goods in different locations should be the same, provided that there exist neither transport costs nor trade restrictions. On the other hand empirical analysis shows that prices of similar goods differ considerably between locations as transport costs and different kinds of trade restrictions exist. In this paper we analyse differences in consumer prices in the EU. Our objective is to answer the question of why prices inside the union differ despite the fact that trade between member states is free. We analyse both macroeconomic and microeconomic factors that can influence prices in the member states. The first include such variables as income levels and differences in monetary and fiscal policies, while the second include transport costs and regulatory systems. We measure income levels with GDP per capita, and participation in the monetary union is a proxy for differences in policies. Transport costs are approximated by the distance between the capital cities and tax levels characterize the regulatory system.

We analyse ten different product groups and we find that a huge part of the differences in relative prices is explained by differences in income levels. The correlation between income levels and price levels is positive. This result was expected as there is consensus in economic theory that this relationship is positive. We even find that the income effect decreased during the second half of the 1990s.

Even if the effect of distance is small compared to other explanatory variables, distance is still one of the factors that give rise to price differences in the EU. This result is consistent with earlier studies that analyse price dispersion in Europe (see Engel and Rogers (2001)) or dispersions between the US states and Canada (see Engel and Rogers (1996)). We also find that the effect did not change considerably during the 1990s, which indicates that transport costs did not change.

Member states with similar monetary and political goals seem to have less dispersed price levels, as the effect of the EMU dummy on price differences is negative. This implies that price levels are more similar in countries participating in the monetary union. Unfortunately we are not able to confirm that this positive effect was stronger during the second part of the 1990s. This may indicate that the effect is only occasional and culminated during the preparatory process of the EMU. In the future, when the EMU has existed longer, it would be of interest to make a closer study of the effects of the monetary union on relative prices.

We also investigate the effects of both VAT and corporate tax rates. As we analyse consumer prices we expect the effects of VAT rates to dominate the effects of corporate tax rates. This holds for the results obtained here. Generally, we can say that the effects of different tax levels on relative prices are not as clear-cut as we expected.

There are several other factors, not explored in this paper, that can influence price levels. In future studies we would like to analyse, for example, the effects of the competition situation of different markets on price setting. Even better classification of commodities into tradables and non-tradables is desirable in order to study whether the effects differ. More disaggregated data is necessary for this purpose.

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Appendix 1 Derivation of the Consumption- Based Price Index

In this appendix, we follow Obstfeld and Rogoff (1996) and derive the consumption-based price index presented in Section 2.1. We have the following optimization problem:

$$\min_{\{C(i)|i\in[0,1]\}} \int_0^1 p(i)c(i)di \text{ subject to} \tag{6}$$

$$C = \exp\left[\int_0^1 \log c(i)di\right] = 1 \Longrightarrow \int_0^1 \log c(i)di = 0 \tag{7}$$

We obtain the first-order conditions by differentiating the Lagrangian with respect to $c(i)$:

$$L = \int_0^1 p(i)c(i)di - \lambda \int_0^1 \log c(i)di \tag{8}$$

$$\frac{\partial L}{\partial c(i)} = p(i) - \frac{\lambda}{c(i)} = 0 \Longrightarrow$$

$$p(i)c(i) = \lambda \Longleftrightarrow c(i) = \frac{\lambda}{p(i)} \tag{9}$$

Substituting (9) into the constraint (7) gives the following

$$\begin{aligned}
\int_0^1 \log c(i)di &= \int_0^1 \log\left(\frac{\lambda}{p(i)}\right) di = 0 \Rightarrow \\
\int_0^1 (\log\lambda - \log p(i))\, di &= \log\lambda - \int_0^1 \log p(i)di = 0 \Rightarrow \\
\lambda &= \exp\left[\int_0^1 \log p(i)di\right] \qquad (10)
\end{aligned}$$

We obtain the index P by inserting (9) into (6) and using (10)

$$P = \int_0^1 p(i)c(i)di = \int_0^1 \lambda di = \lambda = \exp\left[\int_0^1 \log p(i)di\right].$$