Price convergence within the enlarged European Union

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ABSTRACT

In this thesis, the process of price convergence within the enlarged European Union over the last fourteen years is examined. First, a literature review in this report identifies the Law of One Price and the Balassa-Samuelson theorem as main theories that explain price convergence. Then, by means of econometric techniques like unit root tests, and the method of Ordinary Least Squares, converted Harmonised Indices of Consumer Prices (HICP) data of both tradable and non-tradable goods are investigated. Although evidence of price convergence is found for both tradable as non-tradable goods, tradable goods show faster convergence rates. The overall speed of convergence for the 27 European country panel is approximately 24 percent per year. For the 12 new European Union countries price convergence was slower with an overall price convergence rate of around 10 percent annually. Most evidence of price convergence is found for the pre-euro introduction period. Both the literature study as well as the econometric analysis lead to the conclusion that the Law of One Price is the best theory to explain the process of price convergence. Nevertheless, some indication that the Balassa-Samuelson hypothesis holds is found.

Keywords: Price convergence; Law of One Price; Balassa-Samuelson; enlarged European Union; tradable goods; non-tradable goods; panel unit root test; OLS

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1. INTRODUCTION

Wim Duisenberg, the first President of the European Central Bank, stated shortly after the introduction of the euro that '*the completion of the internal market and increased cross-border price transparency contribute to eroding the scope for the existence of substantial price differentials for products which are easily tradable across borders.*'[1]

Since the end of World War II, European governments started to establish integration of their national markets. This was initiated with the foundation of the European Economic Community in 1957, followed by the Maastricht treaty in 1992 (which spelled out the requirements for membership of the Economic and Monetary Union) and the introduction of the euro in 1999. This process has not only led to more integrated markets, but also to price transparency, to the elimination of the costs of currency conversion and to the reduction of the exchange rate risk for its member states.

Economic convergence among the European Union (EU) members became a condition to be fulfilled before the achievement of the Monetary Union. Within the Monetary Union, a single monetary policy applies to all its members. Price stability is one of the major aims of the European Central Bank; this is in order to achieve its inflation objective of a year-to-year change of price levels of maximum 2 percent. Also the Maastricht treaty requires all members to fulfil the nominal convergence criteria. The inflation rate of a country should not exceed the average rate of the three countries with the lowest (positive) inflation rate in the EU by more than 1.5 percentage points.

The enlargement of the EU[2] and the necessary economic integration emerging from it have been topical issues in politics as well as in economics for decades. The integration of financial markets and the introduction of the euro have improved price transparency enormously and caused an increase in trade of about 10 to 15 percent among its members (Frankel, 2008). This process has led to more competition in the euro area, and between euro area members and third countries. According to Dreger et al. (2008) integration of labour markets, product markets and financial markets, brings convergence in productivity, gross domestic product (GDP), and price levels.

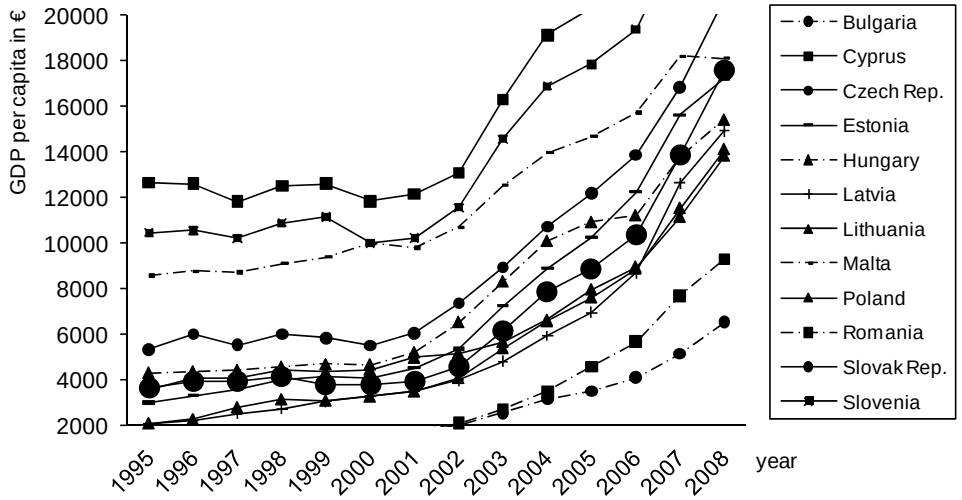
[1] Source: http://www.ecb.int/press/key/date/2000/html/

[2] In 2004 the EU extended with Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia. In 2007, Bulgaria and Romania joined.

The twelve new member states are all in the process of catching-up in per capita income, as illustrates by Figure 1. This is mostly due to the change made in the legal frameworks of transition countries in order to create a more open and friendly environment for multinationals. Multinationals use the comparative advantages of these countries by shifting labour demanding work to these generally low cost regions. This leads to an increase in trade and inflow of foreign direct investment (Johnson, 2006).

Price dispersion among EU members has increased with the recent enlargement. This is due to the substantially lower price levels in the new member states. Many of these new members have expressed their wishes to join the Economic and Monetary Union (EMU) as soon as possible. However, before becoming member of the EMU, the Maastricht criteria have to be fulfilled. This implies price stability and a sustainable process of monetary and real convergence. Once countries have joined the EU some convergence of price levels is expected, this convergence of price levels resembles an appreciation of a country's currency. The Maastricht criterion restricts appreciation of currencies (whether by nominal exchange rate appreciation or through inflation), fulfilment of this criterion therefore becomes a problem for new members.

Figure 1: GDP per capita in the 12 new EU countries



1.1 Research question

This thesis is about price convergence within the enlarged European Union. In recent years, there have been increased interests of both academics and policymakers into the main driving forces of differences in prices and inflation rates among EU countries.

The focus on price level convergence comes from the conviction that it is an appropriate way of measuring integration. Smaller price deviations between markets are in general the result of more integrated and competitive markets. The central research question to answer in this thesis is the following:

Do the prices of tradable and non-tradable goods and services within the enlarged European Union converge among its members?

From a macro-economic perspective, it is interesting to investigate what the expansion of the EU means for price levels of different goods in different countries. This implies finding out if price convergence actually occurs among European countries, and if so, whether there are differences in the strength of price convergence. All new EU members are expected to introduce the euro at some point. Before their EMU entry however, the Maastricht criteria have to be fulfilled. To achieve this, these countries have to control the inflation in price levels. If the mechanisms behind price convergence are clear, the impact of future entry of the countries that are still on the waiting list of joining the EU (like Croatia, Turkey and Macedonia) can be estimated. In addition to this, recommendations can be made concerning current EU members entry into the EMU.

1.1.1 Main theories explaining price convergence

There are two main theories that are frequently referred to, that explain the process of price convergence. One is known as the "Law of One Price" (LOOP), which states that identical tradable goods should be sold for identical prices within a union.

The other one is the "Balassa-Samuelson" hypothesis, which predicts that price levels are higher in more productive countries. Differences in price levels and inflation rates between countries are generally assigned to the Balassa-Samuelson effect. Before entering the EU, exchange rate stability is required for a period of two years at least. According to the Balassa-Samuelson hypothesis, inflation differentials between countries emerge through the existence of productivity differentials between the traded and the non-traded goods sector.

It may happen that because of the inflationary effects of the catching-up in price levels, the new member states are unable to reach the inflation criterion.

1.1.2 Contribution to existing literature

In addition to measuring the strength of price convergence, this study hopes to identify the most appropriated theory to explain price convergence. Other than in previous studies, a detailed description of the theories that explain price convergence is given. A large literature review is done to present evidence of the LOOP and the Balassa-Samuelson proposition found in the last fifteen years, and to reveal the most important factors that explain price convergence. This thesis will contribute to existing studies in the way that by using the latest econometric techniques, it investigates the process of price convergence, its strength, and other explanatory variables that contribute to explain price convergence. This is done by analysing a dataset covering monthly prices (1996m01 to 2009m11) of both tradable and non-tradable goods and services for all 27 EU countries. Different from other studies which consider only one of two theories (either the LOOP or Balassa-Samuelson proposition) this study will try to explain price convergence by incorporating both theories into the econometric analysis. Furthermore, differences in the strength of price convergence of tradable versus non-tradable goods are investigated. In addition to this, differences that might exist in strength of price convergence between the pre-and post euro introduction period are looked at. For the 12 new members also the pre- and post joining the EU (in 2004) period is examined. Moreover, the newest econometric techniques (not used in examining price convergence for the enlarged EU so far) are used to investigate a new, more accurate, and larger dataset. Price convergence in the enlarged European Union has never been investigated in this way.

The next chapter provides an overview of literature and empirical evidence covering price convergence. The hypotheses and expectations concerning the research into price convergence based on the literature study are presented in Chapter 3. The econometric method and the data that are used to investigate price convergence are explained in Chapter 4. Chapter 5 presents the econometric analysis and describes the results found. Finally, Chapter 6 presents the conclusions and discussion points.

2. THEORETICAL FRAMEWORK

This chapter provides a survey of most important literature and papers concerning the Law of One Price, the Balassa-Samuelson proposition and price convergence. The first section deals with the theoretical background of all three subjects and gives the necessary background to understand further analysis and conclusions. Section 2 gives a detailed description of the most influential papers written in the last 15 years.

2.1 Literature Review

This section will give theoretical insight in the most important subjects covering price convergence. These are the theories of the Law of One Price (LOOP) and the Balassa-Samuelson proposition. Both theories are necessary to understand the process of price convergence. In the first part, the LOOP is explained. The LOOP predicts that international price arbitrage leads to identical prices of identical tradable goods in different countries when these prices are expressed in a common currency and adjusted for contract differences, transportation costs, or other trade distortions. In the second part, a review of the papers by Balassa and Samuelson that led to the Balassa-Samuelson proposition is given. The fundamental idea behind this theory is that price levels and wages are higher in wealthier countries. Once less wealthy countries start to trade with wealthier countries, spill over effects from trade cause productivity and wage to increase in the tradable products sector of a less wealthy country. Labour mobility between sectors ensures that wages also increase in the non-tradable good sector of less wealthy countries. This has its effect on the prices of goods and services in the non-traded goods sector, which will go up as well. Price convergence is the last subject discussed as it includes both subjects and measures economic integration between countries. The LOOP predicts price convergence of tradable goods, whereas the Balassa-Samuelson proposition explains how non-tradable good prices in less wealthy countries can converge to the price levels of richer countries.

2.1.1 The Law of one price

The following section examines the hypothesis that due to price arbitrage on the trade market individual good prices tend to equalise among countries. This idea is known as the Law of One Price (LOOP). The LOOP holds when goods market arbitrage enforces equality in prices across a sufficient range of individual goods. This arbitrage ensures that buying a good in one country and selling it in another is not profitable in the long run.

This so-called competition effect of the goods market causes prices to equalise among countries. The LOOP asserts that once goods prices are converted into a common currency, similar goods should sell for similar prices in different countries. A high correlation in aggregate price levels should therefore be noticeable in the long run. In its absolute form the LOOP can be stated for good *i* (abstracting from transportation costs and trade barriers) as in equation 2.1, where $P_{i,t}$ is the domestic currency price of good *i* at time *t*, P_i * is the foreign currency price of good *i*, and e_t is the exchange rate at time *t*, defined as the home-currency price of foreign currency.

$$P_{i,t} = e_t P_{i,t}^* \tag{2.1}$$

$$P_t(CPI) = P_t^*(CPI) + s_t \tag{2.2}$$

If the LOOP holds for individual goods then (according to Froot and Rogoff, 1995) it must also hold for a basket of identical goods as formulated in equation 2.2. P_t is the log of the time domestic currency price of basket of goods, P^*_t is similar but for the foreign country, and s_t the log of time domestic price of foreign exchange rate. In its relative form (see equation 2.3), it asserts that the change in relative price of good *i* between two countries should be offset by a change in nominal exchange rate:

$$(e_{t+1} P^*_{i,t+1} / P_{it+1}) = (e_t P^*_{it} / P_{it}) \tag{2.3}$$

$$\Sigma_i P_{it} = e_t \Sigma_i P^*_{it} \tag{2.4}$$

Where the LOOP is about individual prices, the Purchasing Power Parity (PPP) theorem is about aggregated prices. PPP holds according to the relation of equation 2.4, in which the sums are taken over a consumer (home or foreign) price index. The most distinct difference between PPP and LOOP is that PPP is a rather subjective way of measuring prices equalisation among countries. PPP uses a long-term exchange rate (not similar to the nominal market exchange rate) to equalise paying power. Furthermore, PPP calculations take into account the cost of living and inflation rates of different countries to give comparable good prices between countries. The LOOP is about absolute or relative nominal price differences. Nevertheless, both actual prices as well as price based on PPP calculations can be used for price convergence investigation.[3]

[3] PPP is explained in more detail in the next section.

Convergence to the LOOP in mathematical or econometric terms implies that the time series of relative prices are mean reverting or stationary. This means that a possible shock to the price of a good in a country is only of a temporarily nature and that over time this price will revert to its long-run stationary value. However, there may be significant costs of transportation and transaction in interregional trade, which complicates the dynamics of price convergence. Convergence to the LOOP is established when a long run measurable relationship between similar goods and goods prices exist. Short run deviation of prices is possible (due to e.g., transaction costs, tariffs and other barriers) as long as in the long run the differentials converge.

The half-life of deviations from the LOOP is the longitude it takes for an inflationary shock to make it half of the distance back to its stationary level. The degree in which that happens is an indication for the strength of LOOP convergence. Half-life's give the speed of a mean-reversion process. Take for example, the price of bread which rises because of some inflationary shock. If a half-life of 3.3 years is found in the price data, the price of bread reverses each year by about 19 percent so that after 3.3 years this price is halfway back to its stationary level.

It is possible for the LOOP to hold even when PPP does not. This can be the case when weights assigned to individual products are not the same in all countries. The other way around is not possible as PPP is about a basket of individual goods that should all fulfil the requirements of the LOOP. Latest developments in statistical-software make the panel unit root test the most common approach to examine the LOOP. This approach examines whether price differential series are stationary.

2.1.2 The Balassa-Samuelson hypothesis

This thesis is not about the comparison of exchange rates and the Purchasing Power Parity (PPP) doctrine as it is the case in both papers by Balassa (1964) and Samuelson (1964). Nevertheless, these papers deal with a topic necessary to understand the mechanism of price convergence. For that reason, this section will focus on the most important and relevant conclusions drawn from both papers. Without any collaboration of the authors, both papers led to the Balassa-Samuelson theory. This was due to the high amount of similarities in their work and ideas.

The foundation for the Balassa-Samuelson theory was led by Gustav Cassel (Cassel, 1916) during the First World War period. In those days, exchange rates were considered unrealistic or incorrect and people started to look for other measures to validate exchange rates.

Cassel claimed in the absolute version of his PPP doctrine that the exchange rate between two countries is determined by the quotient between general price levels in the two countries. He argued that the currency of country A could only have value in country B if it had some paying power in country A. Therefore, the price in country B of currency A represented the proportionate buying power of currency A. The price in B would be proportional to price levels in B. The 'Parity' is the quotient between purchasing power of money in one country in relation to another country. The absolute version of the PPP holds when the prices of each product in domestic currency are equalised among countries, providing there will be no trade restrictions (e.g. taxes, non-tariff barriers etc.). In Cassel's relative version, he claimed that when comparing two equilibrium positions of two countries that differed only in absolute price levels, the change in the equilibrium exchange rate would be equal to the change in the ratio of price levels.

During the first 40 years following the paper by Cassel, much had been written on the PPP doctrine. The most important article published before the papers by Balassa and Samuelson was one written by Houthakker (1962). Houthakker argued that purely based on relative price levels of consumer goods, an indication could be given into the over- or undervaluation of currencies. In his paper, he claimed that according to his calculations, the dollar was overvalued in terms of PPP and therefore it should be devaluated.

Both Balassa and Samuelson criticised Houthakker's statement. They did not believe that PPP calculations were accurate enough to translate it into such a practical and important matter. Although they did not claim it to be erroneous, they questioned the way Houthakker came to his conclusion. Therefore, both authors investigated the link between equilibrium of prices, wages, exchange rates, and PPP.

Balassa (1964) investigated what magnitude should be attached to this comparison of PPP's and exchange rates. To do this he suggested a 2 country, 2 commodity (traded and non-traded good) model with constant inputs and only 1 limiting factor, labour. In this model one of the countries had an absolute advantage in the production of both commodities. This advantage was higher in the traded than in the non-traded goods sector.

Due to constant marginal rate of transformation, the relative price of non-traded goods was higher in the country with the highest productivity level. This is due to labour mobility between sectors, which ensure equal wages between sectors. The nominal exchange rate was equal to the number of units of domestic currency per unit of foreign currency. Although non-traded products and services took no part in international trade or exchange rate calculations they did enter in PPP determination. Therefore, poorer countries are generally better off when using a comparative measurement as PPP for international comparison purposes.

Balassa explained that, due to international trade, the prices of traded goods equalise among trading countries while the prices of non-traded goods do not. Productivity differences between countries are greater in production of traded good than that of the non-traded good. This causes the PPP of country 2 (the sum of good prices multiplied by the quantity consumed in country 2 divided by those of country 1 (see relation 2.5)) to be less than the equilibrium exchange rate expressed in currency of country 1 (2.6), independent from using the first or second country consumption pattern.

$$PPP = \Sigma (P2*Q2) / \Sigma (P1*Q1) \tag{2.5}$$

$$\Sigma (P2*Q2) / \Sigma (P1*Q1) < e1 \tag{2.6}$$

$$P1/eP2 = 1 \qquad \text{all in which } e \text{ is the exchange rate.} \tag{2.7}$$

According to the absolute version of the PPP doctrine prices of a common basket of goods in the two countries measured in a common currency should be the same at all times (2.7). However, due to the existence of productivity differences in the production of the traded good, the currency of the country with higher productivity level will appear overvalued in terms of PPP. This is again due to the fact that services are incorporated in PPP calculations but not in exchange rate calculations. Balassa explained that the larger the differences are in productivity of traded goods between two countries, the larger the differences in the wages and the prices of non-tradable goods will be. This will increase the gap between PPP and equilibrium exchange rate. For this reason the absolute relationship between exchange rates and relative prices does not hold. He proved this by comparing the official exchange rate of the French franc in 1955 by its PPP using United States as well as European quantity weights. The franc appeared to be overrated by using both standards. Productivity differences between the tradable and non-tradable sector alter the internal price structure of a country. Whenever productivity increases in the tradable sector, wages also increase in that sector.

Moreover, due to labour mobility between sectors this will increase real wages in both sectors, and this will lead to an increase in the relative price of the non-tradable goods. Concerning the relative version of the PPP doctrine, Balassa indicates that structural factors like labour demand and supply will give rise to errors in applying PPP doctrine for new exchange rate determination.

In his paper, Samuelson (1964) discussed the issues of the use of absolute PPP theory for exchange rate determination. He did so by reviewing different thoughts and theories regarding the composition of exchange rates and different versions of PPP calculation. He showed the risk of comparing exchange rates to PPP indexes. PPP in its absolute form could never occur according to Samuelson since the baskets of goods were never really the same; different countries have different products and product weightings. In addition, he argued that transport costs and other barriers were not taken into account. He also explained how good prices equalised among different countries and that the overvaluation of the dollar caused an upward pressure on prices and cost levels in other countries.

The Balassa-Samuelson hypothesis, as it is known today, was born out of both papers and is seen as an important price convergence mechanism. It assumes that countries where prices are low are also relatively poor. Catching-up economies will experience relatively higher inflation rates than industrial countries. This is due to stronger convergence of productivity levels in the tradable goods sector and cause wages and output to increase. Labour mobility ensures that wages in the whole economy go up. Therefore, wages and price levels in the non-traded goods sector also increase. However, productivity increases in the tradable goods sector, outpace productivity increases in the non-tradable sector. As productivity growth in the non-tradable sector is slower, higher wages in this sector ultimately result into higher prices of non-tradable goods, and end up in an increase in the overall price level. Overall inflation will rise due to high inflation rates in the non-tradable goods sector. Therefore, a country which has low price levels, and opens up to trade or economic integration, will experience higher inflation rates.

2.1.3 Price convergence

It is important when explaining the process of price convergence to look at both the LOOP as well as the Balassa-Samuelson proposition. Where the LOOP is about competition and pressure on mark-ups over prices that cause price convergence of tradable goods, the Balassa-Samuelson proposition predicts price convergence due to a rise in wage levels (of non-tradable goods) and inflation for poorer countries. The joint effect of both theories on prices can be conflicting. It is therefore necessary to provide a clear overview of both effects in order to understand price convergence better (see Table 1).

Table 1: Price convergence explained by two theories

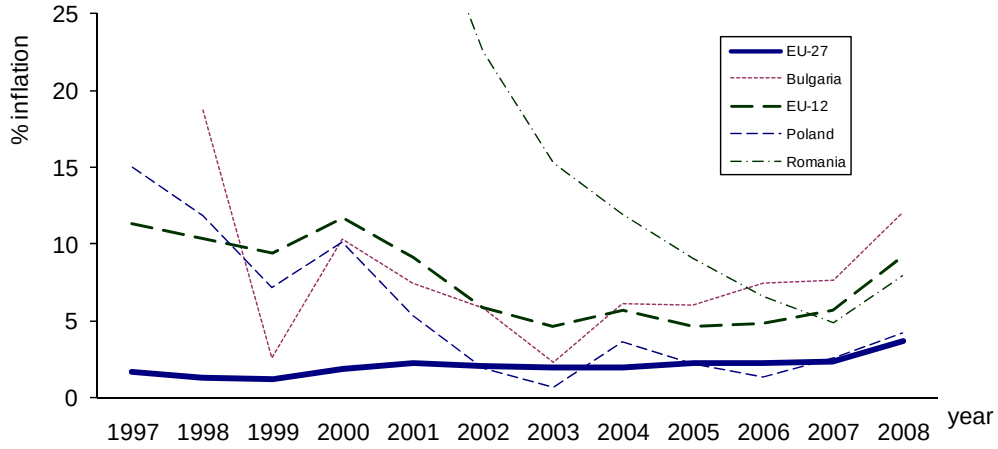
The Law of One Price (competition effect)	Downward pressure on prices of traded goods of richer countries while increasing the prices of traded goods in poorer countries. Does not explain convergence in prices of non-traded goods.
The Balassa-Samuelson proposition (catch-up effect)	Due to price arbitrage and labour mobility, the prices of non-traded goods in poorer countries rise.

Over the past decades, important steps have been taken towards the integration of markets within the European Union. One of the expected effects of international trade and the process of market integration within a system of relatively fixed exchange rates in Europe is price convergence. According to O'rourke (2002) a decline in the international dispersion of commodity prices is the irrefutable evidence that globalisation is taking place. However, due to recent EU expansion, price level differences of consumer goods and services have increased within the EU. At the beginning of 2008, Denmark consumer goods prices were approximately 36 percent higher than the average prices of the 27 EU member states, while in the former Yugoslav Republic of Macedonia prices were 36 percent lower than this average[4]. Price convergence can only happen if different countries have different price levels. Inflation differentials will decrease once prices start to convergence to a common level.

[4] Source: http://epp.eurostat.ec.europa.eu

Since new countries have small impact on the established EU area (since most countries have a relatively small gross national product) inflation will tend to be higher in countries where prices are initially low. This does not mean that once a number of countries join the EU, deflation of prices in the established EU is impossible. However, it might be an explanation for cross-country differences in inflation. Figure 2 shows the annual average inflation in price levels of different countries. It shows that the 12 new EU member countries have had high inflation rates in the pre-2004 period. It also shows that inflation rates of these countries (although at a higher level) show a similar trend to that of the EU-27 countries average. Especially the countries that joined the EU the latest have had a strong decrease in price level inflation in the last couple of years.

Figure 2: Annual average inflation % (HICP data)



Numerous reasons are found in literature to explain why price levels differ across countries or regions within a currency area. The most important ones mentioned are differences in wage behaviour, product regulations, productivity, consumer preferences, taxes and inflation expectations. With the introduction of the euro as the common currency, policymakers hoped that transparency and market access would increase and that prices would converge among the EMU members. In general, the price levels differences between the euro area and the accession countries far exceed the differences in price levels within the old European countries.

Price convergence is possible for traded as well as for non-traded goods. The LOOP and the Balassa-Samuelson proposition are the most important theories to explain price convergence.

The integration of international commodity markets, and the process of price convergence coming from this has also important political consequences for countries wanting to join the EU or EMU. All EU members are expected to implement the euro as a currency in the long run, and EMU entry requires compliance with the Maastricht nominal convergence criteria. These criteria require that accessing countries keep their inflation rate under the 1.5 percent average rate of the three countries with the lowest inflation rate in the EU. Therefore, when joining the EMU a stable inflation of prices is required, however, due to international integration of markets and price convergence, inflation differentials will emerge.

Price convergence works among other things through the competition effect that puts pressure on prices. Once a country opens up to trade, price levels will adjust in an either upwards, downwards or stable way. As soon as a country joins the EU and has a lower price level than the EU-average price level, a decreasing trend in the inflation differentials is expected. Changes in inflation rates are influenced by two factors, the first one being the price level in the other country, the second one being the economic policies made on a national level or by the European Central Bank (ECB). The speed of price level convergence depends on both factors. Average half-life's for overall price indices are generally around 3-5 years (Parsley and Wei, 1996). This implies a convergence rate of about 13 to 20 percent per year.

When one investigates price convergence, one generally looks at the trend in retail prices of tradable and non-tradable goods and services. Tradable goods prices are among other things determined by the costs of manufacturing and the tax rate in a country. Arbitrage costs will be made when goods are sold in another country. These arbitrage costs can be anything from transportation costs, to exchange rate costs, or non-tariff trade restrictions. If the economic policy is market integration, the first step is to keep the arbitrage costs low. Non-tradable goods do not cross the border and therefore no arbitrage costs are made. However, there can be price differences due to different wage costs and tax rate differences. Convergence of non-tradable goods prices is theoretically possible and happens according to the Balassa-Samuelson hypothesis. As discussed earlier, labour mobility causes a flow of workers from the non-traded to traded goods sector once the demand for a traded good increases. Since workers can now earn more by working in the traded goods sector, wages in non-tradable goods sector have to go up in order to keep their workers. This will have an effect on the price of non-tradable goods and they will increase as well.

According to Camarero et al. (2000) long run convergence can happen while price series do not equalise among different countries, they could also be proportionally related to each other. This would still imply long run convergence, as they would experience similar shocks in the convergence process. This is the case when prices have not yet equalised among countries but follow a non-zero trend line and deviations in price levels tend to disappear. The authors suggest the testing of price convergence should be done by means of so-called unit root analysis.

Table 2 provides an outline of the factors or events that influence the process of price convergence. According to Rogers (2007), there is reason to expect price convergence in the European Union due to the progress of a single market as well as the introduction of the euro. He claims that although convergence through tradable goods is mostly of a transitory kind, productivity convergence has a permanent effect on price levels. There are also several factors that hinder the process of price convergence. The most important one according to Gaulier and Haller (2000) is the market structure of a country. Firms determine their optimal price based on the nature and intensity of competition within the market. Since consumers have asymmetrical preferences, prices across countries and across brands will differ. This has its implications for the pricing policies of firms, which will also differ among different firms and countries. Other factors (also listed in Table 2) are of a macroeconomic kind like for example the non-tariff barriers that might exist in a country.

Table 2: Opportunities and threats for price convergence

Opportunities	Threats
Differences in per capita income	High transportation costs
Differences in wage costs	Interventions on the exchange rate market by local governments
The level of competition in countries	Differences in taxes (VAT and indirect taxes)
Comparability of goods prices (e.g through internet)	Trade and non-trade barriers
Differences in quality of public services (roads, telecommunication etc.)	The possibility of setting local prices by management (market power)
	But also different: climate, clients taste and culture

The next section provides empirical evidence into all three subjects discussed. The theoretical framework provided is necessary to understand the results of different studies into these subjects.

2.2 Empirical evidence

Over the years, there has been much research done into the LOOP, the Balassa-Samuelson proposition, and price convergence. This section will provide an overview and a detailed analysis of the most influential academic papers written in the last 15 years. Although all of them try to explain the process of price convergence, they differ in which theory and methods they use to explain this process. This overview will give insight into the results that are found by using the latest techniques and datasets.[5]

2.2.1 The Law of One Price

Engel and Rogers (1996) wrote a paper in which they examined the flaws of the LOOP. In this paper, Engel and Rogers claim that the LOOP does not hold and explain why by looking at 14 disaggregated goods sold in 9 Canadian and 14 United States cities covering over a time span of 16 years. The authors started by converting the log of absolute price data into relative ones (price indexes) for each good in each city. Consequently, they calculated price volatility as the standard deviation and reported the average standard deviation for each product and a pair of cities. Then the authors examined whether differences in prices of similar goods in cities are correlated to the distance between these cities. They found strong evidence that price dispersion rate between cities are bigger when there is more distance between those cities. In addition, they found borders to have a significant impact on price dispersion. Both variables are therefore important factor in explaining price dispersion among cities and countries. Distance is important as local sellers are mostly interested in for what price local sellers are offering their products. Borders are important because good prices do not adjust easily (sticky) especially once they are sold in a country that has a different currency.

Haskel and Wolf (2001) did a case study into the extent and permanence of violations of the LOOP. They studied IKEA prices in 25 countries over a three years interval and found evidence of mean-reversing prices by estimating a standard mean reversion regression of the log in relative prices. The authors found that price differences were not due to differences in wage costs, tariffs or taxes, but instead due to mark-up over cost price. This is a violation of the LOOP in the way that it is a failure of the arbitrage effect.

[5] Some papers address multiple subjects and are therefore categorised according to the subject discussed most profoundly.

The short time frame and insufficient econometric methods used in this article give room for questions concerning the accuracy of the results found.

Chen and Devereux (2003) studied the behaviour of absolute price levels (cost of a basket of goods) for United States cities from 1918 onwards and compared their result to the findings of Engel and Rogers (1996) who did a similar research for the Organisation for Economic Cooperation and Development (OECD) countries. They measured price dispersion by taking the coefficient of variation of the log absolute price levels and found strong evidence of price convergence in the United States. A 40 percent decline in price level differences was found after 1920. Possible explanations for this were improvements in transportation and communication. By making a comparison between the speed of price convergence of tradable and non-tradable goods price convergence was examined in more detail. Two sub-indices, food and rent were investigated. For food prices they found strong evidence of convergence, nevertheless due to small variation that existed in the price of food this index converges slowly. For rent prices however no evidence of convergence or supporting the Balassa-Samuelson proposition was found. This confirmed the author's suspicions of faster price convergence for tradable goods and no or slow convergence for non-tradable goods. They also investigated the bilateral exchange rate of cities. By bilateral exchange rates they meant the log of price level for the *i*'th city minus the log of United States CPI price data[6]. They rejected non-stationary exchange rates in 11 out of 19 cities. The speed of adjustment of overall price levels was low with a mean of half-life deviation from PPP of around 5 years. They claim that theoretically PPP requires the real exchange rate to be stationary. If it is accompanied by price level convergence however, real exchange rate non-stationarity is not evidence against PPP (allowing for reductions in transport costs and improved market integration). In the case of food the absolute version of PPP would clearly fail. But, price dispersions were very low for this product and since the 1920's (due to increasing market integration) prices converged even more sometimes up to 60 percent. Therefore, they conclude that non-stationarity when it is combined with price level convergence actually provides evidence of the relative version of PPP.

Goldberg and Verboven (2004) studied the market integration and the convergence to the LOOP by looking at the European car market. They investigated car list prices data from 5 EU countries.

[6] Relative price = log (price city *i*/ price US average)

By means of a Levin and Lin[7] (1992) unit root analysis, they found strong evidence for the relative version of the LOOP with estimated half-life's of shocks of about 1.3 to 1.6 years. The Levin and Lin (1992) regression model (given by equation 2.8) is a model for testing for a unit root (random walk in the price data).

$$\Delta p_{i,t} = \alpha_i + \beta\, p_{i,t-1} + \sum_{l=1}^{L} \gamma \Delta p_{i,t-1} + \varepsilon_{i,t} \tag{2.8}$$

$$half - life = -\ln(2) / \ln(1-\beta) \tag{2.9}$$

$\Delta p_{i,t}$ should be seen as the log difference in the price of a product in country i compared to a chosen numeraire country. β is the main parameter of interest and denotes the speed of price convergence, α which is a constant captures country specific information (e.g. differences in GDP per capita or taxes compared to the numeraire country) contained in the price data. Under the null hypothesis (no convergence), β is equal to zero and therefore a shock in $p_{i,t}$ is permanent of nature. γ_l is the coefficient of the lags. The half-life of a shock is given as by equation 2.9. The authors even found evidence for the absolute version of the LOOP, although this evidence was less strong and implied half-life's range between 2.2 years and 8.8 years.

Funke and Koske (2008) researched the validity of the LOOP. By analysing Eurostat's CPI of monthly data of between 1995 and 2005 by means of a panel unit root test (explained in next chapter) they compared the strength of the LOOP for three different panels. The first one containing the 15 established countries, the second one containing the 10 new entry countries that joined in 2004, the third panel comprised the two previous panels. Different numeraire countries were chosen, so that conclusions on the validity of the LOOP were not depending on the numeraire country chosen. It seemed that this choice of numeraire country had a significant impact on strength of the found evidence. Still, they found that price convergence occurred in about 70 percent of the total 90 product groups investigated. Interestingly enough they found stronger evidence of the LOOP in the old EU-15 panel group than in the 10 new member countries. According to Funke and Koske the reason for this is the way exchange rate system were managed in the 10 new countries; central banks intervened in the foreign exchange market, which is an effective short term inflation control solution. Also for most tradable goods the hypothesis of no convergence was rejected.

[7] See Chapter 4 for a more thorough explanation of this test.

While for non-tradable products such as health this was not the case. Highest rejection rates were found for non-alcoholic beverages and food. By using the auto-regression coefficients of the panel unit root tests the half-life's of goods were calculated. Across all product groups they found a convergence rate of around 25 percent annually. The half-life's of the 10 new countries are however in general much lower than those of the old 15 countries. This implies that although for less product groups price convergence was found, for those groups that proved evidence of LOOP convergence is much faster.

Gil-Pareja and Sosvilla-Rivero (2008) investigated the process of price convergence within the European car market. They used recommended retail prices of specific car models net of taxes. The focus in this paper is on the absolute version of the LOOP. The data used covers a time span of 12 years (1993 to 2005). Price dispersion was measured by a technique called coefficient of variation. This is the ratio of the standard deviation to its mean. Price convergence was measured by the Sigma convergence method[8]. For the period covering data from 1995 up to 1998, no evidence of the LOOP was found. The reason for this was the incomplete pass-through of exchange rates to prices. When adding data from after the 2002 period price convergence becomes evident. As in the paper of Funke and Koske (2008) more evidence for the relative version of the LOOP was found for EU-15 than for the new EU countries. Overall stronger evidence of price convergence was found for the post-euro period.

Most papers reject the absolute version of the LOOP[9] whereas evidence for the relative version was found in most cases. Price dispersion increases with distance between countries, borders (stickiness of prices), mark-up over prices and by interventions on the foreign exchange rate market. The relative version of the LOOP however, holds in most cases due to increasing openness to trade, improvements in transportation facilities and in communication possibilities.

2.2.2 The Balassa-Samuelson proposition

In the year 2000, De Grauwe and Skudelny wrote a paper in which they investigated whether the Balassa-Samuelson effect was present in goods price data of the EMU countries, and if so, if it had consequences for the EMU countries.

[8] Sigma convergence occurs if cross sectional dispersion of a variable decreases over time.

[9] Exceptions are Haskel and Wolf (2001) and Goldberg and Verboven (2004)

The Maastricht criterion requires stability of inflation rates, however the authors expected that productivity differentials caused price inflation differentials. By means of a panel unit root test, the effect of differing productivity levels between countries on inflation differentials within the EMU was investigated. The authors used a dataset covering the period between 1970 and 1995. They found that the effect of a productivity shock by 1 percent on the inflation differential was about 8 percent. This matches with the Balassa-Samuelson theory. In addition to this, the authors found that inflation of traded good prices had a significant effect on overall inflation.

Rogers, Hufbauer and Wada (2001) did research into the subject of price convergence and inflation in Europe in the 90's. For this study into the LOOP as well as into the Balassa-Samuelson proposition, they constructed price indices out of Economist Intelligence Unit (EIU) data covering 165 goods and services in 25 European and 1 Israeli city. The data from the years 1990, 1995, and 1999 was analysed only and evidence of price convergence was found by looking at the overall standard deviations of the price indices. This evidence could imply a negative relationship between initial price level and inflation. To investigate this assumption they presented a cross-country regression that also incorporated other variables influencing inflation like gross domestic product (GDP) growth and the output gap. They found a significant and negative correlation between 1999 price level and current inflation. Evidence for higher inflation levels after a period with lower price levels in a country. A 10 percent lower price level than EU average in 1999 was followed by a 0.5 percent higher inflation rate. The authors saw this as evidence for the catch-up effect that was initiated according to the Balassa-Samuelson proposition.

In a similar paper to that of De Grauwe and Skudelny (2000), Lommatzsch and Tober (2004) found very different results. They used a comprehensive data set containing Harmonised Indices of Consumer Prices (HICP) data, a data set of productivity levels and a dataset with unit labour costs levels. By analysing this data, the authors did not found any link between productivity growth and inflation in prices of services and other non-tradable goods. A word of caution must be made concerning the amount of countries the authors analysed. Only data of the 7 richest countries in Europe was analysed and for a relatively short time frame covering only 10 years.

Maier (2004) did research into the inflationary effects that would emerge due to convergence of tradable good prices. He also looked at what kind of inflation developments countries would experience when joining the EMU. By looking at disaggregated data he hoped to avoid the main problems that arise when using baskets of goods, like similarity problems and the weight assigned to each individual good in a basket. Consumer Price Index (CPI) data was used in order to calculate the inflationary impact of price convergence. First, products belonging to the tradable sector and to the non-tradable were categorised. This was done on the grounds of earlier work by Rogers (2001) and Yan (2002). Then he simulated inflation rates of the new EU members by converting CPI data to the established EU-area average and found inflation differentials of around 1.5 to 3 percent. By undertaking several robustness checks, he concluded that his results were surprisingly robust and that the inflation differentials have a negligible impact on the established EU. Finally, he recommended that price levels of new member countries have to adjust (via exchange rates) to EU average before entering the EMU as this would restrain domestic inflation. He therefore argued that new countries should not join the EMU too early. It is important however to notice that the author used a relatively short period of time (7 years) and in addition to this did not used profound statistical methods. This makes it somewhat hard to rely to the relevance of his work.

Égert (2008) did research into differences in price levels and inflation among EU members. Based on HICP data of developed and less-developed EU countries he tried to find the link between price level differences, inflation and the Balassa-Samuelson proposition. By quantifying the share of services in HICP data he calculated the so-called imputed Balassa-Samuelson effect using productivity growth figures of 15 manufacturing sectors between 1995 and 2005. He found a small Balassa-Samuelson effect for emerging Europe even though these countries experienced high productivity gains in the manufacturing sector. This was due to a low share of non-tradable goods and services in the overall HICP inflation basket (impact was less visible). Other reasons the author gave for this were the weak link between productivity gains and wages in the tradable sector and the incomplete equalisation of wages across sectors. The low visibility of the Balassa-Samuelson effect was also due to the low quality and reputation of low-income country goods. At the same time, price level convergence could occur thanks to changes in tradable and regulated prices. He argued that price level convergence does not necessarily show in inflation rates and that higher inflation rates do not automatically imply price level convergence.

For instance, a lower exchange rate pass-through yields stronger relative price level adjustments with less impact on inflation. Also, different weights of goods in the HICP data due to differences in economic development could imply differing inflation rates but similar effects on the price level.

Some similarity to the paper of Funke and Koske (2008)[10] and to that of Dreger et al. (2008) was found in the fact that both investigated the effect of extending the EU on price convergence. Differences lie in how the data they used was analysed. Dreger et al. investigated the strength of the competition effect (LOOP) and the catch-up effect (Balassa-Samuelson) by analysing Comparative Price Levels (CPL) data from the Eurostat's comparison database. They analysed different control variables, the first one was the catch-up effect variable which measures the catch-up in income per capita, the second one was the competition effect variable which is an indicator of the trade openness in a country. They used a panel framework to investigate whether price convergence has occurred during the years 1999 to 2005 and across different countries and markets. The fact that they did not use any uni-variate time series was due to the short time period of the data. Evidence of price convergence in certain variables was searched for by means of Beta and Sigma convergence. The Beta convergence test hopes to identify a negative relationship between the inflation rate and the initial price level in a country. Sigma convergence looks for evidence of narrowing price dispersion rates among countries and markets measured by the standard deviation. It implies narrowing income per capita across countries. Beta convergence is established when a negative relation is found between the initial price level and subsequent price increases. The initial CPL level explains subsequent changes in the CPL. Equation 2.10 measure Beta convergence in which the initial CPL is used to explain subsequent changes in the CPL measure, α is a term that captures fixed effects and μ captures the error term.

$$\Delta CPL_{i,t} = \alpha_i - \beta_i CPL_{i,t-1} + \mu_{i,t} \quad (2.10)$$

$$\lambda = -\ln(1-\beta_i) \quad (2.11)$$

$$t^* = -(\ln 0.5)/\lambda \quad (2.12)$$

[10] This paper was discussed in the previous section.

The speed of convergence was calculated as in (2.11) where β_i is coefficient of the variable CPL. The half-life of shock is t^* and measured in years as in (2.12), the half-life indicates how long it takes for the effect of a unit shock to diminish by 50 percent. Sigma convergence was investigated by looking the sign and significance of the slope coefficient in the CPL dispersion regression. By means of a panel regression covering 41 goods and 3 different panels (the EU-25, EU-15 and the 10 new EU members) evidence of Beta as well as Sigma convergence was found. Especially the evidence for Beta-convergence turned out to be strong. This implies that countries with initial low prices tend to have a relative high growth in price levels. This is evidence of the catch-up effect. The authors found that each year 7 percent of price differential is removed for the EU-15 countries each year, whereas the new members had a convergence speed level of 6.7 percent. Overall convergence was slow with half-life of around 11.4 years for all 27-EU members. For the EU-10 the half-life of approximately 10 years, was faster (conflicting with the results of Funke and Koske, 2008). The main reason the authors gave for this slow level of price convergence was that although the enhanced competition among countries causes prices to fall, the catch-up effect causes an upward trend in prices of low-income countries and creates higher inflation in those countries. Both effects seemed to cancel each other out.

Although some studies did indeed find evidence of the Balassa-Samuelson hypothesis, its magnitude is mostly rather small. This is mostly due to incomplete equalisation of wages across sectors, the short time period investigated or the unsatisfying amount of non-tradable good price data available. This provides research opportunities for further studies.

2.2.3 Price convergence

In another paper by Engel and Rogers (2004) the authors investigated whether the introduction of the euro led to further price convergence among EMU members. They expected exchange rate volatility to have a negative impact on price convergence. By using absolute Economist Intelligence Unit price data (EIU) covering 1990 to 2003 for 101 goods from 18 countries they found that although there is evidence of price convergence up to 1999, no evidence was found for it after that period. They measured price dispersion as the mean squared error of relative log prices and found that price convergence was initiated by market changes and therefore not by the introduction of the euro as a common currency. The decline in price dispersion for non-tradable goods was stronger than for tradable goods. This suggests some evidence of the Balassa-Samuelsson proposition at least for the first half of the 90's.

An important matter concerning these conclusions is the fact that they were not built upon any model. For that reason, they also did an analysis based on a regression model that included taxes, mark-up, wage and transportation costs differences. Nevertheless, their conclusion remained unchanged. The effect of the introduction of the euro was quite simply not visible. This might be due to the short period. Therefore, further research should be done in this field. They finally claimed that it is not the process of adapting the euro that initiates price convergence but more so the commitment of harmonisation of monetary policies, which was done in an earlier stage starting by initiating the Maastricht convention.

Camarrero, Esteve and Tamarit (2000) examined price convergence and inflation between Italy, Spain and the United Kingdom compared to EU respectively Germany. By means of a unit root test they analysed price data covering the 1980 to 1994 period. They found some evidence of the catch-up effect however, they did not find evidence of full convergence.

Cecchetti, Mark and Sonora (2002) analysed CPI data of 19 US cities between 1918 and 1995 and hoped to find evidence of price level convergence among those cities. By means of panel unit-root test they investigated whether prices in different cities converge to a steady state value. If this is not the case prices follow a random path. The first uni-variate[11] test showed that there was no evidence of rejecting the unit root hypothesis when series are examined individually. Due to the low power of uni-variate tests Cecchetti, Mark and Sonora performed a panel unit root test making use of two separate procedures, the first one of Levin and Lin (1992) and the second one derived by Im, Perasan and Shin (2003)[12]. Both tests allowed them to reject the null hypothesis of no convergence. The speed of the half-life was approximately 9 years. This rather slow process of price convergence was explained by three factors being transportation costs, nonlinearities, and presence of non-traded goods in the database.

Lutz (2004) examined whether the EMU has led to diminishing price dispersion among its members. He looked at four different data sets of good prices; the price of Big Mac in the EU countries, the price of the magazine The Economist, the prices of cars, and the prices of some goods and services from a publication by the Swiss bank UBS.

[11] Uni-variate tests look at the price convergence properties of a good in a country relative to a chosen numeraire country.

[12] This test is differs from the one of Levin and Lin in way it treats the β, the Im, Perasan and Shin test allows for heterogeneity across the individual β_i's whereas Levin and Lin calculates a common panel β.

Data ranging between the year 1970 to 2001. The results of this study suggest that the common currency has had little impact on price convergence so far. Engels and Rogers (2004) came to similar conclusions.

Maier and Cavelaars (2004) did similar research into inflation differentials and price convergence as did Maier (2004) for Germany after their reunification. However, this time, they analysed more elaborately by means of a model that contained not only downward wage rigidity but also incorporated differences in country size, they found clear evidence for price convergence for the period 1991 to 2002 with almost full convergence after 5 years. Both differences in wage rigidity as in country size caused asymmetric price adjustments. Moreover, they concluded that price convergence is much faster for tradable goods than for non-tradable goods.

Gil-Pareja and Sosvilla-Rivero (2004) researched price convergence in the EU using HICP data covering the period of 1975 to 1995. For their analysis, they used the Levin and Lin (1992) regression model given by (see equation 2.8) a model testing for a unit root in the data. Out of 25 cases, 17 cases showed evidence of price convergence. Overall half-life found was about 10 years. For non-tradable goods no evidence of price convergence was found, neither for goods that are subjected to special taxes or regulations (like tobacco and alcoholic drinks).

Faber and Stokman wrote two papers about price convergence in the European Union. The first one written in 2004 looks at price convergence from a macro economic perspective. They analysed transformed HICP data in combination with CPI data in order to get absolute price levels for goods and services dating from the 1960 to 2003. As a measure of price dispersion they used the standard deviation. For their statistical analysis they did an Augmented Dickey-Fuller unit root test[13] and looked at several other variables that might explain price convergence by means of a regression. These variables were GDP per head in PPP, tax level, the countries openness and the countries business cycle position. They found strong evidence of price convergence between the 60's and the 90's. Furthermore, they concluded that price dispersions within EMU until the year 2003 was higher than within the old Deutsche mark zone suggesting further price convergence was possible. Price dispersions since the start of EMU did not decrease substantially in comparison with pre-1999 years.

[13] Explained in Chapter 4.

Therefore, consequences of monetary policy seemed limited. Their overall conclusion was that convergence of prices is expected for countries joining the EU.

In 2005, Faber and Stokman did a similar research in order to find some proof of price convergence in Europe, this time for a shorter period. As before, the authors combined HICP data with CPI data for all EU countries and transformed them into absolute price levels taking 1999 as a benchmark for the 1980-2003 period. In order to measure price convergence they calculated dispersion rates for each good in a country by a method known as the coefficient of variation. They found that tradable goods had lower price dispersion levels than non-tradable goods. Furthermore, price dispersion rates were highest for goods like alcoholic drinks and tobacco. Non-tradable showed no sign of convergence after the beginning of the 90's whereas tradable goods like furniture, food and clothing have had significant drops in price differences in the 1980-2003 period.

In 2006, Wolszack-Derlacz investigated price disparity in the European Union in the 1990 to 2005 time period. Actual price data of 148 products in 15 European cities was taken from Economist Intelligence Unit database and was used to analyse price convergence. By means of the Sigma convergence method dispersion of prices was investigated by analysing whether or not the standard deviation of prices decline over time. The author found that price dispersion in non-tradable good prices was higher. In addition, she found a significant decrease in price dispersion in the early 90's. Over the whole period the decrease in price dispersion was around 15 percent. By using the method of Beta convergence, the author measured the decrease price dispersion in the absolute log-difference in price data of a country compared to another country. A more statistical way of analysing price convergence (see equation 2.10). The half-life's of shocks turned out to be 2.3 years for all goods, 1.9 years for tradable goods and 4.3 goods for non-tradable goods. In addition to this, the author used the method of Ordinary Least Squares in order to analyse the factors that causes price dispersion. Wolszack-Derlacz indentified differences in distance between cities, income levels, labour costs, value added tax (VAT) rates, exchange rates and trade importance as explanatory variables. The labour cost was included to measure the Balassa-Samuelson effect. Wolszack-Derlacz found that increase in income level and in labour cost differences between countries causes price dispersion to increase.

To summarise, evidence of price convergence seemed mostly prominent for the 1980 to 2001 period and not after that period. Also, tradable good prices showed faster converge than those of non-tradable goods. Based on theories of both the LOOP and the Balassa-Samuelson hypothesis this was expected. Half-life's of shocks of varied between a fast 2 years to a slow 10 years. Results of research into all three subjects have been mixed. Other than findings of for example Gil-Pareja and Sosvilla-Rivero (2008) most evidence of price convergence was found in the pre-euro decades. The LOOP and the Balassa-Samuelson proposition did not hold in most cases due to market imperfections like VAT, mark-up over cost price, stickiness of prices, interventions in the foreign exchange rate market by local governments, transportation costs and other non-linearities. Although most papers find some evidence of price convergences there remains too little conclusive empirical evidence indicating that prices in Europe are converging after the euro introduction in 1999. Something that therefore is worth investigating. A complete overview of all papers discussed and their findings is given in Table 3.

Table 3: Overview of literature and outcomes

Paper	Year	Econometric Method used	Data investigated	Countries / Cities	Goods	Period range	Evidence found	Half-life's of shocks
Engel, Rogers	1996	Regression model	CPI	23	14	1978-1994	against the LOOP	-
Cecchetti, Mark and Sonora	1999	Unit root test	CPI	19	n.s*	1918-1995	price convergence (slow)	9 years
Camarrero, Esteve and Tamarit	2000	Unit root test	CP/ IOP	5	n.s	1980-1994	catch-up effect**	-
De Grauwe and Skudelny	2000	Panel Unit root test	CPI	13	n.s	1970-1995	catch-up effect	-
Rogers, Hufbauer and Wada	2001	Cross-country regressions	EIU	26	165	1990, -95, -99	catch-up effect	-
Lutz	2002	Standard deviation of the logarithm of common-currency prices	EIU	17	n.s	1970-2001	no evidence of price convergence was found	-
Chen and Devereux	2003	Unit root tests	CPI	19	n.s	1918-2000	price convergence tradable good	5 years
Faber and Stokman	2003	ADF panel unit root test	HICP/CPI	17	n.s	1960-2003	price convergence	-
Haskel and Wolf	2003	Mean reversion regression	Abs.IKEA prices	25	100	1995-1998	mean reversion of prices	-
Engel, Rogers	2004	M.S.E of relative log prices & econ. Model	EIU	18	101	1990-2003	price convergence until 1999	about 1 year
Maier	2004	Regression model	Dis.CPI	16	33	1996-2003	catch-up effect	-
Maier and Cavelaars	2004	Inflation differential regression	CPI	6	11	1992-2002	price convergence	5.5 years
Gil-Pareja and Sosvilla-Rivero	2004	ADF panel unit root test	CPI	12	15	1975-1995	price convergence	10 years
Lommatzsch and Tober	2004	Johansen cointegration test	HICP	12	n.s	1991-2001	against the Balassa-Samuelson proposition	-
Faber and Stokman	2005	Coefficient of variation	HICP/CPI	25	n.s	1980-2003	price convergence tradable goods	-
Goldberg and Verboven	2005	Panel Unit root test	Car list prices	5	150	1970-2000	relative LOOP	1.3 years
Wolszczak-Derlacz	2006	Beta and Sigma convergence	EIU	15	148	1990-2005	price convergence	1.9 to 4.3
Egert	2008	Standard deviation of productivity growth	HICP	15	n.s	1995-2005	Balassa-Samuelson	-
Funke and Koske	2008	Panel Unit root test	CPI	27	90	1995-2006	LOOP	2 years
Dreger et al.	2008	Panel regression	CPL	24	41	1999-2005	catch-up effect/ price convergence	10 to 11.4 years
Gil-Pareja and Sosvilla-Rivero	2008	Coefficient of variation	Car prices	12	17	1993-2005	against the LOOP	-

*n.s = not specified

**Catch-up of the prices of goods and services in less developed or new-EU countries

3. THEORY AND HYPOTHESIS

Based on the literature study and empirical evidence presented in the previous chapter, this section will describe the hypothesis to be investigated and the expectations of the results coming from the econometric analysis.

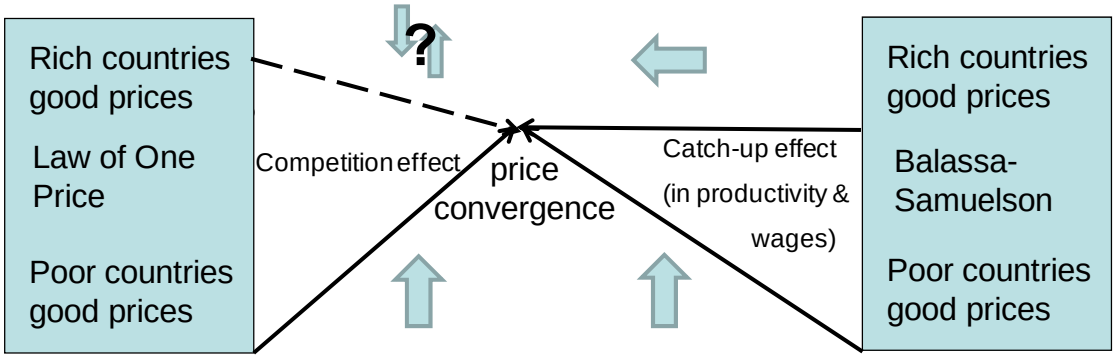
3.1 Theory

The central question of interest in this study is whether price convergence occurs among countries within the enlarged European Union. The enlarged European Union consists of 27 countries of which 12 of them joined the Union after 2004. The most distinct issue that came up when reviewing the literature was that price convergence has mostly been investigated by looking only at the Law of One Price. Although some papers discuss the Balassa-Samuelson theorem briefly, they did not consider it to be of much importance for explaining price convergence. However, the literature review and some of the papers discussed in the previous chapter gave the impression that both theories are important for explaining the process of price convergence. To illustrate this idea, a somewhat simplified conceptual model of the effect of the LOOP and Balassa-Samuelson on price convergence is given in Figure 3. It explains what happens to prices of poor countries once they join some trade union (or the EU). The rich countries could therefore been seen as the established European countries.

The effect of the LOOP is known as the competition effect, the LOOP predicts that once a country opens up to trade, prices will converge to the level of the trading partner countries. This pressure on prices might have a downward effect of good prices in rich countries but will most likely have an upward effect of prices in poorer countries. Therefore, expectations are that once a poor country increases its trade openness (e.g. by changing its legal framework) this will be followed by an increase of the price levels in that country. The Balassa-Samuelson hypothesis predicts that price levels of relatively poor countries will increase due to productivity and wage catch-up relative to other richer countries. This is due to the mobility of labour between the trade and non-tradable good sector. Prices of goods in rich countries are not expected to change due to the Balassa-Samuelson effect. It is important to realise that this is only a simplified model and that price convergence is not only determined by the competition and catch-up effect, nevertheless it gives a prediction of the forces driving price convergence once a relatively poor country joins a trade union that exists of relatively rich countries.

Furthermore, it hopes to illustrate the mutual importance of both theories and effects discussed.

Figure 3: Conceptual model of price convergence mechanisms



3.2 The Hypothesis

The hypothesis that is investigated in this thesis is the following: *The prices of both tradable as well non-tradable goods of countries within the enlarged European Union converge to similar levels in the long run.*

In order to find evidence of price convergence, of the LOOP and of the Balassa-Samuelson proposition, this study examines the prices of 13 product aggregates and 20 individual products included in these aggregates for 27 countries over a 14 year time period. It will look at differences that might exist in the strength of price convergence between tradable and non-tradable goods. It will also identify differences in the strength of price convergence for the pre- and post euro period. Other than looking solely at price convergence of a group of countries (e.g. EU-27, EU-15, EU-12) this study will also look for price convergence in price data of individual countries. The hypothesis will be tested by means of the Levin and Lin panel unit root test. According to the literature this method is the most appropriate one for analysis three-dimensional data covering different goods, countries, and time frames.

Based on the fact that countries which joined the EU after 2004 are in general relatively poorer and have lower price levels than the established EU, and based on the literature study, at least some evidence of price convergence is expected to be found. This is also expected by looking at Figures 1 and 2 of the previous chapters.

According to most previous studies the relative version of the LOOP holds within the EU. Wage costs, productivity, transportation costs, tariffs and taxes determine the price of products.

Overall prices of traded goods seemed to converge within the EU due to the common market, changes in legal framework and due to better infrastructure and communication facilities. Conflicting results are found about the strength of convergence. Some authors find evidence of faster convergence for EU-15 countries compared to the EU-12, other claim the opposite. Evidence of the Balassa-Samuelson proposition to hold is harder to find. According to some authors this is due to slow or incomplete equalisation of wages across sectors, the limited amount of price data available for non-tradable goods and services and the way central banks of new-EU countries manage their exchange rate to keep inflation in good prices low.

The strength of price convergence is hard to estimate due to very different outcomes in previous studies. Half-life of shocks in these studies vary between a relatively fast 2 years to a slow 10 years. Dealing with both tradable (generally shorter half-life) and non-tradable good prices, half-life's of shocks are expected to vary within this range. Expectations are that (in line with other studies) the strength of price convergence will be stronger in the pre-euro period. Due to the relatively short period under investigation, and the other reasons discussed, the effect of the Balassa-Samuelson proposition will be small.

The competition as well as the catch-up effect are measured by means of Ordinary Least Squares. For different products, the impact of variables explaining these effects is measured. These variables have all been identified in previous literature. The competition effect is measured by looking at the relative trade openness of a country compared to EU average trade openness. Expectations are that the more open to trade a relatively poor country becomes has a positive effect on the price levels in that country. The catch-up effect is investigated by analysing the effect on prices of two explanatory variables identified in literature. These are the unit labour cost and the GDP per capita of a country relative to the EU average. A relative increase of these variables should also have positive inflationary impact on prices.

The next chapter will describe the econometric methods and data used for investigation of price convergence, the LOOP and the Balassa-Samuelson proposition. The study uses the latest available data and focuses on a relative large group of tradable and non-tradable goods. In some cases this study will convert from the general classification of tradable and non-tradable goods as known in price convergence literature. No previous study has simultaneously investigated price convergence, the LOOP and the Balassa-Samuelson proposition in this way.

4. ECONOMETRIC MODEL and DATA

This chapter describes the econometric methods and the data used in order to find evidence of price convergence, the effect of the LOOP and the Balassa-Samuelson effect. First, the econometric methodology used to investigate the properties of price data is explained. This study makes use of three techniques; the Augmented Dickey-Fuller test, the Levin and Lin test and the Ordinary Least Squares regression method. In the second part of this chapter a detailed description of the investigated data is given.

4.1 Econometric methodology

In this section, the econometric methods that will be used to analyse price convergence, the LOOP and the Balassa-Samuelson effect are presented. Since the introduction of modern econometric techniques, price convergence has mostly been investigated by means of panel unit root tests. The Augmented Dickey-Fuller test and the Levin and Lin test are such tests and are used in order to investigate price convergence and the half-life's of shocks of different products sold in different countries. In addition to finding evidence of price convergence, this study will also try to explain the effect of the LOOP and the Balassa-Samuelson effect by the analysis of different explanatory variables. The first part of this section explains the basic convergence equations. The technique (Ordinary Least Squares) used to find the effect of the LOOP and Balassa-Samuelson proposition on prices of goods is described in the second part of this section.

4.1.1 The basic price convergence equations

In recent price convergence literature ($\geq$ 1995), researchers started to make use of unit root tests in order to simultaneously investigate price convergence behaviour of price data for numerous countries and products over a period of time. Investigating price convergence implies finding out whether price data converges to a steady state value in the long run. If this is not the case, meaning that the data contains a so-called stochastic or random walk, no convergence path is found and this indicates the presence of a unit root in the price data. Unit root analysis are used to look for random walks in macro-economic data. If some variable (e.g. price) follows a random walk, the effect of a temporary shock (e.g. a sudden in/decrease) will not dissipate after several years but instead will be permanent. If by analysing price data the unit root hypothesis is rejected, a possible shock in data is mean reverting and evidence of price convergence may be found.

The unit root properties of price data can be assessed in two ways. For individual countries good prices, this can be done by means of a uni-variate unit root test. This method looks for evidence of a unit root in good price data in a country relative to some benchmark country. This type of test is called the Augmented Dickey-Fuller test. For a panel of countries unit root properties of price data can be tested by means of the Levin and Lin test, which allows examination of joint behaviour of good prices for a panel dataset.

4.1.2 Augmented Dickey-Fuller test

The Augmented Dickey-Fuller (ADF) test measures whether or not the real exchange rate between two countries (some country x and the bench mark country (EU-27)) is stable. If this is not the case than the relative price of a product in a country wanders apart indefinitely. The overall EU-27 average price data is chosen as the benchmark because it provides a convenient way to compare outcomes and data. Theoretically, the choice of benchmark country should not affect results. The log real exchange rate for a good between some country *k* and the EU-27 aggregate is given by $p_{k,t}$ as in equation 4.1. In which $q_{k,t}$ is the log price of a product in a country *k* at time *t,* and $q_{EU27,t}$ is the log price (expressed in the same currency) of the chosen benchmark country in this case the aggregated EU-27 average.

According to Cecchetti et al. (2002), $p_{k,t}$ can also be written as a (k_i+1)-th ordered autoregression as given in equation 4.2 where α_k is a specific constant, γ_{kj} are the lag coefficients and $\varepsilon_{k,t}$ is the error term. When subtracting $p_{k,t-1}$ from both sides the change in relative price of a good in some period *t* is given by the ADF equation in 4.3.

$$p_{k,t} = q_{k,t} - q_{EU27,t} \tag{4.1}$$

$$p_{k,t} = \alpha_k + \sum_{l=1}^{l+1} \gamma_{kj}\, p_{k,t-l} + \varepsilon_{k,t} \tag{4.2}$$

$$\Delta p_{k,t} = \alpha_k + \beta p_{k,t-1} + \sum_{l=1}^{l-1} \gamma_{kj} \Delta p_{k,t-l} + \varepsilon_{k,t} \tag{4.3}$$

Investigating price convergence for individual countries is interesting because it will show the differences in price convergence for similar products in different countries. Overall price convergence could be due to only one or two countries in the sample. When analysing all products, a complete overview of countries and goods for which the evidence of price convergence is the strongest can be given.

4.1.3 Levin and Lin test

The problem with uni-variate tests such as the ADF test is that they have a low degree of power. This means that is difficult to reject the null hypothesis when in fact it should be rejected. Fortunately, panel unit root tests have a higher degree of power. The Levin and Lin (1992) unit root test looks for a common unit root process in price data for a panel of countries. The Levin and Lin equation for price convergence is given in equation 4.4. In this equation (see 4.5) $\Delta p_{i,k,,t}$ is the dependent variable and the first difference in the log price of good *i* in country *k* relative to the benchmark country (EU-27). Assume $q_{i,k,t}$ to be the log price of a product *i* in country *k* at time *t,* and $p_{i,t,k,}$ (the real exchange rate (see equation 4.6)) to be the log price of the product relative to the benchmark country the EU-27. The dependent variable is therefore a cross-country price differential and measures the differences of a country's prices compared to the EU-27 prices. Therefore, $p_{i,EU27,t}$ equals to 0 for all goods.

$$\Delta p_{i,k,t} = \alpha_{i,k} + \beta p_{i,k,t-1} + \sum_{l=1}^{L} \gamma_l \Delta p_{i,k,t-l} + \varepsilon_{i,k,t} \tag{4.4}$$

$$\Delta p_{i,k,t} = p_{i,k,t} - p_{i,k,t-1} \tag{4.5}$$

$$p_{i,k,t} = q_{i,k,t} - q_{i,EU27,t} \tag{4.6}$$

$\alpha_{i,k,}$ β and γ_l (coefficient of the lags) have to be estimated, $\varepsilon_{i,k,t}$ measures the error term. The parameter that measures the speed of convergence is β. Unit root analysis tests whether the speed of convergence is equal to zero. This implies that a shock in the price of a product is of a permanent nature and therefore no evidence of price convergence is found. Evidence of price convergence implies β to be negative. The constant $\alpha_{i,k}$ captures fixed non-time depending price differences in the price data across countries, such as transportation costs difference, quality differences, or differences in mark-up of goods. The presence of α's indicates that the relative form of LOOP is investigated, large values α's are a sign of market segmentation. The absolute version of the LOOP (not investigated in this study) requires α's to be equal to zero. The price of a good in a country would then equal the price in another country times the exchange rate between these countries. The lags of prices are used to account for serial correlation in the error term.

The test requires choosing the optimal amount of lags. This is done by automatic selection using the Schwarz information criteria. A criteria used for choosing an order for a model in panel analysis[14].

Unit root tests relate the first difference of the log price to the log price in the previous period. The coefficient of the previous period price should be negative since then price differentials become smaller over time (Goldberg and Verboven, 2004). The Levin and Lin test further assumes that there is a common autoregressive parameter β, and does not allow for country specific β*'s*. Unit root tests can be employed to relatively short time series, this as including a limited amount of cross sectional data would significantly improve the power of the test (Funke and Koske, 2008). The half-life of a shock, which measures how long it takes for a shock to make it half-way back to its stationary level is given by equation 4.7.

$$-\ln(2)/\ln(1+\beta) \tag{4.7}$$

For the ADF test as well as for the Levin and Lin test, the null hypothesis is that of an individual/common unit root in the data and the alternative hypothesis is no unit root in the data. The null hypothesis could also be stated as no price convergence versus price convergence in the alternative hypothesis.

The panel unit root tests are carried out on price data for 3 panels of countries (see Appendix 1 for the list of countries belonging to each panel). In order to say something meaningful about the strength of price convergence in the new EU-12 countries, comparative analysis should be done for different groups of countries. The first panel incorporates all 27-EU countries. The strength of price convergence within the established EU is measured by constructing a unit root test for a panel containing the 'old' EU-15 countries. The last panel is composed of the 12 countries that joined the EU after 2004. The outcome of the panel analysis will give insight into possible differences that exist in evidence of price convergence over the three panels.

[14] The optimal lag can also be found by experimenting e.g. by choosing 5 lags and estimate the equation, if the t-values for $\gamma 5$ is less than 1.96 the excises has to be redone with 4 lags and continued until the number of lags is found for which the γ has a t-value of 1.96 or higher.

4.1.4 The impact of the competition effect and the catch-up effect on prices

Literature on both the LOOP as well as on the Balassa-Samuelson proposition suggests a couple of key indicator variables that explain price convergence. Therefore by means of Ordinary Least Squares (OLS), the relative price of a product can be estimated by looking at different variables that explain the price and the inflation of prices. OLS is a method of finding regression parameters and applying the linear model. The OLS model as given in (4.8) allows testing the contribution of different variables that explain price inflation. The relative price is calculated as the price of a good divided by the EU-27 average price of that same good.

$$\Pr_{i,k,t} = c + \beta_1 * \Pr_{i,k,t-1} + \beta_2 * Tax_{k,t-1} + \beta_3 * ULC_{k,t-1} + \beta_4 * GDPpc_{k,t-1} + \beta_5 * TO_{k,t-1} \quad (4.8)$$

The variables incorporated into regression are the lag of the relative price *(Pr)*, and the lags of the change in relative tax rate *(Tax)*, unit labour costs *(ULC)*, GDP per capita *(GDPpc)* and the trade openness relative to EU-27 average *(TO)*. The regression is carried out for all aggregated good categories in different countries (to be specified) for which the ADF test rejected the unit root hypothesis. This is because the rejection of the unit root hypothesis implies price convergence, and therefore a trend in the dispersion of price data for that country should be visible. Increases in the relative value of the variables should have similar effects on different goods (tradable and non-tradable).

The variable selected to explain the effect of the LOOP in price data is the trade openness variable. The Balassa-Samuelson theory or the catch-up effect will be examined by looking at the effect of changes in the country's GDP per capita and in changes of the unit labour cost relative to the EU-27 average. Control variables are the lagged relative price of the given good as well as change the relative taxation rate on goods. The lag of the relative price is incorporated as it explains a large part of the price in current period. Although frequently mentioned in other studies, distance is not taken as a variable into the regression, because it would always remain constant. All data used is taken from the Eurostat database.

The relative change in taxation rates to the EU-27 is included as a control variable. It is not included to explain the effect of either the LOOP or the Balassa-Samuelson effect, but the literature identified it as an important factor that should explain price differences. A positive change in the relative tax rate on consumption should lead to a positive change in the relative price of a good. The effect of this variable should be similar independent from whether developed or relatively undeveloped country price data are examined.

As a measure of trade intensity or openness to trade, a widely accepted measure from Sachs and Warner (1997) is used. This measure calculates global openness as the sum of exports plus imports divided by the GDP of a country. Trade openness is the variable closest linked to the LOOP. A positive relationship between the price of a good in some country and openness to trade of this country should exist, meaning that the more open a country is the higher its price level will be. This is based on the idea that rich countries (having high price levels) are generally more open countries. The openness indicator should therefore partly explain increases in price inflation. A rise in the openness of a country has different implications for richer and poorer countries. Once poorer countries become more open, prices are expected to rise due to the competition effect. For the established richer EU countries, becoming more open implies more pressure on their relatively high prices, which could be followed by a price decline.

The unit labour costs (ULC) measure the average cost of labour per unit of output relative to EU-27 average. It provides a link between productivity and cost of labour. All ULC's are adjusted for exchange rate difference to provide comparable measurement over different countries. The Balassa-Samuelson proposition predicts that non-tradable good prices of countries that are in the process of catching-up increase with the increase of productivity and wages. Both of these factors are incorporated into the calculations of this variable. An increase in relative ULC should be followed by an increase in prices and therefore the effect of an increase of the ULC on the relative price is expected to be positive. Increasing ULC would also make production cost higher in relatively rich countries and therefore the price effect should also be positive.

According to the previous literature (e.g. Rogers (2007), Faber and Stokman (2004)), the GDP per capita of a country can also be used as a measure of production cost. This is based on the idea that relative prices are determined by income levels (richer countries have higher price levels). Once production costs and therefore wages increase in a country the Balassa-Samuelson proposition predicts that this will positively affect the prices of non-tradable goods as well. GDP expressed in PPP's is divided by the number of inhabitants in each country, resulting in real expenditure per inhabitant. PPP's are used in order to account for exchange rate disturbances and therefore can be used as an indicator of the relative standard of living. The issues with using GDP per capita expressed in PPP is that the growth rates do not reflect real growth, since PPP's are somewhat subjective and the expenditures are expressed in common current prices.

It is however a useful variable when expressed as an index in per capita terms and is therefore incorporated into the model as a second variable that explains the Balassa-Samuelson effect. An increase in relative GDP per capita of a relatively poor country should also have a positive impact of the relative price of a good in that country.

The regression is carried out for all goods and a couple of countries for which the ADF test rejected the unit root hypothesis. This is because the rejection of the unit root hypothesis implies price convergence, and therefore a trend in the dispersion of price data for that country should be visible. Analysing the results from the regression is difficult as each variable can have a different effect on a good (tradable or non-tradable) in a different country (rich or relatively poor).

4.2 Data description

The first part of this section describes the data that is used to investigate price convergence with the ADF and Levin and Lin unit root test. This data is also used to construct the dependent variable (the relative price) for the OLS regression. The second part explains the categorisation of goods into tradable and non-tradable goods.

4.2.1 The dependent variable

In order to investigate price convergence, the LOOP and the Balassa-Samuelson proposition a large three-dimensional database is constructed. Containing transformed monthly Harmonised Indices of Consumer Prices (HICP) data for the 27 EU countries of both tradable as non-tradable products for the period 1996m01 to 2009m11. The converted price indices form the basis to construct the dependent variable of both the unit root tests and the OLS test.

The disaggregated level HICP data used provides a cross-country comparable measurement of consumer good price inflation. There are some limitations to the use of HICP data for price convergence analysing purposes. Cross-country products are generally not homogeneous, which makes compliance with the absolute LOOP hard since individual products as well as basket of goods are not homogeneous. Nevertheless, research into the relative version of the LOOP does not require the products to be identical between different countries, as long as the importance of factors explaining price dispersion does not change much over the sample period (Goldberg and Verboven, 2004).

It can also occur that the products that make up a basket of goods change with the years. The main problem with HICP data is that it is an index and that although it can very well be used, for price convergence analysis absolute price data would be preferable.

The HICP data provided by Eurostat[15] gives the monthly inflation in prices relative to some base year of different goods covering a 14 years period. This data, however, does not provide insight into differences in absolute or relative prices between these countries. In order to provide data of relative prices, HICP are converted by using Eurostat's Comparison Price Level (CPL) program. CPL's are PPP prices divided by the nominal exchange rate. This provides price data of different goods in different countries relative to the EU-27 average.

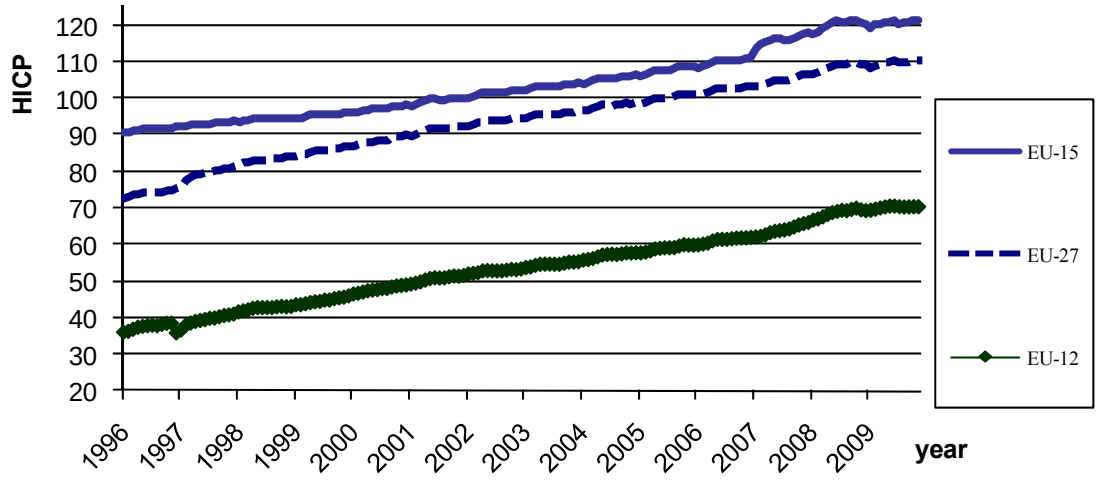
From the Eurostat website, "*PPP's are currency conversion rates that convert economic indicators expressed in national currencies to a common currency, which equalises the purchasing power of different national currencies and thus allows meaningful comparison.*"

The CPL of a product is its cost in one country, specified as a percentage of its cost in another country, when prices are expressed in the common currency. CPL's are measured in terms of indices. The index of the reference country (the EU-27 average) is set equal to 100 for each year. By combining this CPL data with the HICP data a new dataset is constructed containing comparable prices indexes for all different products and product groups relative to the EU-27 average. An example of the way the data is converted is given for the product Meat in Appendix 2. This is done by setting the HICP data in the year 2005 for the EU-27 average to be equal to 100 and dividing each of the HICP data of the other countries by this figure. This gives a relative HICP figure for each country compared to the EU-27. By multiplying this figure by the country CPL value we get an index reflecting inflation figures of absolute prices. The monthly inflation rates are transferred onto these figures to give monthly converted HICP data. Since CPL data is adjusted for exchange rate differences, exchange rates are not taken into consideration as an exogenous variable when performing the econometric analysis. One should note that the inflation rates of good prices remain unaltered after converting the data. For comparison purposes this newly create dataset provides a more complete and realistic overview of differences in prices. The price data now reflects relative prices of goods compared to EU-27.

[15] http://epp.eurostat.ec.europa.eu

The HICP dataset contains data of more than 100 products that are categorised into 12 different aggregated product groups and 1 product group covering all HICP products (see Appendix 3). From each group, two disaggregated products are taken as a measure of control in order to give insight into differences between tradable and non-tradable goods (Appendix 3). Figure 4 illustrates the converted HICP figures for the All-items aggregate price data.

Figure 4: Converted HICP data for the 'All-items' aggregated good (EU-27 = 100 in 2005)



4.2.2 Tradable versus non-tradable goods

The difference that might exist in the strength of price convergence between tradable and non-tradable goods will also be investigated in this study. The LOOP is mostly applicable for tradable goods and the Balassa-Samuelson effect should affect the prices of non-tradable goods in poorer countries. It is therefore interesting to examine these differences in more detail. In order to do this, tradable and non-tradable goods have been categorised according to previous literature (e.g. Rogers (2001), Maier (2004), and Faber and Stokman (2004)). In previous studies, there has been some discussion about the accuracy of the classification of certain goods, for example, goods belonging to the good aggregate Alcoholic drinks and Tobacco, labelled as containing non-tradable goods in most studies due to high level of taxes implied on those products. Although realising that the tax rate on these goods are most of the time disproportional high in comparison with other goods, this study controls for tax differences and therefore categorises it as a tradable good (as in Rogers, 2001). In addition, Recreation and Household tools, goods that are normally seen as non-tradable, are categorised as tradable in this study. Recreation incorporates Garden plants and Books (tradable goods) which are considered as tradable goods. The whole list of categories is presented in Appendix 3, Rogers (2001) is followed in most cases.

5. ECONOMETRIC ANALYSIS

The econometric analysis outcomes presented in this chapter give the answers to expectations based upon the literature and empirical research. First, the Augmented Dickey-Fuller unit root test is done to give insight into the unit root properties of individual country goods prices. Second, price convergence of different products in European countries is investigated by means of the Levin and Lin panel unit root test. Differences between individual countries, panels, periods, and between tradable and non-tradable goods are also discussed in this chapter. The last section of this chapter gives the outcome of the Ordinary Least Squares regression capturing the effect of the LOOP and of the Balassa-Samuelson hypothesis in price inflation.

5.1 The Augmented Dickey-Fuller unit root test

To investigate the unit root property of prices of tradable as well as non-tradable products and services in a country, the Augmented Dickey-Fuller (ADF) test is used. For each of the 27 countries, 13 product groups are examined. The ADF test determines whether the country's real exchange rate of a product follows a random walk while the alternative hypothesis is that the data follows a trend and therefore has a mean. The alternative hypothesis suggests a trend in the dispersion rates. Evidence of price convergence is found once a trend of diminishing dispersion rates is established. Theoretically, it can also be the case that dispersion rates are growing in which case the null hypothesis is also rejected.

Table 4 gives an overview of the different goods investigated and the countries for which the unit root is rejected at a 5 percent significance level. Rejection of the unit root hypothesis is evidence for a trend in price differentials, and an indication of price convergence. The different t-values and probabilities belonging to the outcomes of the ADF test are given in Appendix 4. On individual country level, most countries that are part of the EU-15 panel reject the hypothesis of an unit root in the aggregated price data. Among the 12 newcomers, only Bulgaria and Romania rejected the null hypothesis for a majority of good aggregates. These countries show a fast decrease in price dispersion figures in the 1996-2000 period as illustrated for Romania, Germany, and Latvia in Figure 5 for the good aggregate Food. For Germany, the dispersion of the price of Food compared to EU-27 decrease to almost zero at the end of 2009. This is in line with recent drop in price level in Germany. In Appendix 5 more countries for which the ADF either accepted or rejected the unit root hypothesis in the price data of Food are given.

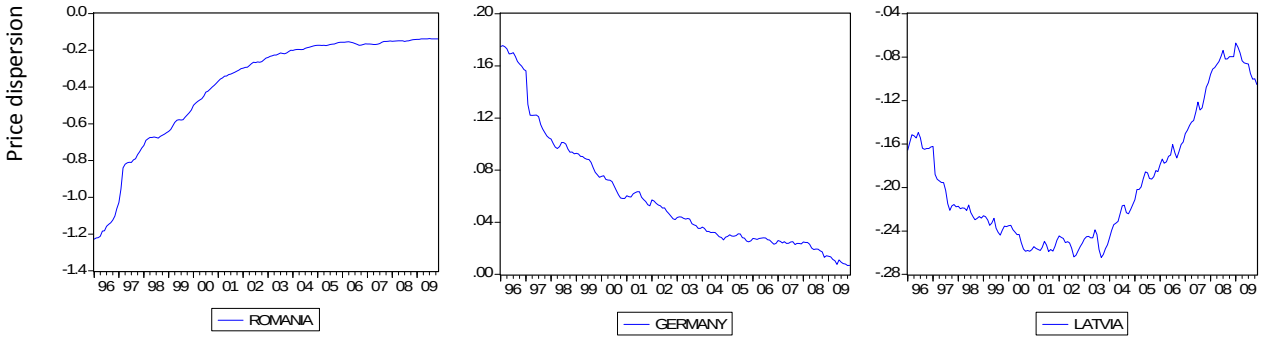
Other than for the EU-12 countries, most of the EU-15 countries reject the null hypothesis, this is a sign that price levels in these countries are less sensitive to variables that cause shocks to prices (e.g. exchange rates). It also suggests a strong link between integration and price convergence in international markets. For Food, about 80 percent of the EU-15 countries rejected the null hypothesis whereas for the EU-12 this was only about 40 percent. Only Ireland showed no sign of a trend in its price data at all. This is in line with research of Sosvilla-Rivera and Gil Pareja (2004) in which they excluded Ireland from their analysis as they considered it an outlier. Among the twelve new EU members, only the members that joined the EU recently show evidence of convergence of the real exchange rate for most products.

Table 4: Results of the Augmented Dickey-Fuller unit root test

Country		All items	Food	Alcoholic beverages	Clothing and footwear	Housing	Household equipment	Health	Transport	Communicatio	Recreation	Education	Hotels and restaurants	Miscellaneous goods
Austria	EU-15	*	*		*	*	*	*			*		*	*
Belgium	EU-15	*	*		*		*	*					*	*
Denmark	EU-15	*	*		*			*			*		*	
Finland	EU-15		*		*	*	*	*						*
France	EU-15	*	*		*	*	*	*		*		*	*	*
Germany	EU-15	*	*	*	*	*	*	*	*	*				*
Greece	EU-15		*	*				*	*			*	*	
Ireland	EU-15													
Italia	EU-15	*	*			*		*	*				*	
Luxembourg	EU-15	*	*	*				*	*				*	*
Netherlands	EU-15			*	*		*	*	*		*		*	
Portugal	EU-15	*			*	*		*					*	
Spain	EU-15		*	*		*		*						
Sweden	EU-15	*	*		*			*	*		*		*	
United Kingdom	EU-15	*	*		*		*	*		*			*	
Bulgaria	EU-12	*	*	*		*	*	*	*	*	*	*	*	*
Cyprus	EU-12	*						*						
Czech Republic	EU-12	*								*				
Estonia	EU-12									*		*	*	
Hungary	EU-12			*	*				*		*			*
Latvia	EU-12									*				
Lithuania	EU-12						*		*	*				
Malta	EU-12	*					*	*				*		*
Poland	EU-12		*	*					*					*
Romania	EU-12	*	*	*	*	*	*	*	*	*	*		*	*
Slovakia	EU-12		*											
Slovenia	EU-12								*			*		

* - unit root rejection at 5% significance level

Figure 5: Price dispersion of the aggregate good Food relative to EU-27 average price



The real exchange rate of the good Food in Latvia follows a random path (not completely obvious from Figure 5) and is therefore strongly vulnerable to shocks. Appendix 5 shows the change in dispersion rates for more countries. Rejection of the unit root hypothesis is valid for most of good aggregates for the EU-15 countries. This is of interest as it suggests that prices within the EU-15 are also converging to some long run value. Since real exchange rate of the price of Food in e.g., Germany compared to EU-27 is diminishing, this could mean that converting to the lowest prices is a plausible assumption. Especially because at individual country level most new coming countries do not show sign of a trend in the dispersion rates. It is however a generally accepted idea that prices in the established EU do not decrease when new countries become members of the EU. This is due to the low economic weight attached to these new countries. If the EU-27 average inflation in prices keeps increasing due to inflation in the prices of the EU-12 members, and the stable and decreasing trend in relative price level found in most EU-15 countries continues in the future it could be argued that the enlargement of the EU does impact prices in the established countries. This is in contradiction with result found in previous studies (e.g. Maier, 2004).

Although it is interesting to see how real exchange rates change over the years for individual countries, it is more informative to analyse price dispersion of goods for a panel of countries. This is done in order to find out whether countries follow similar convergence paths. This appears in the next section. By analysing the ADF test results it became clear that Romania and Bulgaria could have a significant impact on the level of price convergence of the EU-12 aggregates. Therefore, when performing the Levin and Lin test these countries should also be considered as outliers.

5.2 Levin and Lin unit root test

The Levin and Lin test is done for four panels of countries covering all products and product aggregates. As mentioned before, the ADF test shows the importance of Romania and Bulgaria in the sample and that is why an extra panel is included (EU-10) that does not incorporate these countries (outliers).

By analysing the differences that might exists between these panels the impact of joining the EU on countries can be captured. The differences that exist in the strength of price convergence of tradable versus non-tradable goods is also examined. To account for possible price effects of the introduction of the euro, the Levin and Lin test is also applied to the 13 product aggregate prices controlling for the pre- and post euro introduction period. In addition to this, for the EU-12 and EU-10 countries the impact of joining the EU is isolated by controlling for the pre- and post 2004 period.

5.2.1 Price convergence

Table 5 shows the half-life's of shocks of product prices for the different panels for which the unit root hypothesis is rejected at a 5% significance level. These are the products for which in the long run their relative price converge to some steady state value. The results belonging t-values and probabilities of the All-items aggregate is given in Appendix 6.

For the EU-27 panel, the hypothesis of an unit root in the price data is rejected for almost all goods. The aggregates Clothing and footwear as well as the individual goods Clothing and Footwear show however evidence of a unit root in the price data. This is also the case for Furniture, Pharmaceutical products and Garden plants price data, for which the unit root hypothesis is not rejected. This matches with the findings of Faber and Stokman (2005) who found that some tradable goods like Furniture, Clothing, and Footwear showed significant drops in price dispersion, and therefore already converged, in the period from 1980 to 2003. The All-items good aggregate speed of convergence[16] is approximately 24 percent per year with a half-life of 2.1 years, which is surprisingly in line with those found in previous literature (e.g., Funke and Koske (2008) or Wolszack-Derlacz (2006).

[16] The speed of convergence = (0.5/half-life in years)*100%

Table 5: Half-life's of shocks found by using the Levin and Lin panel unit root test

Product	EU-27	pre-€	post-€	EU-15	pre-€	post-€	EU-12	pre-€	post-€	pre-2004	post-2004	EU-10	pre-2004	post-2004
All items	2.1	1.6	2.6	2.1	2.8	2.5	4.9	0.9	2.7	3.3	4.3	5.0	3.2	3.8
01 Food	2.6	1.5	2.9	2.1	1.6	3.3	3.5	1.2	2.8	2.7	2.8	3.6	2.6	2.8
Meat	2.5			2.0										
Fruits	0.9						0.8					0.9		
02 Alcoholic beverages&tobacco	3.9	1.8	4.8	4.1	2.6		3.9	1.1		2.8		4.1	3.4	
Wine	3.8			4.4			3.5					3.6		
Tobacco	4.6						3.3					3.1		
03 Clothing and footwear		1.4			0.9			2.5		2.0			2.5	
Clothing														
Footwear														
04 Housing	3.7	3.4	4.3	3.7			3.7	1.4	3.8	2.4		5.8	2.9	
Water supply	5.2			7.0			3.6					6.0		
Electricity	3.7			5.4			1.7					2.4		
05 Household equipment	5.0		6.2	2.4	1.4				6.6		3.2	10.2		
Furniture				4.6								6.7		
Household tools	3.3			7.8			2.0					2.6		
06 Health	2.8	1.8		2.5	0.9		4.2			3.0			3.6	
Pharmaceutical products														
Dental services	3.8			1.7			5.0							
07 Transport	2.5	2.4	2.2	2.1	2.3	1.4	2.8		2.6	2.7		3.1	3.1	
Personal transport equipment	1.5			1.5			1.5					2.0		
Transport services	2.8						2.8							
08 Communication	3.0		1.9	3.3			2.8		1.7	2.4	1.1	3.6	3.0	1.1
Postal services	2.4						2.0					2.3		
Telephone services	6.1						5.2					4.4		
09 Recreation	3.4	1.8	3.2		0.9		3.1	2.3	2.8	2.3	1.7	3.9	2.4	1.2
Garden plants														
Books	3.7			2.6			4.2							
10 Education	3.2			4.0			2.4			1.4		3.4	1.6	
11 Restaurants	3.5	1.9	3.9	2.1	2.6		4.4	1.7		2.2		5.8	2.2	
Restaurants and cafes	4.1			8.6			2.8					9.4		
Accommodation services	1.5						1.7					3.8		
12 Miscellaneous goods	3.5	2.7	2.3	2.9	2.8	2.7	4.0	2.6	2.2	3.3		3.6	2.8	
Jewellery	4.3						2.5							
Insurance	3.7			3.9			3.1					2.6		

Only the half-life's that are significant at a 5 percent level are shown

Comparing the rejection rate of the unit root hypothesis for goods in the EU-15 panel to those of the EU-12 panel indicates that for the EU-15 countries less evidence of price convergence is found, especially for the post-euro introduction period. This is in contrast to the findings of the ADF test that show that on individual country level, EU-15 countries show more sign of convergence. This finding matches with the expectations of no price convergence for the EU-15 panel after the euro introduction period. Nevertheless, the speed of convergence for the All-items aggregate covering the whole period for the EU-15 panel and for the EU-27 panel is 24 percent.

More surprisingly is that the half-life of shock for the good aggregate All-items within the EU-12 turns out to be the slowest with 4.9 years, implying a slow speed of convergence of 10 percent each year. Only the data of Meat, the aggregate Clothing and footwear, the goods Clothing, Footwear, Furniture, Pharmaceutical products and Garden plants show sign of a unit root in the price data. Half-life's of shocks of good prices range from a fast 0.8 year for Fruits to a relatively slow 5.2 years for Telephone services. Although the speed of price convergence is slower for almost all goods, there is price convergence found for almost every good and good aggregate. It confirms the idea that countries being in the process of catching-up in price levels and opening up to trade, experience price convergence.

As expected from the ADF test, results change when Bulgaria and Romania are excluded from the analysis. Although evidence of price convergence is found for a majority of products and product aggregates, half-life's become much slower than those of the EU-12 panel. As a striking example of this is found for the good Restaurants and cafes with a half-life of shock exceeding that of the EU-12 by 6.6 years. Therefore, it is safe to conclude that the countries that joined the EU the latest (Bulgaria and Romania) have a severe impact on the speed level of convergence.

A couple of reasons can explain the slow speed of convergence of prices in the EU-12 compared to those in the EU-15. The first one is that price convergence of the countries that joined the EU before Romania and Bulgaria started the convergence of their prices before 1996. This means that price convergence starts as early as 10 years before joining the EU with its fastest level of convergence in the first couple of years.[17] This could be proven by looking at price data of countries that are on the EU membership waiting list. After initial fast catch-up, limitations in access to information devices, communication, transportation facilities and quality of the products produced might formed a bottleneck into full or further convergence to the EU-27 prices. Also, protectionism of industries, non-tariff trade barriers (e.g. quality or environmental regulations) and even changes in legal frameworks, of trading partner countries may play a role in this phenomenon. Due to the lack of data this cannot be verified in this study. The most likely reason is interventions of local governments on the foreign exchange rate market, that cause short-term adjustment affecting the real exchange rate are used to control inflation levels. This in order to keep inflation of prices low and to be able to fulfil the Maastricht criteria so that entering the EU was possible.

[17] This result is in line with results found of Camarrero et al. (2000), Lutz (2004), and Engel and Rogers (2004).

5.2.2 The effect of the introduction of the euro and joining the EU

In order to explain differences in price convergence that might exist due to euro introduction, the pre-and post euro introduction period are analysed for 13 product aggregates. Compared to the post-euro introduction period, for practically all product groups, shorter half-life's are found in the pre-euro time period (1996m01- 1998m12). For the aggregate All-items, the half-life's for the EU-27, EU-15 and EU-12 are respectively 1.6, 2.8 and 0.9 years. For the post-euro introduction period, they are respectively 2.6, 2.5 and 2.7 years. This implies that countries had started their convergence processes before the actual introduction of the euro. The EU-15 show similar speed of convergence (around 19 percent) over both periods. Agreeing with Engel and Rogers (2004) it seems that adaption of the euro is not the only reason for price convergence, but it is the commitment of harmonisation of monetary policies in an earlier stage that initiates it. Nevertheless, the relative version of the LOOP seems to hold. This is evidence of good market arbitrage enforcing equality in prices across a sufficient range of individual goods.

When analysing the differences between the pre-2004 and the post-2004 period for the EU-12 and EU-10 countries, similar results are found. Although the differences in speed of convergence of goods in these two time periods are smaller than those in the pre- and post 1999 periods, price convergence is faster in pre-2004 EU joining period. This is in line with the previous finding of the fastest level of convergence in the pre-euro period. Overall, this study proves that price convergence is an ongoing process. Not only for the 12 new-member countries but also for the established EU-15 countries. Possible explanations for this are the ongoing improvements in regulations or legal frameworks, in transportation and in information facilities.

5.2.3 Price convergence of tradable versus non-tradable goods

The differences in the half-life's of shocks that exist between tradable and non-tradable goods are presented in Table 6. For all products in the sample and for the three main panels the fastest and the slowest half-life's of shock are compared. Not surprisingly, and in line with previous findings, the slowest half-life's are found for non-tradable goods and services. This is an indication of the (in literature identified) incomplete pass-through of productivity and wage increases in the tradable sector towards those of the non-tradable goods sector. Since evidence of price convergence is found for most non-tradable goods and services the Balassa-Samuelson hypothesis cannot be rejected on this ground.

However, the slow speed of convergence is in affect a first indication that the Balassa-Samuelson effect may be hard to measure by means of OLS regression. The fact that tradable good prices converge at a faster level is seen as evidence for the LOOP and the competition effect. The categorisation of Household tools as a tradable good leaves room for discussion. Although the half-life of shocks seems fairly in line with those of other half-life's of tradable goods for the EU-27 and EU-10 panel, the half-life of the EU-15 panel shows a deviating value.

Table 6: Half-life's differences between tradable and non-tradable goods and services

		Tradables		Non-tradables	
EU-27	**Fastest**	Fruits	0.9	Accommodation services	1.5
	Slowest	Tobacco	4.6	Telephone services	6.1
EU-15	**Fastest**	Pers.transport eq.	1.5	Dental services	1.7
	Slowest	Household tools	7.8	Restaurant and cafes	8.6
EU-12	**Fastest**	Fruits	0.8	Acc.serv./Electricity	1.7
	Slowest	Books	4.2	Telephone services	5.2

5.3 The competition effect (LOOP) and the catch-up effect (Balassa-Samuelson)

The previous sections proved that price convergence is an ongoing process. Literature into the LOOP and the Balassa-Samuelson identified different variables (explained in Chapter 4) that might explain this process. To measure the impact of different variables on prices of goods that are in the process of converging, the method of Ordinary Least Squares (OLS) is used. Price data of aggregated goods of Romania (see Table 7), Bulgaria, Germany, and France (see Appendix 7) are investigated. These countries are chosen for the reason that they rejected the unit root hypothesis for almost all goods in the ADF test. The dependent variable in the OLS regression is the relative price of a good compared to the EU-27 average price. Although this is a somewhat simplified model, according to the theory there should be some coherence in the way the variables affect prices of different goods (tradable and non-tradable). Expectations are that for non-tradable goods in Romania and Bulgaria, an increase in the relative Unit Labour Costs (ULC) or GDP per capita (which measure the Balassa-Samuelson effect) compared the EU-27 average, would imply an increase in the relative price of this good. An increase in Taxes should make both tradable and non-tradable good prices to increase. The positive impact of increasing the openness to trade in a country, the competition effect, should be more visible in tradable good prices.

The lag of the relative price is as expected the most important variable in explaining the relative price. Including this variable significantly improves the explaining power of the model. However, the part that is not explained by this variable (the inflation of the relative price) should theoretically be explained by the other variables included in the model.

Table 7: The outcome of the OLS regression for Romania

Relative price good	all	Food	Alcohol & Tobacco	Clothing & Footwear	Housing	Household equipment	Health
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.01 **	0.01 **	0.00	0.02 **	0.01 **	0.02 **	0.01 **
Relative price good $_{t-1}$	0.99 **	0.98 **	1.01 **	0.97 **	0.99 **	0.99 **	0.98 **
Δ Taxes	0.00	0.03	-0.01	0.00	-0.02	-0.02 **	0.00
Δ Unit Labour cost	0.00	-0.03	0.01	0.00	0.04	-0.01	-0.02
Δ GDP per capita	-0.02	-0.03	-0.29	0.18	0.08	-0.25 **	-0.11 **
Δ Openness	0.12	0.07	0.45	-0.20	0.13	0.25 **	0.24 **
R-squared	1.00	1.00	1.00	0.98	1.00	1.00	1.00
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Transport	Communication	Recreation	Education	Restaurants	Miscellaneous goods	overall sign
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.01 **	0.03 **	0.01 **	0.00 *	0.01 **	0.01 **	+
Relative price good $_{t-1}$	0.99 **	0.96 **	0.98 **	0.99 **	0.99 **	0.98 **	+
Δ Taxes	0.03	-0.22 **	-0.05	0.01	0.00	0.00	+/-
Δ Unit Labour cost	-0.03	-0.10	0.09	0.01	0.02	-0.01	+
Δ GDP per capita	0.07	0.47	-0.05	-0.05	-0.13	-0.03	-
Δ Openness	0.13	-0.12	0.01	0.11 *	0.16	0.06	+
R-squared	1.00	0.99	1.00	0.99	1.00	1.00	
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	

**** significant at 5% level**
*** significant at 10% level**
Test for Heteroskedasticity: Newey-West

For most product aggregates, no significant relationship between the relative price and any of the other variables exist. Comparing the newcomers Bulgaria and Romania with established EU members France and Germany, differences in the way variables influence the relative prices are visible. For comparison purposes, the influence of the different variables on the relative price of the tradable good Food and the non-tradable good Housing are analysed.

These goods are chosen as the null hypothesis of a unit root in the price data is rejected for all four countries. Appendix 8 shows for each country how the relative prices of these goods behave.

The relative price of Food in Romania is for 98 percent determined by the price of this product in the previous month. A rise of 1 percent in the relative Tax level of Romania causes the relative price of Food to increase with 0.03 percentage points. The parameters of the variables ULC and GDP per capita both have a (unexpected) negative sign. A 1 percent increase in the relative level of both the variables cause the price level of Food to decrease by 0.03 percentage points in the subsequent month. Whereas a 1 percent increase in the relative Openness (although not statically significant) positively affects the relative price of Food by 0.07 percentage points.

The signs of the parameters of the variables that explain the relative price of the non-tradable good Housing are in line with expectations. Only for the variable Taxes, which according to expectations should have a positive sign of the parameter, this is not the case. Although not statistically significant, a 1 percent increase in the relative value of ULC, GDP per capita and Openness has a positive impact on the relative price of Housing of respectively 0.04, 0.08, and 0.13 percent.

It is interesting to see that for the new EU members (Romania and Bulgaria) the variables ULC and GDP per capita have a positive effect on the non-tradable whereas the coefficient is negative for the tradable good. Although the coefficients are not significant, this is in line with the Balassa-Samuelson hypothesis. The Openness variable also has a positive coefficient for the non-tradable good in both countries, its coefficient is however negative for the tradable good in Bulgaria. Appendix 9 gives an overview of how the Openness variable behaves over the years for all of the countries in the sample. Analysing the way the Openness variable evolved over time for Bulgaria did not help in explaining this negative coefficient. Over all goods, increasing the openness to trade in Romania ensures the prices to go up as well. This is in line with the LOOP.

For the established countries, the relative prices are decreasing for both goods. Therefore, the variables should explain the deflation of prices. According to expectations, increases in the relative openness of a country should have a negative impact on tradable good prices in these countries. This, in line with the competition effect, as more pressure is put on these prices. However, this effect is found only for the good Food in France.

For the non-tradable good, the coefficient of the ULC variable is positive. Once more, the coefficients are not significant. Nevertheless, this finding suggests that even within the richer countries there is an ongoing process of pass-through of wages between sectors.

Although tradable goods proved to converge faster than non-tradable goods and the relative version of the LOOP is considered to hold, analysing the results of the OLS regressions showed that evidence of the competition effect is hard to find. For some of the goods the parameter estimates have the expected signs, however in many cases they have not. The lack of explanatory power or statistically significance of the variables is worrying too. One could argue that the period chosen to measure the influence of specific variables on price convergence is too short. Nevertheless, for the goods under investigation, some similarity is found in the way variables react on different goods (tradable and non-tradable). This is especially the case for ULC, which has a positive influence on the prices of non-tradable goods for both Romania and Bulgaria. This could be considered as a weak indication of the Balassa-Samuelson proposition. However, due to the slow level of convergence and the insignificance of the coefficients, this theory remains very hard to prove.

6. CONCLUSIONS

In this thesis, a study into price convergence within the enlarged European Union is presented. The aim of this study is to identify the most important theories and factors that explain the process of price convergence in the enlarged European Union. The central question this thesis answers is: *Do the prices of tradable and non-tradable goods and services within the enlarged European Union converge among its members?* It tries to answer this question by using the latest econometric techniques. The differences between the speed of price convergence of tradable and non-tradable goods have also been identified. In addition to this, possible differences existing in the amount of evidence of price convergence found for products in different time periods are investigated.

From the literature survey, two main theories that explain the process of price convergence were selected. These are the Law of One Price and the Balassa-Samuelson proposition. The Law of One Price (LOOP) predicts that opening up to trade will ensure international price arbitrage and will lead to equalisation of prices of identical goods among different countries. The other theory taken into consideration is the Balassa-Samuelson proposition, the fundamental idea behind this theory is that productivity, wages and therefore price levels are high in wealthy countries. Spill over effects from trade causes productivity and wages to increase in the tradable goods sector of a less wealthy country. Labour mobility between sectors ensures that also wages increase in the non-tradable goods sector of less wealthy countries. This has effect on the prices of goods and services in the non-traded goods sector which increase as well.

The literature and empirical study done in this thesis shows that evidence of the LOOP was found in most studies. Increases in the openness to trade of new European Union countries is the main reason given for prices to converge. Other reasons which are mentioned are improvements in legal frameworks, in transportation facilities and in communication facilities. Although some evidence of the Balassa-Samuelson proposition was found, its magnitude was mostly rather small. This can be attributed to incomplete equalisation of wages across sectors, and the unsatisfying amount of non-tradable good price data available. Evidence of price convergence seemed mostly prominent for period between 1980 and 2001. Tradable good prices show faster convergence than those of non-tradable goods. The overall half-life's of shocks found in previous research varied between a relatively fast 2 years to a slow 10 years.

In this thesis, by means of a unit root tests the process of price convergence in the enlarged European Union is investigated. This is done by using converted Harmonised Indices of Consumer Prices data of both tradable and non-tradable products and services. Within the time period of 14 years (from 1996m01 to 2009m11), evidence of price convergence of both tradable as non-tradable goods is found[18]. Overall half-life's of shocks vary. For the EU-27 and EU-15 panels, half-life of the All-items aggregate good is 2.1 year, for the EU-12 and EU-10 panels they are respectively 4.9 and 5.0 years. The speed of convergence of tradable goods is generally faster than that of non-tradable goods.

The introduction of the euro and the commitment of harmonising monetary policies have had a positive impact on the speed of price convergence. Aggregated goods prices in the pre-euro introduction period have half-life's ranging between 1.4 and 3.4 years whereas in the post-euro period these are significantly slower with a range of 1.9 to 6.2 years. For fewer products evidence of price convergence was found in the post-euro introduction period. In addition, for the EU-12 and EU-10 countries the pre- and post EU entry periods are compared. Results found are similar to those of the pre-euro introduction period. Price convergence was faster in the pre-2004 period with an average half-life of 3.3 compared to 4.4 years for the EU-12 in the post-2004 period. Most of all, the last countries to join the EU, Bulgaria and Romania, showed the strongest evidence of convergence in price levels.

The most important mechanisms that cause price convergence to happen are indentified, not only by looking at evidence of price convergence but also by looking at different variables that explain inflation. Although little evidence of the importance of the variable (trade openness) explaining the LOOP is found, the variables explaining the Balassa-Samuelson effect (unit labour cost and GDP per capita) proved more consistent in the way it influenced prices of the new-EU countries investigated (Bulgaria and Romania). However, other than finding price convergence for most non-tradable goods in the unit root analysis, no strong evidence was found in favour of the Balassa-Samuelson hypothesis[19]. This is due to the incomplete pass-through of productivity and wage improvements into the non-tradable goods sector. Also the relatively short time period may play an important role in this. Both the literature study as well as the econometric analysis lead to the conclusion that the LOOP is the most appropriate to explain the process of price convergence.

[18] Contradicting to findings of e.g. Gil-Pareja and Sosvilla-Rivero (2004).

[19] This is in line with previous finding of studies into the Balassa-Samuelson effect (e.g. Lommatzsch and Tober, 2004).

This study demonstrates that price convergence is an ongoing process. Not only within the new-member countries, but also within the established EU-15 countries. Possible explanations for this are improvements in infrastructure, in the sources to acquire information (e.g. through internet) and in legal frameworks that create an environment that is more open to trade.

The commitment to apply the Maastricht criteria is another important reason for price convergence to occur. It seems that the process of price convergence is initiated well before joining the EU or EMU. For this reason most countries should be able to fulfil the Maastricht inflation criterion before entering. Because of the relatively fast level of convergence found for both tradable and non-tradable goods in the early years of the sample period, influencing inflation levels artificially by interventions on the foreign exchange rate market by central banks should not be necessary in order to create stable inflation rates, only time is required.

Although the use of converted Harmonised Indices of Consumer Prices data for price convergence analysis forms no obstacle in finding meaningful results, it would be better to use absolute price data. Also using the method of Ordinary Least Squares to explain inflation is a simple basic tool. It would be preferable to use more advanced methods like panel unit root tests that incorporate different explanatory variables (for this advanced programming skills are required).

The results of this study also provide possibilities for future study. Due to the ongoing process of price convergence it will be interesting to find out whether in the long run the prices of the EU-15 countries will (due to more competition among these countries) adjust to the price levels of the EU-12 countries. Another question that remains is whether the process of price convergence will continue over the next couple of years.

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8. ABBREVIATIONS and SYMBOLS

8.1 Abbreviations

ADF: Augmented Dickey-Fuller

CP: Consumer Prices

CPI: Consumer Price Index

CPL: Comparative Price Levels

ECB: European Central Bank

EIU: Economist Intelligence Unit

EMU: Economic and Monetary Union, members: from the first of January 1999 Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain. On the first of January 2001 Greece joined and on the first of January 2007 Slovenia joined EMU.

EU-10: members that joined the EU in 2004, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia

EU-12: EU members that joined the EU after 2004 including the members that joined in 2007 Bulgaria and Romania

EU-15: European Union 15 initial members; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom

EU-27: all countries belonging to the European Union Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom

GDP: Gross Domestic product

GDPpc: gross domestic product per capita

GNP: Gross National Product

IOP: Industrial Output Prices

HICP: Harmonised Indices of Consumer Prices

LOOP: Law of One Price

OECD: Organisation for Economic Cooperation and Development

OLS: Ordinary Least Squares

PPP: Purchasing Power Parity

TO: trade openness

ULC: unit labour costs

VAT: value added tax

8.2 Symbols

α: a constant that captures country specific information

β:the speed of price convergence

γ_l: the coefficient of the lags

i: good

k: country

λ: the speed of convergence per period

Δp_i: the log difference in price of a product in country i compared to a chosen numeraire country

P_i :is the domestic currency price or log price of good i

P_i *: is the foreign currency price or log price

ε_k: is the error term.

e: is the exchange rate of a country relative to some other country

Q: quantify of a good sold

q_k : is the log price of a product in a country

q_{EU27}: is the log price of the chosen benchmark country the aggregated EU-27 average.

p_k: is the log real exchange rate for a good of country k and the EU-27 aggregate

Pr: relative price calculated as the price of a good divided by the EU-27 average price of that same good.

s_t : the log of time domestic price of foreign exchange rate.

t: time

t*: half-life of shock in years

μ: captures the error term

9. APPENDICES

Appendix 1

EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom

EU-12: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia

EU-27: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom

Appendix 2

	CPL	x	Relative HICP	=	Conv.HICP	
Meat	2005 CPL		2005 HICP	2005 Relative HICP	2005 Conv. HICP	2007 Conv. HICP
EU-27	100.0		99.6	1.000	99.6	103.5
EU-15	111.6		99.5	0.999	111.5	116.6
Belgium	122.6		99.1	0.995	122.0	127.0
Bulgaria	46.8		98.4	0.988	46.2	50.0
Czech Republic	58.6		100.5	1.009	59.2	57.4
Denmark	150.1		99.0	0.994	149.3	155.1
Germany	118.5		100.1	1.005	119.1	121.9
Estonia	63.1		98.2	0.986	62.2	66.7
Ireland	128.6		101.5	1.019	131.1	132.4
Greece	90.4		99.3	0.997	90.1	95.6
Spain	79.1		99.3	0.997	78.9	85.2
France	120.9		99.2	0.996	120.5	125.2
Italy	117.7		99.8	1.002	118.0	124.1
Cyprus	77.7		97.8	0.983	76.3	85.5
Latvia	55.3		95.4	0.958	53.0	61.2
Lithuania	49.1		98.3	0.987	48.5	52.7
Luxembourg	118.6		98.7	0.991	117.6	123.3
Hungary	65.9		100.5	1.010	66.5	75.3
Malta	67.4		99.0	0.994	67.0	70.8
Netherlands	105.5		99.4	0.998	105.3	106.9
Austria	121.6		99.3	0.997	121.2	124.1
Poland	53.1		101.8	1.022	54.3	52.1
Portugal	81.6		99.6	1.000	81.6	84.4
Romania	58.8		96.8	0.972	57.2	60.1
Slovenia	82.7		101.2	1.016	84.0	85.5
Slovakia	57.5		102.8	1.033	59.4	56.5
Finland	118.9		100.1	1.005	119.5	122.6
Sweden	132.1		98.8	0.992	131.1	135.0
United Kingdom	126.6		99.4	0.998	126.4	131.6

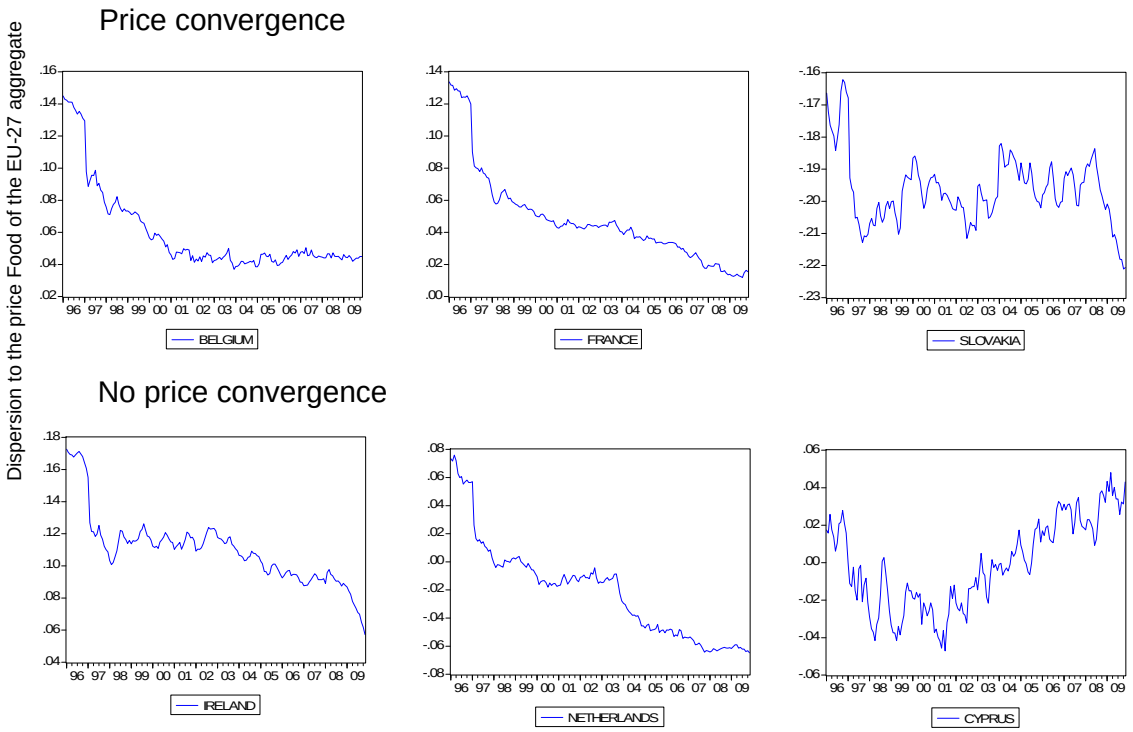
Appendix 3

List of transformed HICP goods		
		Classification
All-items		
01 Food		Tradable
	Meat	Tradable
	Fruits	Tradable
02 Alcoholic beverages and tobacco		Tradable
	Wine	Tradable
	Tobacco	Tradable
03 Clothing and footwear		Tradable
	Clothing	Tradable
	Footwear	Tradable
04 Housing		Non-tradable
	Water supply	Non-tradable
	Electricity	Non-tradable
05 Household equipment		Tradable
	Furniture	Tradable
	Household tools	Tradable
06 Health		Non-tradable
	Pharmaceutical products	Non-tradable
	Dental services	Non-tradable
07 Transport		Differentiated
	Personal transport equipment	Tradable
	Transport services	Non-tradable
08 Communication		Non-tradable
	Postal services	Non-tradable
	Telephone services	Non-tradable
09 Recreation		Tradable
	Garden plants	Tradable
	Books	Tradable
10 Education		Non-tradable
11 Hotels and restaurants		Non-tradable
	Restaurants and cafes	Non-tradable
	Accommodation services	Non-tradable
12 Miscellaneous goods		Non-tradable
	Jewellery	Non-tradable
	Insurance	Non-tradable

Appendix 4

	All items		Food		Alcoholic beverages		Clothing and footwear		Housing		Household equipment		Health		Transport		Communication		Recreation		Education		Restaurants		Miscellaneous goods	
	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob	t-stat	prob
Austria	-6,30	0,00	-4,85	0,00	-2,16	0,22	-3,12	0,03	-3,10	0,03	-4,70	0,00	-4,22	0,00	-2,03	0,27	-1,62	0,47	-3,39	0,01	-0,29	0,92	-4,23	0,00	-5,07	0,00
Belgium	-7,36	0,00	-3,93	0,00	-2,58	0,10	-4,34	0,00	-2,49	0,12	-3,57	0,01	-4,37	0,00	-2,32	0,17	-1,92	0,32	-1,83	0,37	-0,55	0,88	-4,37	0,00	-5,47	0,00
Bulgaria	-9,99	0,00	-12,14	0,00	-4,44	0,00	0,20	0,97	-13,57	0,00	-2,99	0,04	-7,55	0,00	-11,73	0,00	-8,12	0,00	-3,91	0,00	-10,01	0,00	-9,81	0,00	-9,12	0,00
Cyprus	-4,83	0,00	-1,67	0,45	-1,25	0,65	-1,07	0,73	-1,80	0,38	-1,77	0,40	-3,88	0,00	-1,32	0,62	-0,99	0,76	-0,92	0,78	-2,46	0,13	-1,30	0,63	-0,71	0,84
Czech republic	-3,51	0,01	-1,79	0,38	-1,46	0,55	-0,85	0,80	-2,72	0,07	0,64	0,99	-0,89	0,79	0,22	0,97	-2,76	0,07	-2,59	0,10	-1,44	0,56	-2,18	0,21	-2,78	0,06
Denmark	-3,81	0,00	-3,43	0,01	-1,00	0,75	-4,49	0,00	-2,00	0,29	-1,82	0,37	-3,65	0,01	-2,12	0,24	-2,27	0,18	-3,64	0,01	-2,02	0,28	-3,32	0,02	-1,72	0,42
Estonia	-1,32	0,62	-1,83	0,37	-1,68	0,44	-0,31	0,92	-0,43	0,90	-2,39	0,15	0,19	0,97	-2,73	0,07	-4,14	0,00	-1,23	0,66	-3,74	0,00	-4,56	0,00	-1,85	0,35
Finland	-2,83	0,06	-3,21	0,02	-1,41	0,57	-4,80	0,00	-3,38	0,01	-6,85	0,00	-4,82	0,00	-0,67	0,85	-0,92	0,78	-1,28	0,64	-2,03	0,27	-1,91	0,32	-4,06	0,00
France	-6,24	0,00	-3,26	0,02	-2,13	0,24	-3,01	0,04	-5,13	0,00	-3,23	0,02	-6,65	0,00	-3,75	0,00	-3,01	0,04	0,25	0,98	-3,13	0,03	-3,76	0,00	-6,29	0,00
Germany	-6,66	0,00	-4,09	0,00	-3,12	0,03	-5,05	0,00	-3,37	0,01	-3,93	0,00	-4,74	0,00	-3,18	0,02	-3,74	0,00	-2,72	0,07	-1,89	0,34	-2,81	0,06	-3,56	0,01
Greece	-0,09	0,95	-4,00	0,00	-2,89	0,05	2,40	1,00	-1,87	0,34	-1,04	0,74	-5,35	0,00	-2,51	0,11	-1,48	0,54	-0,03	0,95	-3,30	0,02	-2,97	0,04	-1,29	0,63
Hungary	-2,05	0,26	-0,91	0,78	-4,26	0,00	-4,41	0,00	-2,62	0,09	-1,75	0,41	-1,75	0,40	-3,36	0,01	-2,46	0,13	-3,05	0,03	-1,46	0,55	-2,47	0,12	-9,52	0,00
Ireland	-2,19	0,21	-1,75	0,41	-2,23	0,20	0,06	0,96	-1,39	0,59	0,86	0,99	-1,21	0,67	-2,50	0,12	-1,93	0,32	-1,76	0,40	-0,85	0,80	-0,85	0,80	-0,92	0,78
Italia	-10,26	0,00	-3,60	0,01	-2,57	0,10	-0,16	0,94	-3,06	0,03	-0,93	0,78	-3,84	0,00	-2,87	0,05	-0,18	0,94	-1,09	0,72	-2,25	0,19	-2,91	0,05	-2,78	0,06
Latvia	-2,05	0,27	-2,18	0,21	0,94	1,00	-1,72	0,42	0,04	0,96	-0,61	0,86	0,76	0,99	-1,82	0,37	-4,37	0,00	0,83	0,99	-1,00	0,75	-2,80	0,06	-0,41	0,90
Lithuania	-0,32	0,92	-2,12	0,24	-1,03	0,74	1,40	1,00	-1,77	0,39	-2,91	0,05	-0,83	0,81	-2,79	0,06	-2,92	0,05	-2,04	0,27	-0,94	0,77	-1,45	0,56	-1,24	0,66
Luxembourg	-4,01	0,00	-3,69	0,01	-3,39	0,01	-1,53	0,51	-2,50	0,12	-1,08	0,72	-3,43	0,01	-3,02	0,04	-1,36	0,60	0,92	1,00	-1,77	0,39	-2,96	0,04	-3,48	0,01
Malta	-5,00	0,00	-2,58	0,10	-1,49	0,53	-2,14	0,23	-2,15	0,23	-3,39	0,01	-3,14	0,03	-1,29	0,63	-0,22	0,93	-1,10	0,72	-3,37	0,01	-1,87	0,35	-2,96	0,04
Netherlands	-1,70	0,43	-2,81	0,06	-3,07	0,03	-3,47	0,01	-1,97	0,30	-3,08	0,03	-3,84	0,00	-3,61	0,01	-1,72	0,42	-2,68	0,08	-0,38	0,91	-3,43	0,01	-2,67	0,08
Poland	-2,64	0,09	-3,78	0,00	-3,32	0,02	-0,70	0,84	-1,34	0,61	-2,18	0,21	-1,87	0,35	-3,44	0,01	-2,70	0,08	-2,53	0,11	-2,24	0,19	-1,92	0,32	-6,83	0,00
Portugal	-4,19	0,00	-2,08	0,25	-2,46	0,13	-3,63	0,01	-3,86	0,00	-1,50	0,53	-3,45	0,01	-1,13	0,70	-2,12	0,24	-1,77	0,40	-2,03	0,27	-2,90	0,05	-1,18	0,68
Romania	-4,96	0,00	-4,91	0,00	-4,04	0,00	-4,00	0,00	-5,74	0,00	-6,82	0,00	-5,54	0,00	-5,46	0,00	-6,12	0,00	-9,35	0,00	-2,82	0,06	-5,64	0,00	-5,05	0,00
Slovakia	-1,30	0,63	-3,23	0,02	-0,92	0,78	-1,60	0,48	-1,27	0,64	-1,35	0,61	0,67	0,99	-1,63	0,46	-1,90	0,33	-2,62	0,09	-0,50	0,89	-1,17	0,69	-1,85	0,36
Slovenia	-2,51	0,11	-1,23	0,66	-1,57	0,50	-1,03	0,74	-2,19	0,21	-0,31	0,92	-1,32	0,62	-2,85	0,05	-2,18	0,21	-2,47	0,13	-4,09	0,00	-0,40	0,91	-1,95	0,31
Spain	-1,52	0,52	-3,90	0,00	-3,57	0,01	-0,32	0,92	-3,82	0,00	-1,00	0,75	-3,05	0,03	-2,34	0,16	-1,99	0,29	-1,37	0,60	-2,51	0,11	-1,38	0,59	-1,48	0,54
Sweden	-4,80	0,00	-3,78	0,00	-1,36	0,60	-3,17	0,02	-2,51	0,11	-2,01	0,28	-5,91	0,00	-2,97	0,04	-0,48	0,89	-2,96	0,04	-1,17	0,69	-3,39	0,01	-2,55	0,10
United Kingdom	-4,62	0,00	-4,02	0,00	-0,67	0,85	-2,88	0,05	-2,24	0,19	-4,55	0,00	-5,25	0,00	-1,90	0,33	-3,03	0,03	-2,23	0,20	-0,39	0,91	-3,84	0,00	-1,58	0,49

Appendix 5


Price convergence
Dispersion to the price Food of the EU-27 aggregate
BELGIUM
FRANCE
SLOVAKIA
No price convergence
IRELAND
NETHERLANDS
CYPRUS

Appendix 6

Product	Panel	Coefficient	t-Stat	SE Reg	mu*	sig*	Obs	t-Stat	prob	Half-life months	Half-life years
All items	EU-27	-0.02771	-15.302	1.035	-0.515	0.763	2370	-15.6398	0	24.7	2.1
	EU-15	-0.02771	-15.302	1.035	-0.515	0.763	2370	-15.6398	0.000	24.7	2.1
	EU-12	-0.01177	-7.999	1.04	-0.515	0.763	2063	-7.3238	0.000	58.5	4.9
	EU-10	-0.0114	-5.977	1.021	-0.515	0.763	1744	-4.54546	0.000	60.5	5.0
Pre euro introduction <1999m01	EU-27	-0.03479	-8.106	1.355	-0.533	0.837	1227	-6.95865	0.000	19.6	1.6
	EU-15	-0.02025	-5.155	1.002	-0.533	0.835	692	-4.02132	0.000	33.9	2.8
	EU-12	-0.06208	-6.858	1.684	-0.534	0.84	535	-6.21071	0.000	10.8	0.9
	EU-10	-0.04236	-5.452	1.062	-0.533	0.837	454	-3.96565	0.000	16.0	1.3
Post euro introduction >1999m01	EU-27	-0.02157	-14.287	1.013	-0.517	0.774	2983	-14.5356	0.000	31.8	2.6
	EU-15	-0.02316	-6.71	1.003	-0.517	0.774	1648	-4.49724	0.000	29.6	2.5
	EU-12	-0.02121	-12.515	1.024	-0.517	0.774	1335	-13.8309	0.000	32.3	2.7
	EU-10	-0.01388	-4.642	1.02	-0.517	0.774	1100	-2.86876	0.002	49.6	4.1
Pre 2004	EU-12	-0.01736	-6.919	1.168	-0.52	0.781	1102	-6.81594	0.000	39.6	3.3
	EU-10	-0.01802	-6.33	1.032	-0.52	0.781	925	-5.99797	0.000	38.1	3.2
Post 2004	EU-12	-0.01348	-3.156	1.064	-0.524	0.797	852	-1.76505	0.0388	51.1	4.3
	EU-10	-0.01508	-2.74	1.075	-0.524	0.797	710	-1.17411	0.120	45.6	3.8

Appendix 7

Bulgaria

Relative price good	all	Food	Alcohol & Tobacco	Clothing & Footwear	Housing	Household equipment	Health
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	-0.01	-0.02	0.01	0.14 **	0.01	0.04 **	0.01 **
Relative price good $_{t-1}$	1.02 **	0.95 **	0.99 **	0.77 **	0.98 **	0.95 **	0.96 **
Δ Taxes	0.00	0.01	0.37	0.03	0.00	-0.01	0.01
Δ Unit Labour cost	-0.10	0.05	1.12	0.34	0.00	0.00	0.20
Δ GDP per capita	0.11	0.49	-0.95	3.26	0.22	0.20	0.33
Δ Openness	-0.12	-0.34	2.54	-0.81	0.22	-0.30 **	-0.02
R-squared	0.99	0.92	0.97	0.71	0.98	0.96	0.99
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Transport	Communication	Recreation	Education	Restaurants	Miscellaneous goods	overall sign
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.02	0.04 **	0.03 *	0.01	-0.01 **	-0.01	+
Relative price good $_{t-1}$	0.96 **	0.96 **	0.94 **	0.92 **	1.04 **	1.03 **	+
Δ Taxes	0.00	0.01	-0.01	0.00	-0.01 **	0.00	+
Δ Unit Labour cost	0.27	0.52	0.03	0.00	-0.11	-0.01	+
Δ GDP per capita	1.40 **	0.35	-0.04	0.07	0.28	-0.20	+
Δ Openness	0.18	-0.28	-0.42	0.00	-0.07	-0.12	-
R-squared	0.96	0.98	0.91	0.95	0.99	0.98	
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	

**** significant at 5% level**

*** significant at 10% level**

Test for Heteroskedasticity: Newey-West

Appendix 7 (continued)

France

Relative price good	all	Food	Alcohol & Tobacco	Clothing & Footwear	Housing	Household equipment	Health
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.03 **	0.02	0.08 **	0.07	0.03 **	0.04 **	0.06 *
Relative price good $_{t-1}$	0.99 **	0.98 **	0.98 **	0.89 **	0.99 **	0.96 **	0.99 **
Δ Taxes	-0.19 *	-0.50	-0.15 *	-0.37	-0.05	-0.09	-0.44
Δ Unit Labour cost	-0.17	-0.53	-1.96 **	1.24	0.17	0.15	0.71
Δ GDP per capita	-0.02 *	0.01	-0.06 **	0.03	-0.02	0.00	-0.04
Δ Openness	-0.39 **	-0.49	-0.70	1.54 **	-0.47	-0.08	-1.05 *
R-squared	1.00	0.99	0.96	0.88	1.00	0.98	1.00
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Transport	Communication	Recreation	Education	Restaurants	Miscellaneous goods	overall sign
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.04 **	0.07 **	0.00	0.02	0.01	0.02 **	+
Relative price good $_{t-1}$	0.98 **	0.96 **	0.96 **	0.99 **	0.98 **	0.99 **	+
Δ Taxes	-0.07	0.00	0.00	-0.04	-0.16 **	-0.11 *	-
Δ Unit Labour cost	-0.09	-0.27	-0.18	0.55	0.00	0.15	-
Δ GDP per capita	-0.02	-0.02	0.03	-0.02	0.01	-0.01	-
Δ Openness	0.03	0.31	0.22	-1.29 **	0.12	-0.34 **	-
R-squared	0.99	0.97	0.99	1.00	0.99	1.00	
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	

**** significant at 5% level**
*** significant at 10% level**
Test for Heteroskedasticity: Newey-West

Appendix 7 (continued)

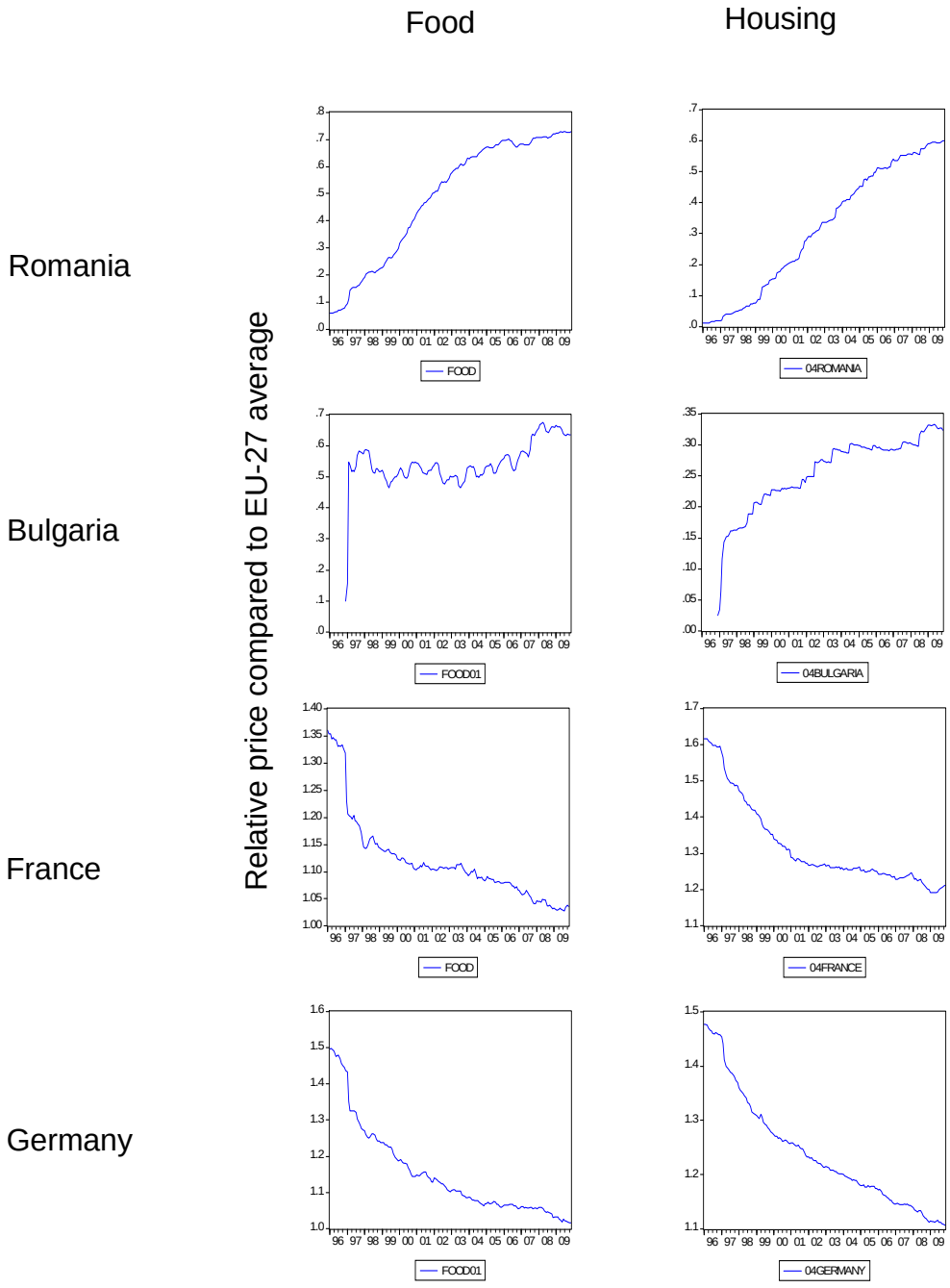
Germany

Relative price good	all	Food	Alcohol & Tobacco	Clothing & Footwear	Housing	Household equipment	Health
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.03 **	0.02 **	0.03 **	0.17 **	0.01 **	0.02 **	0.03 **
Relative price good $_{t-1}$	0.97 **	0.98 **	0.96 **	0.84 **	0.99 **	0.97 **	0.97 **
Δ Taxes	0.03	0.11	0.06 *	0.02	-0.02	0.02	0.09
Δ Unit Labour cost	0.23	1.04	-0.50	-2.10 *	0.25	-0.02	-0.04
Δ GDP per capita	-0.10	-0.02	1.10 *	-4.38 **	-0.13	-0.17	0.63
Δ Openness	0.37	1.17	1.44 **	-0.45	0.34	0.23	0.48
R-squared	1.00	1.00	0.98	0.84	1.00	0.99	0.99
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	0.00

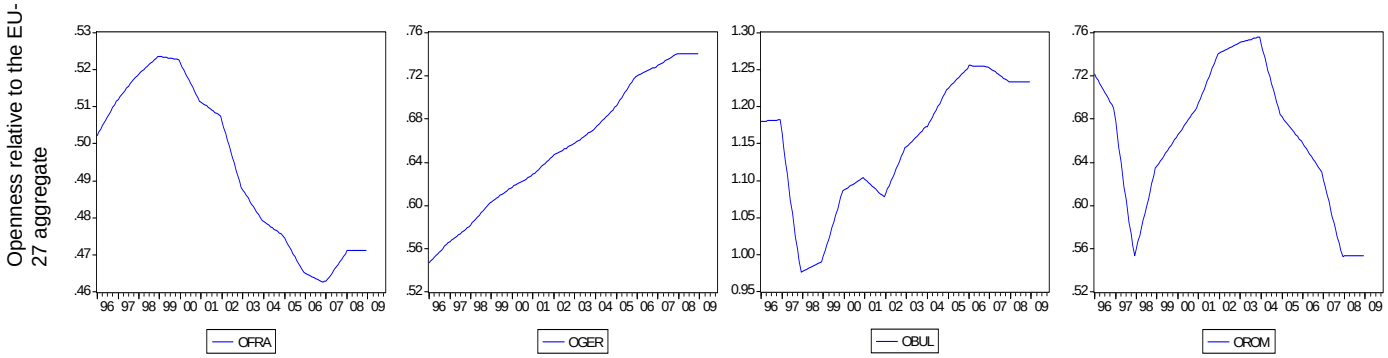
	Transport	Communication	Recreation	Education	Restaurants	Miscellaneous goods	overall sign
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
C	0.04 **	0.02 **	0.19 **	0.04 *	0.04 **	0.01 **	+
Relative price good $_{t-1}$	0.96 **	0.98 **	0.82 **	0.97 **	0.96 **	0.99 **	+
Δ Taxes	0.01	-0.05	-0.04	0.06	0.04	0.02	+
Δ Unit Labour cost	0.25	-0.58	-0.11	-0.22	-0.06	0.29 *	-
Δ GDP per capita	-0.05	1.06	-4.27 **	-0.93	-1.53 *	-0.02	-
Δ Openness	0.19	-0.02	-0.06	-0.24	0.52	0.08	+
R-squared	0.98	0.99	0.80	0.97	0.96	1.00	
P-value whole regression	0.00	0.00	0.00	0.00	0.00	0.00	

**** significant at 5% level**
*** significant at 10% level**
Test for Heteroskedasticity: Newey-West

Appendix 8


Food
Housing
Romania
Bulgaria
France
Germany
Relative price compared to EU-27 average
FOOD
04ROMANIA
FOOD01
04BULGARIA
FOOD
04FRANCE
FOOD01
04GERMANY
96 97 98 99 00 01 02 03 04 05 06 07 08 09

Appendix 9


Openness relative to the EU-27 aggregate
OFRA
OGER
OBUL
OROM