Inflation Differentials, Price Differentials, and Convergence in the Eurozone

William Braun

Faculty Advisor: Prof. Geoffrey Woglom

Submitted to the Department of Economics at Amherst College in partial fulfillment of the requirements of the degree of Bachelor of Arts with Honors

May 6, 2010
Abstract

This thesis addresses the determinants of inflation differentials within monetary union, focusing on the original 11 Eurozone countries in the decade following the adoption of the common currency in 1999. Much of the literature suggests that price level convergence, and thus the overall integration process, may be a significant determinant of these differentials. Thus, I first construct a dataset of comparative price level indices and find that overall price levels are indeed converging. Dispersion is much greater in the nontraded (services) sector than in the traded goods sector, and price level convergence is much more substantial for traded goods.

I apply a model of inflation differentials based on Honohan and Lane (2004) and Egert (2007) to overall and sectoral-level inflation and find that price level convergence does appear to be a determinant of inflation differentials, though the overall magnitude of this effect is limited. Inflation persistence and the business cycle are also important. Convergence exerts a much greater effect on traded goods inflation but does not matter for non-traded inflation, which is much more attributable to inflation inertia and the business cycle. I also find tentative evidence in support of the Balassa-Samuelson effect, as productivity growth rate differentials between the manufacturing and nontraded sectors exerts upward pressure on services prices. However, the overall impact on inflation is quite small, and is insignificant for the overall inflation rate.

Keywords: Price levels; inflation; economic integration; monetary union; the euro
Acknowledgements

I would first like to thank my thesis advisor, Prof. Geoffrey Woglom, for all of his help over the past year. He first suggested this topic and, without his insight and helpful comments, this thesis would not have been written. I know that my fierce independence was often exasperating and, had I allowed myself to be reined in and focused a little bit earlier, this would very likely have been a much less painful process.

Many thanks to the rest of the economics department, especially Professors Reyes, Barbezat, Honig, Westhoff, and Kingston, for my wonderful experiences in all of their classes. They have made me love economics, and this past year has made me greatly appreciate the time and effort that goes into their research. I want to thank Prof. Reyes in particular for her patience and dedication as my major advisor, for her encouragement in the days leading up to the completion of this project, and for all of the general chats and advice throughout the past several years. Those kinds of relationships are the reasons one comes to Amherst, and I hope that future students can appreciate everything she does for us. And many thanks to Jeanne Reinle, whose plentiful supply of free coffee and good cheer made all of those long hours in the computer lab much more bearable.

I am especially grateful to my parents, Jan and Steve Braun, for all of their love. The sacrifices that they have made for my sister and me are astounding, and I am grateful for their positive example for doing things the right way. I hope that I can one day be half as good of a parent as they have been to me. Meredith, I hope that you seize every opportunity and take risks to improve yourself intellectually and socially as you prepare to go to college yourself. The times that I have done so have been my most rewarding in the last four years, and my only regret is that I have not done it enough.

For all of my friends, thanks for your support. I’m especially grateful to Peter Tang for four years of Sunday brunch with the New York Times, and to Philip Spencer for his succor and assistance. And AGonz, I think that what we’ve done the past four years and with our senior theses has done Central Catholic proud.

And most of all, thank you to Haley for always being there for me. I do not think that I could have made it through this process without her love and constant presence, and I know that she is probably happier than I am that this thesis is complete.
Table of Contents

I. Introduction ...................................................................................................................................................... 2  
   The Policy Challenge ................................................................................................................................. 7  
   Possible Explanations ................................................................................................................................. 9  
II. Price Level Data ........................................................................................................................................... 12  
III. A Model of the Inflation-Price Level Nexus ......................................................................................... 18  
   The Determinants of Inflation Differentials ............................................................................................. 19  
IV. Empirical Framework ............................................................................................................................... 23  
   Econometric Specification ........................................................................................................................ 24  
   Results ....................................................................................................................................................... 26  
V. Conclusion .................................................................................................................................................. 28  
Appendix A: Data .......................................................................................................................................... 31  
Appendix B: Price Level Dispersion, Euro-11, 1996-2009 ......................................................................... 34  
Appendix C: Price Level Dispersion, 7-Country Subsample, 1991-2007 ................................................. 36  
Bibliography .................................................................................................................................................. 39
I. Introduction

The process of European integration and the establishment of the single market culminated with the introduction of the Euro in 1999, nearly fifty years after the establishment of the European Coal and Steel Community in 1951. Supplementing the elimination of non-tariff barriers achieved with the fulfillment of the Single Market Program in 1992 (Bottasso and Sembenelli 2001), the Euro was expected to lead to further market integration throughout the Eurozone by increasing price transparency and eliminating exchange rate risk, transaction costs, and border effects. With the removal of these barriers and freer movement of goods, labor, and capital, convergence in price levels was expected, especially for traded goods. In addition, convergence in inflation rates was expected to occur under the common monetary policy set by the European Central Bank. Such convergence is a prerequisite for the appropriateness of the common monetary policy among Euro-area countries. In addition, price and inflation developments are crucial determinants of the long-run viability of a currency union. Nitsch (2005), for example, examines a series of sustained and dissolved monetary unions and finds that large and persistent inflation differentials are a leading cause of currency dissolution, although Eurozone inflation differentials do not appear to be large enough for this to occur.¹ Moreover, during the ongoing process of Eurozone expansion, price and inflation dynamics within the accession countries are an area of significant interest to policymakers (Cihak and Holub 2005).

¹ Nitsch finds the average inflation differential immediately prior to exit from a currency union to be approximately 11 percent, compared to 4.5 percent during periods of stability. By comparison, inflation differentials among the original 11 Eurozone countries (the “Euro-11”) were 2.3 percent in 2008 and 3.3 percent in 2009, when a handful of countries actually saw decreases in their overall price level, presumably due to the financial crisis in that year.
One common method of examining price level developments within the literature is what Fischer (2007) has dubbed the “Relative Purchasing Power Parity (PPP)” method. In this approach, price indices are calculated based upon a given base year in which the price level is counterfactually assumed to be equal for all countries and all product categories. This method allows for an easy comparison of price changes among countries in the sample. Figure 1.1 shows price indices calculated on the basis of year-over-year changes in the overall Harmonized Index of Consumer Prices within the Euro-11 countries (i.e. the original 11 members of the Eurozone) since 1999, with the price level in base year 1999 equal to 100 for all countries. Changes in this index range from 18 percent in Germany to as much as 40 percent in Ireland, resulting in differentials of relative price changes of more than 18% since 1999. Moreover, these differentials are not driven by outliers; rather, they are almost uniformly distributed. For this and for all other figures in which legends are included, countries are listed in descending order of the value of the variable being examined in the final year.

---

2 These indices are also often referred to as “relative price levels” in the literature. Thus, within the context of this paper the term “relative price” refers not to the ratio of the price levels of two different goods, but to the price index of a good (or category of goods) in a given year relative to a base year; that is, the cumulative change in the price of the good relative to the base year.

3 The Harmonized Index of Consumer Prices (HICP) is the official price index measure that is compiled by Eurostat, the official statistical agency of the European Union, and is broadly similar to traditional Consumer Price Index measures. See Appendix A for a more thorough discussion of these indices.

4 Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain.
As these indices are calculated on the basis of changes in the overall price index, these differentials reflect persistent differentials in inflation rates, but not necessarily in levels of actual prices. Figure 1.2 shows headline HICP inflation rates from 1996-2009 for the Euro-11 sample, while Figure 1.3 shows the year-over-year changes in the GDP deflator and figure 1.4 shows the coefficient of variation (a measure of overall dispersion of the inflation rate) for both samples (excluding Germany, as the absorption of the East German economy upon reunification in 1991 was a very significant shock that led to a large temporary increase in inflation in that year). Both samples are included because year-over-year changes in the HICP provide a more accurate measure of the behavior of consumer prices than do changes in the GDP deflator.

---

5 Similarly, the differentials for more disaggregated product categories thus represent differentials in the cumulative price level changes for these categories of goods alone.

6 The coefficient of variation for a given year is defined as the standard deviation of the cross-sectional inflation series divided by the mean. While the standard deviation also provides a measure of dispersion, the coefficient of variation is a “unit-free” measure of dispersion that allows for the comparison of dispersion of variables that are denominated in different units. Although this distinction is not as important for examining inflation rates, it will be especially important in discussing price level dispersion. As overall price levels increase over the sample period, the standard deviations may rise even when price levels themselves are converging.
Figure 1.2: Headline HICP Inflation, Percent, 1999-2008

Source: Eurostat New Cronos database

Figure 1.3: Percentage Change in GDP Deflator, 1989-2008

Source: Author’s calculations based on IMF World Economic Outlook Database, October 2009
While dispersion in inflation based upon the GDP deflator is much higher than that based upon the HICP, the longer sample suggests that inflation rates converged during the early 1990’s, and both measures show divergence in the years immediately preceding Euro adoption. Inflation rates continued to converge steadily from 1999 to 2008 (before diverging greatly in 2009). Examining the longer time series, rates appeared to converge rapidly from approximately 1990 to 1993, before diverging slightly during the next three years and more rapidly during the years immediately preceding the introduction of the Euro. Rates have converged since then, with a transitory increase in dispersion in 2002 (possibly due to the introduction of Euro notes and coins in that year), but this convergence largely appears to be a reversion to the prevailing levels before the Euro. However, it is important to note that rather significant inflation differentials do still exist despite this convergence behavior, as the 2.9% rate of HICP inflation seen in Ireland in 2007 is nearly twice the 1.6% seen in Finland, France, and the Netherlands.
The Policy Challenge

Taken alone, such inflation differentials (especially if they persist) are of great concern to policymakers, national central bankers, and the European Central Bank (ECB) because the associated misalignments of real interest rates and real exchange rates question the appropriateness of the common monetary policy for all countries at all times. Turning first to the real interest rate channel, with a common interest rate \( i \) across financial markets in all Euro countries, high-inflation countries see lower real interest rates, and lower-inflation countries see higher real interest rates. Thus, the common monetary policy set by the ECB may be too tight for countries with low inflation rates and too expansionary for countries with high inflation. In addition, inflation differentials can cause countries to accumulate significant changes in competitiveness over time. The bilateral real exchange rate is defined as the product of the nominal exchange rate \( e \) and the ratio of the domestic price level \( P \) to the foreign price level \( P^f \):

\[
RER = e \left( \frac{P}{P^f} \right)
\]

The nominal exchange rate among countries in a monetary union is simply equal to one, so that the real exchange rate is entirely determined by the price ratio. Figure 1.2 shows real exchange rate (RER) developments of the Euro-11 countries in my sample since the introduction of the common currency in 1999, with the RER defined as the ratio of the national price level (in the relative PPP terms previously defined) to the weighted average of the price levels in the other ten countries. Because the price level in 1999 is equal to 100 for all countries, the price ratio (and therefore the RER itself) is equal to one for all countries in 1999. Given this definition, a RER greater than 1 indicates a relative
decrease in competitiveness, while a RER less than 1 suggests that a country has become more competitive.

Since 1999, Germany, Finland, France, and Austria have become relatively more competitive vis-à-vis the rest of the Eurozone; Belgium’s RER remains close to 1; the Netherlands and Italy have seen slight decreases in competitiveness; and Luxembourg, Portugal, Spain, and Ireland have each accumulated a 6-12% decrease in competitiveness relative to the rest of the sample since 1999. With nominal devaluation removed as a possible means of restoring price competitiveness, these competitive pressures will continue in the presence of inflation differentials. Given the effects of these two parameters on savings, investment, exports, and thus output and growth, sustained differentials may result in substantial price, interest rate, and exchange rate misalignments and macroeconomic divergence. DeRoose, Langedijk, and Roeger (2004) further suggest that the interaction of the real exchange rate and real interest rate channels, which have opposite effects on output, could lead to periods of overheating and overcooling, and thus a “divergence cycle.”
**Possible Explanations**

These inflation and relative price level differentials have two possible explanations, each offering a profoundly different conclusion regarding the broader process of European integration and convergence. If these changes in relative PPP measures are accompanied by similar divergence in price levels and macroeconomic factors, the aforementioned monetary policy issues will be salient issues in the long run and the European currency union will appear to have failed in one important respect, at least in the immediate sense. Alternatively, if countries with lower price levels are seeing higher inflation rates as they catch up to countries with higher prices, then the inflation and relative price level differentials will not represent an equilibrium condition. Instead of being an area of significant concern, they will be a welcome and necessary indication of the convergence process (if less than optimal in the short term). As has been explained at length in the literature, if countries with lower price levels are converging to countries with higher prices, higher rates of inflation will be necessary during the adjustment period. The Balassa-Samuelson effect, which explains inflation rates as the result of differentials in productivity between the traded and nontraded sectors, is a commonly discussed component of this convergence framework that will be discussed more thoroughly in section III. Both of these possible explanations (pure price level convergence and the Balassa-Samuelson productivity approach) suggest that inflation differentials may be a transitory phenomenon that should diminish over time. Rogers, Hufbauer, and Wada (2001) posit an interesting extension of this framework and raise the possibility of currency misalignments during the process of euro adoption. Namely, if the currency conversion rates that were irrevocably fixed in 1999 before the introduction of
Euro notes and coins in 2002 did not adequately calibrate price levels across the eurozone, then further convergence is to be expected thereafter. In countries with low initial price levels, higher inflation will exist during this convergence process. Thus, while price and inflation differentials may be a concern in the short- and medium-term, they will be much less significant in the very long run.

The impossibility of distinguishing between these two hypotheses within the relative PPP context has been discussed in great detail by Fischer (2007). Constructed price indices like those shown above are interesting in and of themselves and are often necessary due to the paucity of absolute price level data. However, the reliance on this measure is recognized to be a significant shortcoming of the existing literature because the setting of the base year is entirely arbitrary and precludes a thorough discussion of comparative price levels (Engel and Rogers 2004). That is, the cost of a given good in a country like Ireland, that has seen the largest increase in the price of a given good or category of good, could still be lower than in a country like Germany. Several authors, including Rogers (2007), Engel and Rogers (2004), and Rogers, Hufbauer, and Wada (2001) use a unique dataset compiled by the Economist Intelligence Unit (EIU) that contains actual prices of hundreds of very specific goods and services such as “dry cleaning, ladies’ dress,” “batteries (two for flashlight/radio use),” “one drink at bar of first-class hotel,” and “lipstick for women (deluxe type) collected in 100 cities worldwide. Due to the inaccessibility and cost of this data, as well as its urban bias, section 2 explains how Faber and Stokman’s (2004) method for combining purchasing power parity (PPP) observations with constructed price indices like those shown above were
used to construct a dataset of estimates of comparative price levels among the Euro-11 countries.

This paper examines developments price levels and inflation for the aggregate Eurozone, along with indices for consumer goods and consumer services in order to proxy for the differences between tradable and nontradable goods, for each of the decades preceding and following the introduction of the common currency in 1999. General trends in disaggregated price indices at the single-digit product level\(^7\) are examined. First, I examine the Euro-11 sample from 1996-2009, as HICP data is only available from 1996 for all countries. As will be seen, significant differentials in actual prices exist and, while they do appear to be converging, they are doing so quite slowly. While the traded goods sector has seen some convergence as expected, convergence among services is slight. However, much existing work in this area suggests that convergence does not appear to be due to the common currency itself. Rather, the convergence of prices and inflation rates throughout the 1990’s has been well documented, and appears to have been influenced by both the implementation of the Single Market Program and the pursuit of a tighter monetary policy by national central banks in order to fulfill the Maastricht criteria for Euro adoption.\(^8\) Moreover, Faber and Stokman (2009) find evidence that price levels

\(^7\) That is, for the 12 broadest categories of goods for which Eurostat compiles HICP indices and PPP data. It is important to note that each of these 12 categories contains both goods and services components, so I also examine indices for “all consumer goods” and “all consumer services” separately. It would be ideal to use more disaggregated data, but Eurostat only releases absolute price level data for these 12 categories and a very limited number of more specific categories.

\(^8\) In addition to strict limitations on annual government budget deficits (not to exceed 3% of GDP) and gross government debt (not to exceed 60% of GDP), countries were required to bring their inflation rates to within 1.5% of the average of the three best-performing European Union Member States (i.e. the three with the lowest inflation rates); join the Exchange Rate Mechanism of the European Monetary System for at least two consecutive years prior to Euro adoption; were not allowed to devalue their currency during this period; and were required to have a nominal long-term interest rate within 2% of the three lowest-inflation member states.
have been converging throughout most of the European integration process (that is, for the last 50 years).

Thus, in order to examine general trends in price levels over a longer period, price indices were also constructed from 1991-2007 for a subsample of countries for which a longer time series of data is available. For both samples, the general trends in price and inflation differentials and convergence within the Eurozone will be discussed. However, the main aim of this paper is to identify the main determinants of inflation differentials and establish whether they are attributable to the convergence process, focusing on the Euro-11 sample from 1999-2009.

II. Price Level Data

In order to compile data on price levels that are comparable across countries, I follow Faber and Stokman’s (2009) method for “scaling” Harmonized Index of Consumer Prices (HICP) price indices, which they derived from Chen and Devereux’s (2003) study of price level differentials among US cities. Eurostat publishes HICP price index data from 1996 (with base year 2005) for 165 categories of goods of varying specificity, as well as for a handful of special aggregates (e.g. “All prices excluding energy”). PPP data, which provides comparative price levels for each country relative to its eurozone peers, is only available for the 12 broadest (“one-digit”) categories of goods and services and very limited number of more specific categories and special aggregates. In compiling these price indices, I first re-calculate the indices so that they have a base year 1999, and this relative price index for each year is scaled by the PPP

---

9 Austria, Finland, France, Germany, Ireland, Italy, and the Netherlands.
10 Within the currency union, PPP differentials reflect differentials in the purchasing power of a euro in the different countries.
level in 1999\textsuperscript{11} in order to convert these relative price indices into estimates of actual prices. Thus, the estimated price level \( P \) for product category \( j \) in country \( k \) in time \( t \), \( P_{k,t}^{j} \) is calculated as:

\[
P_{k,t}^{j} = (HICP_{k,t}^{j})PP_{k,1999}^{j}
\]

where \( HICP_{k,t}^{j} \) is the price level for product category \( j \) in country \( k \) in time \( t \) and \( PPP_{k,1999}^{j} \) is the PPP level for product category \( j \) in country \( k \) in 1999. Figure 2.1 shows these estimates of comparable price levels for the Euro-11 for the period 1996-2009, and figure 2.2 shows the coefficient of variation, a measure of “sigma convergence.”\textsuperscript{12}

\textbf{Figure 2.1: Estimated Comparative Price Levels, Headline HICP 1996-2009}

Source: Author’s calculations based on Eurostat HICP data

\textsuperscript{11} The choice of the base year is not especially decisive/important in this case. 1999 was chosen simply because it was the year of Euro adoption.

\textsuperscript{12} As explained earlier, the coefficient of variation provides a measure of dispersion that is comparable across variables, and a decrease in the coefficient of variation indicates a decrease in the coefficient of variation over time. Such a decrease in dispersion is referred to as sigma convergence and represents an increase in the degree of integration.
As can be seen above, there exist differentials in comparative price levels on the order of nearly 40% between the most expensive and cheapest countries in the Eurozone. At the same time, the price dispersion of the entire sample has declined by approximately 18% across the sample period. However, this convergence does not appear to be limited to the period after the introduction of the Euro; the coefficient of variation declined by 7.6% between 1996 and 1999, and a further 12% from 1999 to 2009, with an uptick in dispersion in 1999 and a leveling off and slight decrease post-1999. In addition, the annual rate of decrease (a crude measure of the speed of convergence) was faster in the pre-Euro period.

Turning to the differences between goods and services, which proxies for the differences between traded and non-traded prices, there is a large disparity between the two categories for the full Euro-11 sample. Figures 2.3 and 2.4 show these estimates of comparative price levels from 1996-2009 for goods only and services only, respectively. Although price levels for both categories appear to be rising steadily throughout the Euro-11 sample, price levels of goods are much more tightly distributed and are
converging at a faster rate. In addition, prices in the non-traded sector are rising much faster than those for traded goods.

The coefficient of variation is much higher for services, ranging from approximately 0.125 to 0.143 within the 1996-2009 period. For goods, dispersion over the same period ranges from 0.05 to 0.08. Moreover, while dispersion decreased by 5% over the entire period, it actually increased by 4.5% after 1999 after decreasing by 9.2% from 1996-1999. However, this result is not robust to the exclusion of Ireland, which saw
a rate of increase far outpacing all countries in the rest of the sample. When Ireland is excluded, the coefficient of variation decreases by 10% between 1996-1999 period and a further 15.4% decrease for the ensuing decade, with a total decrease of 24% between 1996 and 2009. These decreases are still smaller than those for goods only, as the dispersion of goods decreased by 7.1% from 1996 to 1999 and by 35.6% from 1999 to 2009, with a cumulative decrease of 40.14% from 1996 to 2009. Figure 2.5 shows the dispersion of price levels from 1996 to 2009 for services only for all 11 countries, for services only excluding the outlier Ireland, and for goods only for the entire sample.

Turning to the relative dispersion of the individual product categories, figure 2.6 shows the coefficient of variation for each of the twelve broadest categories of goods in the HICP. Consistent with the goods/services breakdown provided above, the four groups with the highest dispersion at the end of the sample period (communications, education, housing, and health) are categories that mainly comprise non-traded goods, although it is important to note that alcohol, tobacco, and narcotics showed a high degree of initial dispersion before decreasing rapidly. Moreover, the remainder of the categories are
tightly distributed around a CV of approximately 0.1 and are predominantly categories that contain a larger amount of traded goods (with the exception of transportation and restaurants and hotels).

Appendix B offers a more thorough breakdown of the dispersion measures for individual categories, while Appendix C offers the same for the 1991-2007 7-country sample. For both samples, the scales shown in the appendices for disaggregated data are set independently for each category in order to facilitate an easier identification of the disaggregate trends than can be seen in Figure 2.6. While a detailed accounting of these trends will not be given here, a few observations are in order. Decreases in dispersion have been observed for food, alcohol and tobacco, furnishings, transport, and even the non-tradeable restaurants and hotels category. However, dispersion in clothing and footwear, health, and recreation was relatively steady until 2008, when dispersion increased greatly for many categories (again, presumably due to the financial crisis). Moreover, it is clear that, for reasons that will not be discussed here, the Irish economy has been a significant enough outlier in many of these disaggregated categories to greatly

Source: Author’s calculations based on Eurostat New Cronos Database

Figure 2.6: Coefficient of Variation 1996-1999, Excluding Ireland
influence the final estimates of convergence. Turning to the longer time-series, after the shock of German reunification, most categories have seen a fairly steady decrease through 2007, with an increase in dispersion in the mid-1990’s that peaked in 1999. Broadly speaking, it is notable that convergence behavior has been observed for many categories since well before the introduction of the Euro, and prices for many categories even appear to have diverged since then.

III. A Model of the Inflation-Price Level Nexus

A substantial strand of the literature addresses price adjustment as a crucial factor in explaining inflation differentials within monetary union (See Egert 2007; Berk and Swank 2002; Cihak and Holub 2005; and Rogers, Huffbauer, and Wada 2001 for examples). In this literature, countries with lower price levels are found to exhibit higher inflation rates, and two mechanisms are proposed to explain this phenomenon. The first explanation is the previously-mentioned “inflation catch-up”; that is, if price levels are converging among countries, countries with an initially low price level would see an inflation during the catching-up phase. The second, and more complicated, mechanism is the Balassa-Samuelson effect. This mechanism has itself been the focus of a large literature, and pinpoints developments in labor productivity as key drivers of inflation. The basic theoretical argument is as follows: poor countries will initially have lower price levels, and economic integration leads to convergence in productivity for traded goods (Lommatzsch-Tober 2006) while productivity in the nontraded goods sector converges much more slowly. Assuming that both sectors pay the same wages, the productivity increase in the traded sector will spill over into wages in the non-traded sector, thus
exerting upward pressure on prices (Lommatzsch-Tober (2006); Hofmann and Remsperger (2005)). However, the literature on the existence and the magnitude of the Balassa-Samuelson effect is not conclusive. Most work in this area focuses on the Central- and Eastern European euro-accession countries instead of the established Euro-11, with most authors finding that it did have a substantial impact (accounting for 4-5% inflation each year) as productivity levels converged to Eurozone levels. (Dreger, Kholodilin, Lommatzsch, Slacalek, and Wozniak 2007; Egert 2003). Egert (2003) confirms the existence of the B-S effect in Estonia from the period 1993-2002, but has found it to have decreasing explanatory power over time: while productivity developments explained inflation of 4-5% in 1994, productivity-driven inflation was only 0.3-1% in 2001. Mihalkek and Klau (2004) found that productivity differentials only explained 0.2-2% of inflation differentials vis-à-vis the Euro area, which ranged from 2.9% in Croatia to 13.9% in Hungary.

The Determinants of Inflation Differentials

The model presented here synthesizes the previous work of Honohan and Lane’s (2004) paper on inflation differentials in the first three years of the common currency and Egert’s (2007) discussion of inflation rates across the entire European Union. The empirical analysis extends this framework to the “core” Euro-11 sample, a longer time period of data, and disaggregated inflation data for goods and services (to proxy for the differences between the traded and nontraded sectors). I start with Honohan and Lane’s basic specification of the inflation differential relative to the Eurozone defined as a function of the lagged price differential; the lagged inflation differential; the differential in the output gap; and the differential in changes in the standard rate of the Value Added
Tax and supplement it with Egert (2007)’s method for accounting for the Balassa-Samuelson Effect. The theoretical arguments for each of the determinants are given below.

*Lagged Price Differential*

The lagged price differential tests the convergence hypothesis as a key determinant of inflation rates: a negative coefficient on this parameter would suggest that countries with prices that are low relative to the Eurozone mean are seeing higher inflation as they catch up to more expensive countries.

*Lagged Inflation Differential*

This parameter captures the effect of inflation persistence, or inertia in inflation rates, as a determinant of inflation rates: countries with higher inflation relative to the rest of the Eurozone in one year should see higher inflation in the next,\(^\text{13}\) so that the expected coefficient on this parameter is positive. While a thorough discussion of the causes of inflation persistence in the Eurozone will not be undertaken here, the literature identifies several causes of such inflation persistence such as the conduct of monetary policy and the inflation expectations of price-setters (Batini 2002).

*Output Gap*

The relationship between the output gap and inflation is well-known and is based on the simple idea that, if real output is greater than potential real output (i.e. if aggregate demand is greater than aggregate supply), then the resultant pressure on production costs (especially wages) will feed into higher prices and, therefore, inflation (Kasriel 2004). Thus, the expected coefficient of this parameter is positive as well.

\(^{13}\) In addition, I often refer to this as the “structural” dimension of inflation.
Changes in the Value Added Tax (VAT) Rate

Although the European Union as a whole is currently undergoing a process of tax harmonization, the VAT rate is not hypothesized to affect inflation rates in and of itself. Rather, changes in this parameter can be expected to feed into inflation during the year of the policy change.

The Balassa-Samuelson Effect

Egert (2007) derives a simple accounting method that accounts for the Balassa-Samuelson effect, the conceptual theory of which was described above. He begins by assuming an economy with two sectors, traded and nontraded, and makes a number of simplifying assumptions:

- Prices in the traded sector are assumed to be determined exogenously (i.e. the Law of One Price holds for traded goods).
- Wages in the nontraded sector are connected to the level of productivity in the traded goods sector.
- Wages are assumed to be equal in both sectors.
- Prices in the nontraded (“sheltered”) sector depend on wages; that is, on unit labor cost instead of productivity.

Given these assumptions, the Balassa-Samuelson theory provides an explanatory framework for the general observation that price levels tend to be lower in poorer countries: as poorer countries tend to be less productive, the wage rate will be lower (given the fourth simplifying assumption) so that the price of services (i.e. the nontraded sector) will be lower, which leads to a lower overall price level. This basic framework
also provides an explanation for inflation as a function of productivity growth rate differentials.

The formal explanation of the theory is as follows: First, as the wage rate is assumed to be equal in both sectors, the following relationship between the relative price levels in the traded and nontraded sectors and the marginal product of labor in these sectors can be posited:

\[
\frac{p_{NT}}{p_T} = \frac{\gamma}{\delta} \frac{\partial Y^T}{\partial L^T} \frac{\partial L^T}{\partial Y^{NT}}
\]

where \( \gamma \) is the share of labor in the nontraded sector and \( \delta \) is the share of labor in the traded sector. That is, the ratio of the nontraded price level to the tradeable price level is equal to the product of the ratios of the sectoral labor shares and the sectoral marginal products of labor. Given the above equation, an increase in the share of labor in the traded sector relative to the nontraded sector would lead to a decrease in the relative price of non-tradeables, even without a change in productivity (Egert, Halpern, and MacDonald 2006). Assuming a Cobb-Douglas production function in which marginal productivity equals average productivity, the above equation can be re-written as:

\[
\frac{p_{NT}}{p_T} = \frac{\gamma}{\delta} \frac{Y^T}{L^T} \frac{L^T}{Y^{NT}}
\]

where \( Y/L \) denotes average labor productivity in the relevant sector. Taking logs leads to:

\[
p_{NT} - p_T = \text{const} + (\text{productivity}^T - \text{productivity}^{NT})
\]

where \( \text{const} \) is a constant term representing the log shares of the labor, and \( \text{prod} \) is average labor productivity (in log form). Egert’s accounting framework holds that the impact on the overall inflation rate of the non-tradeable inflation in excess of tradeable
sector inflation is determined by the share of non-tradeables in the consumption basket, so that \( \Delta P = (1-\alpha)(\Delta p^{NT} - \Delta p^T) \), where \( \alpha \) represents the share of tradeable goods in the consumption basket. An increase in the productivity growth rate differential would cause a proportional increase in the relative price of non-tradeable goods, so that the amount of inflation attributable to the Balassa-Samuelson effect is given by \( \Delta p^{BS} = (1-\alpha)(\Delta prod^T - \Delta prod^{NT}) \) where \( \Delta \) is the annual change.

IV. Empirical Framework

Given the theory of the determinants of inflation differentials as developed above, the empirical analysis allows for an assessment of the contributions of three major categories of determinants of the inflation rate: convergence factors; idiosyncratic and cyclical factors; and a factor that, if significant, will indicate that there is a significant structural dimension to inflation. Table 4.1 presents these determinants and their expected effects on Eurozone inflation differentials:

<table>
<thead>
<tr>
<th>Table 4.1: Determinants of Inflation Differentials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanatory Variable</strong></td>
</tr>
<tr>
<td>Convergence Factors</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Idiosyncratic and Cyclical Factors</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Persistence/Structural Factors</td>
</tr>
</tbody>
</table>
Econometric Specification

The general econometric model based on the determinants of inflation differentials discussed above is given by:

\[ \pi_{kt} - \pi_{EA,t} = \beta_0 + \beta_1 (P_{k,t-1} - P_{EA,t-1}) \]

\[ + \beta_2 ([1 - \alpha] (\text{Prod}_k^T - \text{Prod}_{NT}^k)) \]

\[ - [1 - \alpha] (\text{Prod}_{EA,t}^T - \text{Prod}_{NT}^{EA,t}) + \beta_3 (\pi_{k,t-1} - \pi_{EA,t-1}) \]

\[ + \beta_4 (\text{OutputGap}_{k,t} - \text{OutputGap}_{EA,t}) + \beta_5 (\Delta VAT_{k,t} - \Delta VAT_{EA,t}) + \varepsilon \]

where the \( k \) subscript indicates the individual countries; the \( EA \) subscript indicates the Eurozone; the subscript \( t \) indicates time period \( t \), the superscript \( T \) indicates the traded sector; and the superscript \( NT \) indicates the nontraded sector. The dependent variable \( \pi_{kt} - \pi_{EA,t} \) is the inflation differential, defined as the difference in inflation from the prevailing Eurozone inflation rate. \( P_{k,t-1} - P_{EA,t-1} \) is the price level differential from the overall Eurozone price level. The price level measure in this specification is an index based upon the comparative price level measure constructed in section II in which the ratio of the domestic price level for each country to the Eurozone mean was multiplied by 100. This construction allows for a simple interpretation of the coefficient estimates that will be presented: a value in this index of 120, for example, would mean that the country has a price level 20% above the Eurozone mean. Therefore, the coefficient estimates for this parameter will represent the impact on the inflation rate of a 1% increase in the price level relative to the Eurozone mean. The \([1 - \alpha] (\text{Prod}_k^T - \text{Prod}_{NT}^k) - [1 - \alpha] (\text{Prod}_{EA,t}^T - \text{Prod}_{NT}^{EA,t})\) parameter captures the effect of cross-country differences in the sectoral productivity growth rate differential on inflation differentials. \( \pi_{k,t-1} - \pi_{EA,t-1} \) is simply the lagged inflation differential, while \( \text{OutputGap}_{k,t} - \text{OutputGap}_{EA,t} \) is
the differential in the output gap, where the output gap is defined as the difference between real output and potential real output, denominated as a percentage of total GDP. $\Delta VAT_{k,t} - \Delta VAT_{E,t}$ is the differential in changes in the standard VAT rate, where the change in the VAT rate is defined as the standard rate (in percent) minus the previous year’s rate (for more details on the data, see Appendix A).

As the prevailing eurozone variables only differ over time instead of across countries, all EU variables can be combined into a time dummy (Parker 2010) so that the above equation simplifies to:

$$\pi_{k,t} = \beta_0 + \beta_1 (P_{k,t-1}) + \beta_2 ([1 - \alpha](\Delta Prod^T_{k,t} - \Delta Prod^{NT}_{k,t})) + \beta_3 (\pi_{k,t-1})$$

$$+ \beta_4 (OutputGap_{k,t}) + \beta_5 (\Delta VAT_{k,t}) + \beta_6 Year_t + \epsilon$$

It is important to note that, although the main interest of this paper is cross-country inflation differentials, this specification estimates the impact of various factors on inflation rates instead of inflation differentials directly. However, the variation in which we are most interested the cross-country differences in inflation rates and their determinants, as opposed to the determinants of the inflation rate within countries over time. Thus, the estimation procedure for the main specification of this paper was a pooled OLS with time fixed effects. Observations from Luxembourg and Ireland were excluded from the regression due to missing productivity data in those countries.

The specification of the determinants of inflation differentials was tested for overall inflation within the sample, as well as for goods-only and services-only indices. While overall inflation is of greatest interest to policymakers, examining the sectoral effects separately allows for a comparison of the relative levels of integration for each sector, with associated conclusions for the prospect of further integration. The sectoral
regressions are run on the lagged parameters for that sample; that is, goods only inflation was regressed on the lagged price level and the lagged inflation rate of the goods only index, as opposed to lags for baseline inflation. As the Balassa-Samuelson effect is assumed to work on the overall inflation rate through its effect on services prices, the term representing the weight of services in the consumption basket is removed for the sectoral-level regressions so that the impact of productivity growth differentials on services-sector inflation can be interpreted directly.

**Results**

These results, presented in Table 4.2 below, suggest that price level convergence, while statistically significant, has a limited impact on overall HICP inflation. The magnitude of the price convergence effect on inflation is rather small, as the -0.0190 coefficient estimate implies that an increase in the price level of more than 50% relative to the Eurozone mean is necessary to reduce the inflation rate by 1 percentage point. The other convergence variable, the differential in sectoral productivity growth rates, is positive but insignificant. Rather, structural and idiosyncratic variables appear to be much more significant for explaining headline inflation rates than any of the convergence processes. Especially notable is the degree of inflation persistence: nearly half of an annual headline inflation rate is determined by the previous year’s inflation. The output gap is, unsurprisingly, significant at the 1% level and suggests that a one percentage-point increase in this measure feeds into a 0.14 percentage point increase in inflation. The change in the VAT rate is also positive, but is statistically insignificant.
The respective results of the traded and non-traded sectors examined separately suggest that the positive coefficient estimate for the lagged overall price level appears to be driven by developments in the traded goods sector, in which the impact of the convergence parameter is much larger than in the overall index. Indeed, the -0.0338 coefficient estimate implies that an increase of 25% in the goods-only price level corresponds to a one percentage point decrease in inflation, as opposed to the 50% increase required for the overall index. The inflation persistence parameter is just over half as large as in the non-traded sector alone, and goods prices are not significantly responsive to changes in the output gap of VAT.

For the services-only index, in contrast, the structural and idiosyncratic control variables appear to be much more significant for explaining headline inflation rates than the convergence effects: the output gap, the lagged inflation rate, and the change in the VAT rate are all positive and significant. Especially notable is the degree of inflation
persistence, as each percentage point of inflation is responsible for more than 0.7 points of inflation in the following year. The positive and significant coefficient estimate of the productivity growth differential between the goods and services sectors offers some evidence that relative productivity growth is indeed reflected in services prices, although the magnitude of the effect is small: a 1% increase in the productivity growth rate differential is reflected in a 0.02 percentage point increase in inflation. Considering that this differential averages approximately 2.25% across the sample, with a maximum of 17% seen in France in 2004, the effect of this parameter on inflation in the services sector is negligible.

V. Conclusion

Beginning with the observation that the Euro-11 countries have seen substantial heterogeneity in inflation rates even since the adoption of the common currency in 1999, this paper has attempted to identify the causes of these inflation differentials within a convergence framework. A general discussion of comparative price levels across countries reveals that, while prices are converging, dispersion remains much higher in the nontraded goods sector and that convergence has been occurring since well before the introduction of the Euro. In order to test the hypothesis that the convergence process is responsible for much of the differences in inflation rates, a model was developed that explains inflation differentials as a function of price level differentials, inflation persistence, productivity growth rates, and idiosyncratic shocks. While price convergence is shown to be a statistically significant determinant of inflation rates, the overall magnitude of the effect is limited. Instead, inflation rates are predominantly determined by the degree of structural inflation and idiosyncratic shocks. Moreover, the effects of the
respective determinants differ between the traded and non-traded sectors: while inflation in both categories appears to be governed largely by inflation persistence, the convergence parameter is only significant for the traded goods sector. On the other hand, services inflation is highly structural and responsive to idiosyncratic shocks. In addition, while the Balassa-Samuelson effect is insignificant for the overall sample, the results presented offer tentative evidence that its basic theoretical assumption holds: sectoral productivity growth rate differentials do appear to exert upward pressure on price in the nontraded sector, although the overall magnitude of the effect is limited.

Given the small magnitude of the effect of the convergence parameter on overall inflation, its insignificance for the nontraded sector, the overall persistence of inflation, and the role of the business cycle, inflation differentials in the Eurozone do not appear to be a mere function of convergence. Thus, the results of this study suggest that, in the absence of convergence in business cycles, the determinants of inflation persistence, or a significant increase in the rate of price convergence, these misalignments in the real exchange rate and the real interest rate will likely be a challenge to European policymakers for some time to come. In addition, while this study has primarily focused on the determinants of inflation differentials, the overall dispersion in prices remains significant (especially for the nontrade sector), despite the convergence process. This dispersion is primarily due to large differentials in per-capita output and productivity, and these differentials have either been diverging or converging quite slowly (Tsagkanos, Botsaris, and Koumanakos 2006). While a thorough discussion of these issues is beyond the scope of this paper, this dispersion in the underlying “real” factors explaining price
levels along with the non-convergence factors explaining inflation differentials would be another area with which to supplement the research presented here.
Appendix A: Data

Country Samples: The sample for the baseline analysis of the years 1996-2009 consisted of the original 11 Eurozone members: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. For the longer time series (1991-2007), price level data was only available for Austria, Finland, France, Germany, Ireland, Italy, and the Netherlands.

Price level data: All price level data is extracted from Eurostat’s New Cronos database. For the 1996-2009 sample, the Harmonized Indices of Consumer Prices (HICPs) are used. The HICPs are Eurostat’s official price level measure and are Laspeyres-type price indices. Thus, instead of being a “cost-of-living” index, they are broadly intended to illustrate the development of a fixed basket of goods over time. However, a caveat to this definition must be noted. While the list of goods included in the basket is the same across all countries, no uniform market basket exists due to cross-country differences in consumption patterns among the included goods. The exact nature of certain goods and services may differ across countries as well. Within-country weights of each good must be revised every seven years, but are in practice often updated more frequently in order to account for the introduction of new goods and services and for significant changes in consumption patterns (European Commission 2004). The European Commission (2004) identifies several examples of the differences between the HICPs and the national CPIs:

- For subsidized healthcare and education, the HICP includes the net price after reimbursements to the consumer, while national CPIs often exclude these purchases from their indices or only account for the gross price.
- The HICPs exclude imputed prices for owner-occupied housing, while many national CPIs often include these measures.

For the 7-country subsample, the implicit consumption deflator for each of the twelve categories is used. As these data are not compiled from direct observations of actual prices, they are an exceptionally broad index and may be especially vulnerable to aggregation bias; that is, the overall trends observed in the price indices may be masking a much greater degree of heterogeneity in the developments of actual prices. To present an extreme and simplistic example, if the consumption basket for a given country consisted of two apples and two oranges, and the price of apples increases by 50% and that of oranges decreases by 50% the overall basket would remain unchanged.

As previously noted in the introduction, disaggregated price indices were compiled at the single-digit product category in addition to the overall price index, and many of the twelve disaggregated categories contain both goods and services within each sample. Special aggregate indices for goods only and services only, as well as the requisite PPP data, were also available, so the 1996-2009 sample includes both of these special aggregates. The twelve included disaggregated categories are as follows: food and non-alcoholic beverages; alcoholic beverages, tobacco and narcotics; clothing and footwear; housing, water, electricity, gas and other fuels; furnishings, household equipment and routine maintenance of the house; health; transport; communications; recreation and culture; education; restaurants and hotels; and miscellaneous goods and services. With the exception of the food and nonalcoholic beverages and alcoholic beverages, tobacco, and narcotics categories, which are goods only, and the services-only
restaurants and hotels and education categories, these levels of disaggregation contain both goods and services elements.

**Output Gap:** Real GDP and output gap data are from the IMF’s World Economic Outlook Database, October 2009 edition.

**Productivity:** Aggregate and sectoral-level productivity measures were constructed from raw Eurostat data. Nominal euro-denominated figures for output in the total economy and in the manufacturing, construction, and services sectors were converted into 2000 prices using their respective price deflators, and the real prices divided by their PPP value in order to make the output data comparable across countries. Each of these output measures in PPP terms was divided by the sectoral employment, and construction and services were combined to proxy for productivity in the non-tradeables sector.

**Value Added Tax Rates:** VAT rate data is compiled from the January 2010 version of the European Commission’s *VAT Rates Applied in the Member States of the European Union* publication. This document provides the current VAT rates that are applied for each category of VAT rates in the Member States (i.e. the standard VAT rate, the reduced VAT rate, and a handful of special reduced or increased rate). It also includes information on which category of VAT rates are applied to very specific goods, but does not address the evolution of which rates have been applied to different goods over time. Thus, only the standard rate is included here.
Appendix B: Price Level Dispersion, Euro-11, 1996-2009
Measure of Dispersion: Coefficient of Variation
Source for all data: author’s calculations based on Eurostat New Cronos database

![Figure B.1: Food](image1)

![Figure B.2: Alcohol and Tobacco](image2)

![Figure B.3: Clothing and Footwear](image3)

![Figure B.4: Housing](image4)

![Figure B.5: Furnishings](image5)

![Figure B.6: Health](image6)

Measure of Dispersion: Coefficient of Variation

Source for all data: author’s calculations based on Eurostat New Cronos database

Figure C.1: All Product Categories

Figure C.2: All Product Categories, Excluding Ireland
Bibliography

Berk, Jan Marc and Job Swank (2002). “Regional Price Adjustment in a Monetary Union”. Tinbergen Institute Discussion Papers 02-077/2.


