Regional inflation

SUMMARY

Inflation differentials across regions of an integrated economy can reflect a proper response to demand and supply conditions, but can also indicate distortions with negative welfare implications. Using a novel dataset of regional inflation rates from six euro area countries, we examine the size and persistence of their differentials and find that they appear to be related to factor market distortions and other structural characteristics, rather than to cyclical and growth dynamics. Our empirical analysis shows that only about half of inflation rates variation is accounted for by area-wide factors such as monetary policy or oil price developments. National factors (such as labour market institutions) still play a very important role, and a regional component accounts for about 18% of inflation variability.

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Regional inflation dynamics within and across euro area countries and a comparison with the United States

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1. INTRODUCTION

In recent years, heterogeneous inflation developments across the euro area have received considerable attention in the economic literature and in economic policy debates. The size, persistence and origins of inflation differentials across euro area countries and their potential policy implications have been analysed extensively both from a theoretical and an empirical perspective.[1] In the absence of the country-specific nominal exchange rate channel and in the presence of low labour mobility, differences in inflation rates play an important role as a macroeconomic adjustment

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[1] In Section 3 we review the literature on the sources of inflation differentials.

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mechanism in response to asymmetric shocks. Thus, inflation differentials within a monetary union such as the European Monetary Union (EMU) can be seen as 'the product of an equilibrating adjustment process . . . and, as such, are not only unavoidable, but also desirable'.[2] Inflation differentials might also be an implication of the process of convergence in per-capita incomes between relatively poor and rich regions. Inflation differentials stemming from this so-called Balassa–Samuelson effect can be considered to be benign as well, even if they are potentially quite long-lasting.

Inflation differentials can, however, also be the result of economic distortions which cause welfare losses. For example, diverging regional developments in the prices of production input factors such as labour or rents, which are not the implication of pure market forces but are caused by structural inefficiencies in factor markets, could lead to production costs and therefore goods prices in the affected regions to diverge. This can have negative implications for the competitiveness of the high-inflation regions, particularly if the inflation differentials are long-lasting.

Harmful inflation differentials can also arise from rigidities in nominal wages and prices. If adjustments to shocks are staggered and non-synchronized, a symmetric impulse will lead to differences in inflation rates. These differences can cause relative price distortions and thus inefficient allocations of households' spending. Moreover, not only differences in levels of inflation but also variations in inflation rates over time can lead to considerable welfare losses in the presence of nominal price rigidities for the same reason. As a consequence, their reduction is considered as an important objective for policy-makers by the recent New Keynesian literature on stabilization policy.[3]

Differences in inflation rates within a monetary union can also have another, potentially destabilizing, effect. Since short-term nominal interest rates are identical in a monetary union, differences in inflation rates directly transmit into differences in real interest rates. As a consequence, regions with relatively high inflation rates experience relatively low real interest rates. These relatively low real interest rates can boost investment and thus aggregate demand which in turn might lead to even higher inflation rates. Of course, these effects are more pronounced the more long-lasting inflation differentials are and would then need to be addressed by policy-makers.

The goal of this paper is to contribute to the existing literature on inflation differentials within EMU in several ways. We complement the existing literature on national inflation rates by providing a systematic analysis of inflation rates at the regional level. Use of regional CPI data allows us to see whether European regions cluster across national borders along this as well as other dimensions.[4] It also makes it possible to identify the empirical importance of the national factor for within-country inflation developments.

[2] See ECB (2005, p. 61).

[3] A standard assumption in this literature is that the policy-maker's objective is to minimize a loss function where losses depend on quadratic deviations of inflation rates from target and on quadratic deviations of output from its natural level. A utility based derivation of such a function is given in Woodford (2003, ch. 6). A more detailed discussion of this point is given in Section 5.

[4] See, e.g., the work by Overman and Puga (2002) on unemployment rates or by Quah (1996) on income growth rates.

Using a novel monthly dataset of regional inflation rates from six euro area countries, namely Austria, Germany, Finland, Italy, Portugal and Spain, we document the extent of long-run inflation rate heterogeneity. Our results indicate that inflation differentials across European regions are not only large but also long-lasting. Moreover, it turns out that regional heterogeneity is substantially larger than national heterogeneity, so that the potential problems mentioned above could be further amplified, and affect in a different way the regions of a given nation.

To determine the potential sources of the observed long-run differences in regional inflation rates and understand whether or not they are worrisome, we regress them on a set of region-specific variables which we use as proxies for sources of inflation differentials within a monetary union. Our findings suggest that labour market variables and the Balassa–Samuelson effect do not play an important role in explaining long-lasting inflation differentials.[5] Instead, we find evidence in favour of the importance of the costs of input factors other than wages, and of both the competitive and economic structure of a region. These results suggest that the observed long-run differences in regional inflation rates do not reflect the response of integrated markets to economic shocks and are not the result of a convergence process in regional incomes but that they are caused by inefficiencies in factor markets and region-specific structural characteristics. Our analysis thus implies that to reduce long-lasting, potentially damaging inflation differentials structural reforms in factor markets are needed to avoid inappropriate factor price movements.[6]

A second major contribution of our paper is that we quantify the extent to which observed inflation variations are caused by area-wide, national and regional factors. In the presence of nominal rigidities, variations in inflation cause relative price distortions and can thus create considerable welfare losses, so that they should be addressed by policy-makers.[7] Before being able to take appropriate measures to stabilize inflation rates, one first has to identify its sources. Thus, following the study by Forni and Reichlin (2001) on output fluctuations, we adopt a factor model to decompose regional inflation rates into a common area-wide, a country-specific and an idiosyncratic regional component. We find that the bulk of the variation in regional inflation rates (at least 50%) is explained by one area-wide factor. However, also the national and regional components considerably contribute to variations in regional inflation rates: The national factor explains on average 32% of observed inflation variations while the remaining 18% is due to regional elements. Furthermore,

[5] Honohan and Lane (2003) do not find an important role of the Balassa–Samuelson effect for national inflation differentials, either.

[6] Our finding that factor market distortions and differences in the competitive and economic structure are an important source of inflation differences gains renewed interest in the light of recent shocks in energy and food inflation. Our results suggest that we should observe an increase in inflation divergence across regions. A similar conclusion follows for the recently observed upward trend of the euro relative to the US dollar, a finding which is in line with previous results by Honohan and Lane (2003) obtained for national data. A more detailed investigation of these issues during the more recent period would be of great interest for further research based on a longer sample to be collected.

[7] See reference to Woodford (2003, ch. 6) in n. 3.

we find that the area-wide and the national factors affect regional inflation dynamics heterogeneously. There are two major conclusions that can be drawn from these results. First, our results suggest that the area-wide monetary policy can considerably contribute to regional inflation stabilization even though it cannot take regional developments into account when making its decisions. Secondly, our results show that in order to address welfare-affecting inflation variations national policies such as fiscal and labour market policies still play a crucial role in addition to the area-wide policy.

The result that about one-third of inflation variation is still determined at the national level is striking. However, one might wonder whether, as a consequence of EU harmonization policy and globalization, other regional characteristics such as the average level of unemployment, unit labour costs, initial income or income growth play an even more important role. From a policy perspective, if regions grouped according to these characteristics are more homogenous than regions within a nation, then, as pointed out by Overman and Puga (2002) EU regional policy should include a transnational dimension and national policies should take regional economic disparities into account. Our empirical analysis shows that nationality based groups remain more homogenous, confirming that national policies keep a major role for inflation developments.

We also evaluate the consequences of the EMU on regional inflation heterogeneity. The national component of regional inflation could reflect heterogeneous monetary policies, so it should be less important after introduction of the euro. In our data, which span the period 1995–2004, EMU inception has virtually no effect on the extent of regional heterogeneity. The most likely explanation for this finding is that (at least at the national level), inflation convergence mostly occurred before 1995. Unfortunately, comparable regional data are not available before 1995.

The last question that we examine is how our results for the euro area compare to similar findings for a monetary union which is of similar size but was established a long time ago, that is, we repeat the analysis for the United States and compare the results with those for the euro area. We find a somewhat smaller degree of dispersion in regional inflation rates across US regions than across euro area regions. Moreover, regional US inflation rates exhibit slightly less persistence than euro area inflation rates. However, the extent of heterogeneity and co-movements in the United States are similar to those for the euro area.

The remainder of the paper is organized as follows. In Section 2 we give a description of our regional dataset and document the extent of long-run differences in inflation rates across European regions. In Section 3 we provide a theoretical discussion of potential sources and implications of differences in inflation rates and inflation dynamics within a monetary union. In Section 4 we analyse to what extent the observed regional inflation differentials can be related to the theoretical causes identified in Section 3. Then, in Section 5, we decompose the dynamics of regional inflation rates into a common area-wide, a country-specific and an idiosyncratic regional component. Furthermore, we examine whether the degree of commonality in inflation

rate dynamics has experienced major changes after the introduction of the euro. In Section 6, we investigate whether national borders are still important for inflation developments in the monetary union by comparing the degree of commonality in groups of regions composed by economic characteristics with groups of regions of the same country. In Section 7, we compare our findings for the European regions with analogous results for US metropolitan areas. Section 8 summarizes our results and draws some policy conclusions.

2. HOW LARGE ARE REGIONAL INFLATION DIFFERENTIALS WITHIN THE EURO AREA?

To investigate and document systematically differences in regional inflation rates in the euro area, we collected a large set of regional and national price data. The data set contains consumer price index (CPI) data from six EMU member countries (Austria, Finland, Germany, Italy, Norway and Spain), and comprises a total of 70 locations. These data cover about two-thirds of the euro area in terms of economic activity and span the period 1995(1) to 2004(10) on a monthly frequency. For the remaining euro area countries comparable regional data are not available or at least not for a similar time span.[8]

All data are monthly, non-seasonally adjusted and are available in index form. Inflation rates π_t are computed as year-on-year percentage changes in the price index in the following way:

$$\pi_t = 100 * (\ln P_t - \ln P_{t-12}),$$

where P_t represents the respective price index in month t. Year-on-year inflation rates are plotted in Figure 1 on a monthly basis.

Figure 1 illustrates the importance and extent of regional inflation rate dispersion for our sample. It shows that short-run regional dispersion is considerable. Over the whole sample, regional year-on-year inflation varies between −1% and 7%. Additionally, there does not seem to be a tendency for overall inflation dispersion to decrease over time (no σ-convergence). There is a tendency for inflation dispersion to increase over the later part of the sample.

So far we have shown that there exists significant dispersion in inflation rates across European regions and that there is no tendency for this dispersion to decline over time. We now assess the persistence of the existing inflation differentials. As we will discuss in more detail in the next section, inflation differentials within a monetary

[8] More specifically, we are using price data for 12 German states (*Länder*), 9 Austrian regions, 5 Finnish regions, 19 Italian cities, 18 Spanish regions (*communidades*), and 7 Portuguese regions. In all cases the regions correspond to NUTS-II regions (in Eurostat's terminology), except for Germany where only data for NUTS-I regions are available. As data for Austria were only available at a city level we compiled NUTS-II level data for Austrian regions by computing a weighted regional CPI index. Weights were given by the number of inhabitants of the respective cities. Data for Italy were available for a sufficiently long time period only for the main cities in each of the NUTS-II regions. All data were provided either by a country's national statistical office (Austria, Finland, Italy, Spain and Portugal) or by the respective region's statistical office (Germany).

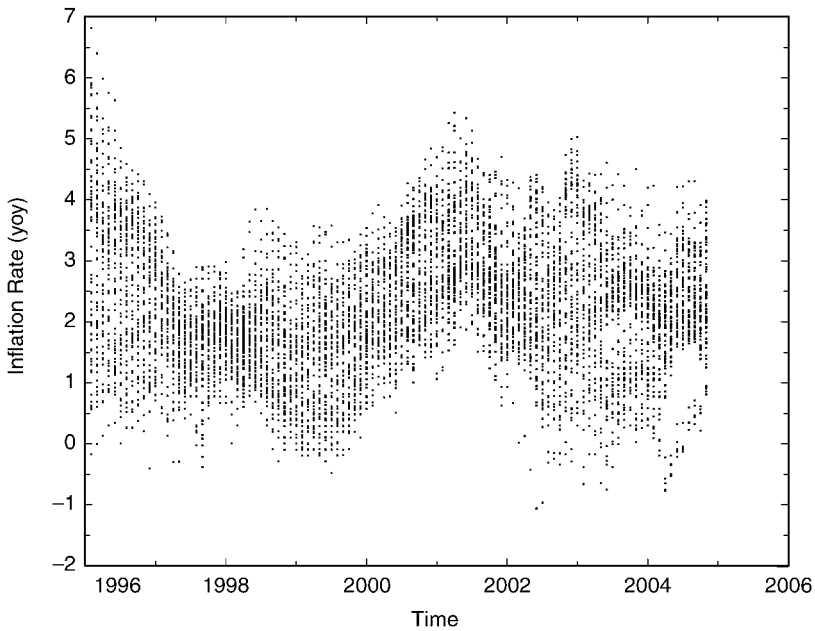

Figure 1. Regional European inflation rates: 1996(1)–2004(10)

Note: Figure 1 plots cross-sectional inflation rates for Germany, Austria, Italy, Spain, and Portugal. Inflation rates are computed as year-on-year percentage changes in the underlying consumer price index.

union are particularly troublesome if they are long-lasting, since they then can cause inappropriate changes in the real exchange rate and thus the competitiveness of the respective economies.

We have computed for each region the average year-on-year inflation over the whole sample period. The results, plotted in Figure 2, illustrate that regional differences in inflation rates are still considerable even when a relatively long time horizon is considered. The figure also shows that long-lasting inflation differentials exist not only across countries but also within countries. This is particularly true for Italy and Austria, but also applies to a smaller extent to Germany, Portugal and Spain.[9]

To quantify the extent of existing long-lasting inflation differentials across EMU regions Table 1 provides some descriptive statistics. The figures in this table confirm the graphical impression from Figure 2 that there is considerable inflation rate dispersion not only across countries but even within countries, and even at the relatively long time horizon of almost nine years. Looking at the reported cross-sectional dispersion,[10] we can see that dispersion at a national level is admittedly lower than at the EMU level; nevertheless, it is still important also at the national level. This

[9] For expositional reasons the data for Finland were omitted in Figure 2.

[10] Dispersion is measured as the standard deviation of regional mean inflation rates.

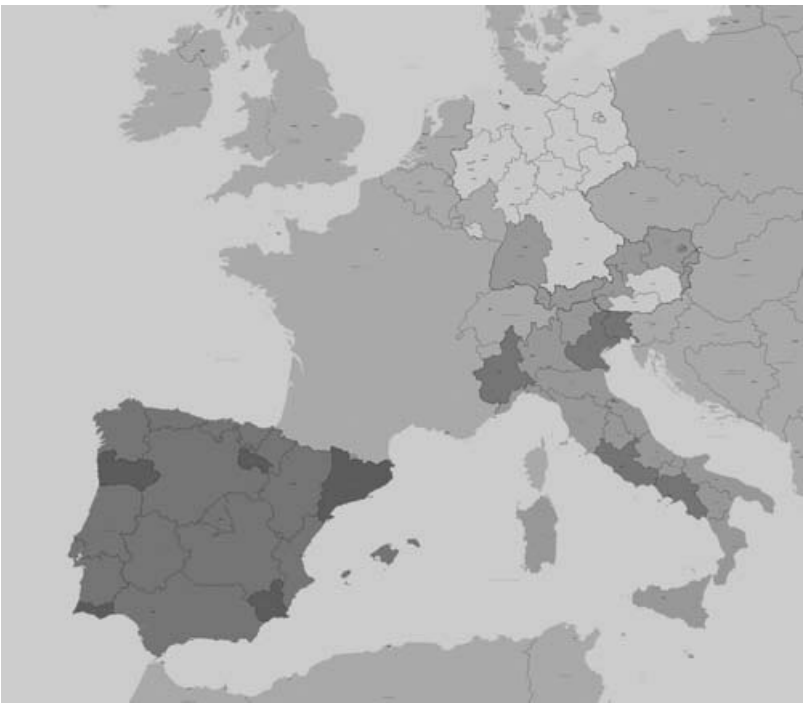

Figure 2. Mean regional European inflation rates: 1996(1)–2004(10)

Note: Figure 2 plots regional mean inflation rates for Germany, Austria, Italy, Spain, and Portugal. Inflation rates are computed as average year-on-year percentage changes in the underlying consumer price index over the period 1996(1)–2004(10). The dark colour indicates regions with average inflation rates above 2.5%, the lightest colour represents regional inflation rates below 1.5% and for the other regions average inflation is between 2.0 and 2.5%.

indicates that regional data might contain information that is not available in national data alone.

Moreover, the reported figures about long-lasting mean inflation rates in Table 1 imply that large changes in the competitive structure of EMU regions might have occurred over the sample period. Looking at the mean inflation rates reported in the upper panel of Table 1, we can see that there have been large differences in the average national inflation rates across EMU countries over the sample period: The lowest average inflation rate prevailed in Germany (1.35), followed by Finland (1.41), Austria (1.62), Italy (2.26), Portugal (2.85), and Spain (2.87, in that order). If one follows the most widely used approach in the vast purchasing power parity (PPP) literature and uses CPI data to construct the real exchange rate between two economies then the observed differences in inflation rates across countries/regions within the EMU correspond to changes in the real exchange rate between these countries/regions. Since the real exchange rate is an important indicator to assess the foreign-trade competitiveness of an economy the observed long-lasting inflation differentials might have strong implications for the relative competitiveness of the countries/regions of

Table 1. Descriptive statistics for euro area inflation rates (1996(1)–2004(10), 1996(1)–1998(12), 1999(1)–2004(10))

Results for all regions and regions grouped by countries

	1996–2004		1996–1998		1999–2004	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
All regions	2.18	0.63	1.89	0.61	2.26	0.70
Germany	1.35	0.15	1.21	0.21	1.31	0.20
Austria	1.62	0.1	1.19	0.17	1.73	0.11
Finland	1.41	0.09	1.07	0.05	1.60	0.13
Italy	2.26	0.22	2.13	0.33	2.22	0.22
Spain	2.87	0.22	2.45	0.25	3.06	0.24
Portugal	2.85	0.15	2.41	0.28	3.09	0.12

Results for regions with lowest/highest inflation rates

Regions with lowest/highest inflation rate		Group of five regions with lowest/highest inflation rates	
Min	Max	Min	Max
1.11	3.83	1.37	3.68

Note: The mean year-on-year CPI inflation rate (mean) is computed as the cross-sectional mean of all regional mean inflation rates (geometric mean) included in the respective sample. The computation of the standard deviation (std. dev.) is likewise based on the cross-section of the geometric means of all regional mean inflation rates included in the respective sample.

our sample. The reported difference in the inflation rate between an average German and an average Spanish region correspond to a cumulative depreciation in the real exchange rate between an average German and an average Spanish region of around 15% over the sample period.[11]

The numbers become even more striking when one not only looks at differences in inflation rates between the 'average' region of a country but also compares differences in inflation rates of individual regions. To this end, the lower panel of Table 1 reports differences in inflation rates between the region with the lowest and the region with the highest average inflation rate. Additionally, it documents differences in inflation rates between the group of regions with the lowest and the group of regions with the highest inflation rates.[12] According to the reported numbers the region with the lowest inflation rate experienced a real depreciation of about 25% over the sample period.

[11] To compute the reported cumulative change in the real exchange rate between an average German and an average Spanish region we define the real exchange rate, Q_t, between a German region and a Spanish region as $Q_t = P_t^G/P_t^S$, where P_t^G corresponds to the CPI of a German region in period t and P_t^S corresponds to the CPI of a Spanish region in period t. The cumulative percentage change in the real exchange rate between the two regions between period t and period $t + k$ is then computed as $(Q_{t+k} - Q_t)/Q_t$.

[12] Each group consists of five regions. Admittedly, the chosen number of five members in each group is very arbitrary. However, it solely serves to illustrate that it is instructive to take a look at the regional rather than only the national level when analysing inflation differentials within EMU. Therefore, we think that our approach is justified.

The gain in the competitiveness of the average region belonging to the group of the five regions with the lowest inflation rates is somewhat smaller but still amounts to 22%.

To gain some insights whether there have been major changes in cross-regional inflation dynamics after the introduction of the euro we split the sample into a 'pre-EMU' (1996(1) – 1998(12)) and an 'EMU' (1999(1) – 2004(10)) subsample. The results of this exercise are reported in the upper panel of Table 1. From the reported figures two observations can be made. First, mean inflation rates are always lower in the 'pre-EMU' subperiod (see Table 1). Second, inflation dispersion remains more or less stable across the two subperiods, in line with the visual impression from Figure 1. The first observation probably reflects the large efforts of EMU countries to meet the Maastricht criteria before 1999. The second observation shows that, despite substantial harmonization efforts, considerable heterogeneities across EMU regions continue to exist.[13] Our discussion and empirical investigation of the sources of those regional inflation differentials in Sections 3 and 4 gains renewed interest in the light of recent shocks in energy and food inflation as well as the recently observed upward trend of the euro relative to the US dollar.[14]

Overall, the results we have obtained so far based on regional inflation rates within and across euro area countries show that there are large and very long-lasting differences in inflation rates across EMU countries implying potentially considerable changes in the competitive structure between the considered economies. Moreover, our results demonstrate that the differences are substantially more pronounced across regions than across country averages.

Before we proceed to the next section in which we discuss potential reasons underlying these observed differences in inflation rates, we discuss whether our choice of the overall CPI data can influence the analysis. In particular, as we will discuss more in detail in the next section, one of the most-cited potential causes of inflation differences, the Balassa–Samuelson effect, has different predictions on the behaviour of the prices of goods in the tradable and non-tradable sectors. More specifically, if there is convergence in per-capita income levels between relatively poorer and richer regions, then the Balassa–Samuelson effect would imply that only the relative price of non-traded goods would increase by more in the poorer than in the richer regions. However, even if this is the case, there should still be a negative relationship between a region's initial income level and subsequent changes in the overall price level, a relationship that we will test in our econometric analysis.

[13] Since inflation rates are generally very persistent, close to unit-root processes we performed Augmented Dickey Fuller (ADF) unit root tests on the regional inflation rate series. As is well-known, the power of single-equation unit root tests is low in small samples like ours. Panel unit root tests on the other hand might not be well suited in our context due to the substantial comovement across regional inflation rates, evident in Figure 1 which would bias the tests substantially (see Banerjee *et al.*, 2005). Given the low power of the single-equation unit root tests and given the results from the panel-unit root tests we decided to base most of our analysis on inflation level data rather than first differences. However, as a sensitivity check we also repeated the analysis for first differences. The results were qualitatively similar to those reported below and can be obtained from the authors upon request.

[14] Previous results by Honohan and Lane (2003), for example, indicate that national inflation differentials can to a large extent be attributed to exchange rate effects, in particular the dollar depreciation.

Moreover, to assess whether the descriptive statistics on inflation differentials that we have reported can be distorted by the use of the overall CPI data, we have also collected comparable regional data for the sectors Food (as an example of mostly tradable goods) and Hotel and Recreation (as an example of mostly non-tradable goods).

It turns out that the dispersion in regional inflation for the food sector is about 30% higher than for the overall CPI; for the hotel sector, it is about 80% higher than for overall CPI. These results are in line with the common wisdom that trade has an equalizer effect on inflation, but also suggest that the use of the overall CPI, if anything, underestimates the extent of regional inflation heterogeneity, likely due to averaging effects in the construction of the overall price index.

Two other empirical approaches to assess the empirical importance of the Balassa–Samuelson effect are based on either absolute price data, or on PPI data. The former would allow examining to what extent observed inflation differences are the result of a convergence in price levels. The latter are assumed to contain a larger share of tradable goods, such that one should observe smaller differences in PPI inflation rates than in CPI inflation if the Balassa–Samuelson effect is underlying the large observed inflation differentials.[15] Unfortunately, absolute price data are not available at a regional basis, but the best available absolute price data normally cover only selected goods and thus are not as representative as CPI data.[16] Similarly, PPI data are not available on a regional basis, but the previously reported sectoral analysis did not highlight any substantial qualitative changes in the extent of inflation differentials with respect to the use of CPI data.

In summary, we think that our CPI data are informative and representative of inflation differentials. Even if the latter were due to the Balassa–Samuelson effect, we should observe a negative relationship between the initial income of a region and its CPI inflation rate, a hypothesis that will not find empirical support.

3. INFLATION HETEROGENEITY IN A MONETARY UNION

In this section we discuss from a theoretical point of view the potential sources of the large and long-lasting differences in inflation rates across EMU regions that we have detected, and the reasons for the differences to be considerably more pronounced across regions than across countries. In particular, we will see that inflation differentials could be either benign, for example reflecting convergence processes or adjustment to asymmetric shocks, or malign, related to market rigidities and other imperfections.

[15] The PPP literature has used both CPI and PPI data but normally does not find significant differences in the results.

[16] One of the best data sources for absolute price data are the EIU (Economist Intelligence Unit) data which were, e.g., used by Engel and Rogers (2004). This database provides complete pricing information on 160 products and services across 123 cities in 79 countries. Its major goal is to deliver information for the personnel departments of firms to enable them to calculate what staff working abroad should be earning and what prices firms' core customers. The selection of the goods included in the database is therefore biased towards these needs of the personnel departments.

The two possibilities have very different policy implications, but they can be only discriminated empirically, which will be the topic of the next section.

Given the importance of heterogeneity of inflation developments within the EMU, its possible sources have received considerable attention in the academic literature in recent years.[17]

The focus of almost all the existing papers is, however, on country data rather than on regional data, at least partly due to the lack of regional data, a gap that we close with this paper.[18] We argue that, while national borders within the euro area are relevant for inflation developments in different regions, it is instructive to look also at regional developments for three main reasons. First, the understanding of the behaviour of regionally disaggregated inflation rate series helps to understand aggregate inflation, since the construction of the latter is based on the regional series. Second, as we will see in Section 5, the use of regional data enables us to disentangle the importance of national from purely regional factors for inflation rate variability, and therefore provides policy-makers aiming at stabilizing inflation rates with useful information. Third, the larger regional than national heterogeneity in economic conditions and production structures can help the identification of the sources of inflation heterogeneity.

The literature has identified several potential sources of inflation differentials:

(a) Differences between the actual positions of the economies within their business cycles, asymmetric shocks, and asymmetric effects of area-wide impulses such as monetary policy impulses, exchange rate movements or oil price changes.
(b) The Balassa–Samuelson effect.
(c) Inappropriate domestic policies or other unwarranted domestic developments such as misaligned fiscal policies, immoderate wage evolution, or other production input factor price developments.
(d) Nominal wage and price rigidities.

Whereas the first two mentioned sources of inflation differentials are normally not worrisome from a policy point of view, since they are either only transitory (point (a)) or reflect the result of convergence dynamics (point (b)) the other two factors can lead to undesirable economic outcomes and should therefore be properly addressed by policy-makers.[19]

[17] See, e.g., the papers by Altissimo *et al.* (2005), Benigno (2004), Duarte and Wolman (2008), ECB (2003, 2005), Honohan and Lane (2003).

[18] Two notable exceptions are provided by Alberola and Marques (2000) and Beck and Weber (2005). The focus of these two papers is different from ours, though. Whereas the analysis of Alberola and Marques (2000) is purely on Spanish regions, Beck and Weber (2005) examine the dynamics of regional inflation rates within the euro area but do not relate their results on the persistence of regional inflation rate deviations from the euro area mean to potential explanatory variables.

[19] For example, the European Commission (2004) identifies problems arising, e.g., from the structural inefficiencies. European regional policies aim to address structural weaknesses of regions that limit their competitiveness. One inflation related aspect of achieving a more balanced spread of economic activity across the Union is that it will reduce bottlenecks in a growing economy and lessen the likelihood of inflationary pressure.

From an empirical point of view, due to the nature of the potential explanatory variables for inflation differentials, it is sometimes not possible to find an exact match between the theoretical variable and the variable for which data are available. For this reason, we sometimes need to proxy the variable of interest. Moreover, since our focus is on the regional rather than on the national level, we face additional data limitations both with respect to the amount of available time series and the frequency at which they are collected. Nevertheless we have been able to collect a set of regional variables which allows us to proxy the major variables that are responsible for inflation rate differentials.

In the following we present a more extended exposition of each of the theoretical factors possibly underlying inflation differentials, and of the variables we will use to proxy them in the empirical analysis of the next section. In most cases, the data for the regional real variables were obtained from Eurostat's Regio database. The original data series are mostly annual, a detailed description of the empirical variables used is given in the Data Appendix.

3.1. Asynchronous business cycles and asymmetric shocks

An important determinant of the inflation rate of a region is its position within the business cycle. A region that experiences a high aggregate excess demand is also likely to experience (due to capacity constraints and the price-setting power of the firms) an increase in goods prices whereas a region that experiences a low aggregate excess demand might experience falling prices. As a consequence, the lack of synchronization of business cycles across regions, or more generally the presence of asymmetric shocks, might represent an important reason for differences in inflation rates.

The increased cost of production which results from existing capacity constraints will not only lead to higher prices in the domestic market but will also very likely be passed on to prices of goods which are exported. As a consequence, the external demand for the goods of the region will decrease, and the increase in prices will be mitigated. The opposite is true for a region which experiences a slow-down in economic activity. Hence, inflation rate differentials are part of an equilibrium adjustment process and should vanish over time, even though in practice the process can be long. They therefore represent one of the channels through which adjustment to asymmetric shocks must occur in a monetary union where national governments no longer have the possibility to offset the effects of asymmetric economic disturbances by adjusting nominal exchange rates.[20]

[20] Alternative mechanisms are high labour mobility, wage flexibility or a monetary union-wide fiscal transfer system. However, none of these mechanisms is very likely to play a role in EMU. There is little evidence of significant labour mobility across and often even within countries and wages normally exhibit downward rigidities. Likewise, a significant centralization of national budgets at the European level has not taken place after the introduction of the euro. A fourth alternative mechanism to insure against asymmetric shocks is a high degree of financial market integration across member countries. If residents of the member countries of a monetary union hold monetary union-wide diversified portfolios the costs of asymmetric shocks will be born by all residents. Since adjustment via relative goods prices often takes very long, the achievement of a high degree of financial market integration has been the focus of European policy-makers in recent years. Empirical evidence shows that much progress has been made in this respect in recent years.

A major explanation for asynchronous business cycle developments is that the economic structures of the regions differ. Differences in the economic structure might, for example, be the result of sectoral specialization as a consequence of the higher integration of European markets.[21] These differences in the production structure can be the origin of asymmetric shocks, and of differences in the transmission of the same shocks. For example, the more open a region is and the more it trades with countries outside the euro area, the stronger will be the effect of a change in the nominal euro exchange rate on its inflation rate. Similarly, the production structure of a region also determines how strong the effect of energy shocks, such as oil price shocks are. The more energy-intensive the production is, the larger will be the influence of changes in energy prices.

Since inflation differentials caused by asymmetric shocks are part of an equilibrium adjustment process, no policy measures are required to offset them. Moreover, inflation differentials of this type should be only temporary.

This discussion suggests regional business cycle measures and indicators of production structures as potential empirical explanatory variables for regional inflation differentials. To proxy for business cycle movements we use regional GDP growth, and to proxy for differences in the production structure we use data on the relative sizes of the agriculture, industry and services sector for the regions of our sample.

3.2. Balassa–Samuelson effect

Another reason for differences in regional inflation rates is related to the process of convergence in incomes. As pointed out, for example, in ECB (2003, 2005), the process of economic convergence in per-capita income levels within a monetary union can lead to differences in inflation rates. As initially shown by Balassa (1964) and Samuelson (1964), economies that experience relatively higher productivity growth in the traded goods sector than in the non-traded goods sector will experience a higher increase in the relative price of their non-traded goods. As a consequence, the overall price levels of the relatively fast-growing economies will rise by more than those of the relatively slow-growing economies, and we will therefore observe inflation differentials between these economies.

Since there are strong differences in per-capita incomes across European countries and even within countries, and since there have been large efforts at the European-wide level to narrow these differences, it can be expected that regions with relatively low initial incomes will experience relatively higher inflation rates. Inflation differences due to this convergence process will, however, not be a major concern from a policy point of view, since they can be seen as the by-product of a desirable adjustment

[21] See, for example, Krugman (1993) or Krugman and Venables (1996). On the other hand, authors such as Frankel and Rose (2002) and Rose and Engel (2002) find that more international trade is likely to result in more highly correlated business cycles. If the latter authors are correct, then we should see a decline in European inflation differentials over time.

process. It should also be noted that inflation differentials arising from the Balassa–Samuelson effect can be expected to be relatively long-lasting. Moreover, since large income differences exist even within our sample countries (such as between Northern and Southern Italian regions or West and East German states) we should expect that inflation differentials arise not only at a national but also to a large extent at a regional level.

Since the Balassa–Samuelson effect implies a negative relationship between initial income levels (or income growth rates) and subsequent inflation rates, we have collected per-capita income series for each region to examine the empirical importance of the Balassa–Samuelson effect. We use these series to construct two different measures, which we employ as potential explanatory variables in our regression analysis: the average level of (log) per-capita income in 1995 and the average per-capita growth rate between 1995 and 2003.

3.3. Diverging prices of input factors

Diverging developments in input factor prices can lead to diverging inflation rates through their impact on marginal production costs. In the following we will discuss the two groups of input factors that can potentially lead to diverging inflation rates: regionally divergent developments in wages, and the cost of other non-traded input factors, such as renting, heating or electricity. The net price of electricity might differ across countries and even across regions (e.g. Germany), and taxes, regulations and market structure in the energy sector are also likely to differ across countries and regions.

3.3.1. Diverging regional wage developments. Different regional developments in the prices of input factors matter for inflation developments. In this context wage developments, but also other labour market variables such as unemployment rates or labour productivity, are of particular importance. Calmfors and Driffill (1988), for example, argue that differences in labour market institutions can give rise to different inflation rate outcomes. More specifically, they argue that economies with either strong centralization or strong decentralization of wage bargaining are better equipped to face supply shocks than economies with an intermediate degree of centralization. To support their hypothesis they compute what they call 'misery indices' which show that economies with intermediate degree of centralization indeed exhibit a worse performance in terms of inflation and unemployment figures than economies with extreme centralization or decentralization. As differences in wage changes are reflected in differences in labour costs, the prices of goods produced in economies with relatively higher wages will increase relatively strongly, and thus external demand for their goods will decrease.

Labour market institutions within EMU are still largely determined nationally. However, there is also some evidence for pronounced regional differences in labour market developments. Various aspects of the geographical segmentation of labour

markets across European and US regions have been analysed and discussed. For instance, Overman and Puga (2002) document the regional and transnational dimension of European unemployment, i.e. geographical unemployment clusters that do not respect national boundaries. They argue that this reflects agglomeration effects of economic integration. Bertola (2006) argues that in Europe unemployment tends to be both higher and regionally dispersed in large and heterogeneous countries than in smaller, homogeneous ones. Layard *et al.* (2005, ch. 6) document persistent regional unemployment differences in the UK. For the United States, Clark (1998) finds that a large part of the cyclical employment variation is region-specific even after controlling for industry differences, while Blanchard and Katz (1992) find regional persistence differences in employment growth, but more transitory differences in unemployment rates. Decressin and Fatás (1995) find greater persistence in the regional relative participation following a shock to regional demand in Italy than in Germany and the UK. Jimeno and Bentolila (1998) find that regional Spanish wages and relative unemployment and participation rates are very persistent.

To capture the potential effects of labour market heterogeneity on inflation differentials, in the next section we will also consider the role of average levels of unemployment, average wage growth, and average changes in unit labour costs over 1995–2004.

Low labour mobility is presumably also important for explaining regional differences. For instance, it has been pointed out in Jimeno and Bentolila (1998) that the responses of migration and participation rates to labour demand shocks are slower in Spain than in the United States. Unfortunately, migration data on a regional level are only available for some of the regions we analyse, and for those only for parts of our sample period. For example, for Germany data are only available until 1994 (for an analysis of migration between euro area countries, see e.g. Heinz and Ward-Warmedinger, 2006, and references therein).

To avoid welfare losses caused by asymmetric wage developments, structural reforms in labour markets aimed at increasing competition and equalizing labour market institutions are necessary. Since labour market institutions within EMU are still mostly determined nationally, these decisions have to be taken at a national or coordinated area-wide level.[22]

3.3.2. Other costs of non-traded input factors. A second important factor for regional price developments are the costs of non-traded input factors other than wages, e.g., the cost of renting, in particular for stores, and the costs of maintaining distribution and production facilities. Input cost changes may differ across regions, both as a result of supply and demand in segmented but freely adjusting markets, or

[22] It must be noted that asymmetric wage developments will occur in the context of the adjustment process following asymmetric shock (see Subsection 3.1). These asymmetries can, however, be considered to be temporary.

because of different and changing structural inefficiencies in regulated markets (such as in the energy sector). Those lead to regional differences in input factor cost changes.

No data are available on a regional level from our data sources on the rents and energy costs for firms and producers. Therefore, we cannot draw any firm conclusion regarding the relevance of inflation in the costs of those input factors for regional inflation differentials. However, as an empirical proxy for these effects, we will approximate inflation in factor rental costs by the average year-on-year change in the COICOP (Classification of Individual Consumption by Purpose) index 'Housing, water, electricity, gas and other fuels'.

3.4. Nominal wage and price rigidities

The existence of nominal wage and price rigidities can result in high persistence in inflation rates. When wages and prices are sticky and react only in a slow manner to exogenous shocks, the adjustment to such shocks takes a long time, and persistent inflation differentials across regions can arise. As a consequence, the functioning of the equilibrating real exchange rate channel can become less efficient. Empirical evidence on the degree of price rigidities shows the existence of sizeable, even though not dramatic, nominal rigidities in the euro area.[23] As a consequence, we observe that inflation rates exhibit a relatively high degree of persistence, which can give rise to persistent inflation differentials.[24] An additional negative implication of the existence of nominal wage and price rigidities is that they decrease economic efficiency because they lead to relative price distortions in response to economic shocks. As Woodford (2003, ch. 6) analytically shows, a policy concerned about maximizing social welfare therefore aims at stabilizing inflation rates. To reduce nominal wage and price rigidities there should be structural reforms that enhance the degree of competition. In other words, the competitive structure of a region might be a crucial factor determining the degree of prevailing nominal inertia.

Typically, nominal rigidities are associated with imperfect competition in the goods and labour markets, which in turn can be approximated by the number of suppliers, i.e., the market density, in a market. Therefore, as an available regional empirical proxy for nominal rigidities, we propose a measure of market density in the manufacturing and in the wholesale sectors.

4. EMPIRICAL EVIDENCE ON THE SOURCES OF REGIONAL INFLATION DIFFERENTIALS

In the previous two sections we have seen that there exist long-lasting and sizeable inflation rate differentials across European regions, we have discussed their potential

[23] See, e.g., Altissimo *et al.* (2006).

[24] Evidence for the persistence of inflation rates is, e.g., provided later in Table 2.

sources from a theoretical point of view, and we have shown that, depending on their sources, the inflation rate differentials can be good or bad. In this section we wish to assess empirically which are the main sources of inflation differentials, whether the differentials are good or bad, whether policy intervention is needed, and if needed whether it should be at the area wide, national or regional level.

We start this section with a discussion of some descriptive statistics for the empirical counterparts of the theoretical sources of inflation differentials that we have introduced in Section 3. In the second subsection we present a more formal regression based analysis.

4.1. Descriptive statistics

We start our empirical analysis of the possible sources of regional inflation differentials with the proxies for labour market heterogeneity introduced in Section 3, namely, average levels of unemployment, average wage growth, and average changes in unit labour costs. Table 2, columns 1 to 3, documents regional heterogeneity of labour market variables for the countries and regions that are included in our new regional inflation dataset presented in Section 2. In the first two columns of Table 2 we report mean regional unemployment rates and mean growth rates of wages for all regions as well as grouped by country, together with the respective cross-regional standard deviation. Moreover, we report the mean correlation of unemployment and wage growth with the respective regional inflation rates. The figures indicate that there is considerable dispersion of regional wage growth and unemployment rates across regions of different countries, but also across regions within a given country. For wage growth, the within country dispersion is particularly pronounced for Portugal. For unemployment rates we find very large regional dispersion in Germany, Italy and Spain. Since relatively higher unemployment rates might dampen wage increases, and since wage changes directly influence firms' marginal costs, the documented large differences in labour market variables at the regional level likely contribute to the substantial differences in regional inflation rates documented in Section 2. Actually, there is substantial negative correlation between regional unemployment and inflation, in particular in Germany and Spain. The figures on the correlation between wage growth and inflation are more varied, with positive values for Spain, close to zero for Portugal, and negative for Austria and Germany.

To capture the cost pressures from the labour market, the change in unit labour costs is a useful additional indicator since it relates nominal wages to labour productivity. For Eurostat's regional measure of changes in unit labour costs a similar pattern as for unemployment rates and wage growth is found. We detect large regional dispersion in unit labour costs developments both across and within countries, and we find a slightly positive correlation with regional inflation rates at the area-wide level. For individual countries, on the other hand, we find both positive (Spain, Portugal) and negative (Austria, Germany, Spain, Finland and Italy) correlations. Of

course, a more formal econometric analysis is required (see Box 1 and the following section), but these findings are already interesting.

Overall, dispersion in regional unemployment rates, wage growth, change in unit labour costs seem likely to have contributed to regional inflation differentials. Those at least in part are likely reflecting differences in the adjustment process to common economic shocks or adjustment to asymmetric shocks.

Let us now consider the average year-on-year change in the COICOP index 'Housing, water, electricity, gas and other fuels', which, as mentioned, we use as a representative for other costs of non-traded input factors. Descriptive statistics on this variable are reported in column 4 of Table 2 (under the heading DP_HOUS). The reported numbers suggest that changes in the housing index are in all cases positively correlated to the overall inflation rate. The observed cross-regional and cross-country patterns reflect those of the overall index. We therefore can conclude that differences in housing costs developments are likely one major driving force not only for the levels but also for the differences in regional inflation rates. Given our discussion above, this result points to the fact that some regions have experienced major increases in their marginal costs which might have led to losses in their competitiveness.

Next we move to the relative sizes of the agriculture, industry and services sector for the regions of our sample, which we have proposed as proxies for the economic structure that in turn can determine asymmetric effects from similar shocks or business cycle asymmetries. The results are reported in columns 5 to 7 of Table 2. It turns out that there are significant differences in the economic structure across regions, both across and within countries. These differences are particularly pronounced in the agriculture and in the industry sectors. Another interesting finding is that the share of industry seems to be positively correlated with inflation, while that of services negatively correlated, though with marked differences in size across countries. This result indicates that asymmetric shocks caused by sectoral specialization might be one of the sources of regional differences in inflation rates. As we outlined above, inflation differences of this type could be considered to be part of the adjustment process in response to the asymmetric shock.

As noted in the previous section, the competitive structure of a region is approximated with a measure of market density. In columns 8 and 9 of Table 2 we report descriptive statistics on the 'market density' in the manufacturing and in the wholesale sectors.[25] Again, the figures confirm that there is considerable heterogeneity across regions. Given our reasoning in the previous section, this observation suggests that goods market imperfections might play a role for inflation heterogeneities.

Finally, we consider the average level of (log) per-capita income in 1995, and the average per-capita growth rate between 1995 and 2003, which could capture Balassa–Samuelson effects. From columns 11 and 12 of Table 2, there is considerable dispersion in both income levels and growth rates within and across countries.

[25] Please see the Data Appendix for a description of how these two variables are constructed.

Table 2. Descriptive statistics for regional real data

		U [1]	*DW* [2]	*DULC* [3]	*DP_HOUS* [4]	*AGR* [5]	*IND* [6]	*SERV* [7]	*DENS_D* [8]	*DENS_G* [9]	*Y_95* [11]	*DY* [12]
All	Mean	9.76	2.94	−0.63	2.51	4.12	28.30	67.58	1.75	6.66	9.62	39.02
	Std.dev	5.93	0.89	0.70	0.69	3.36	7.22	7.68	3.60	11.95	0.28	12.97
	Corr	−0.01	0.57	0.08	0.81	0.36	−0.12	−0.04	0.26	0.27	−0.29	0.49
AU	Mean	3.46	2.40	−1.08	2.07	2.72	32.24	65.04	0.55	1.66	9.83	35.09
	Std.dev	1.23	0.34	0.57	0.42	1.97	7.02	7.84	0.36	1.08	0.23	5.58
	Corr	−0.42	−0.30	−0.41	0.65	0.32	0.34	−0.39	−0.22	−0.17	−0.32	0.30
DE	Mean	11.54	2.41	−0.73	1.69	1.64	29.21	69.15	0.07	–	9.68	28.44
	Std.dev	5.74	0.29	0.95	0.24	1.16	4.66	4.56	0.06	–	0.26	9.55
	Corr	−0.55	−0.18	−0.12	0.43	−0.01	0.83	−0.85	0.39	–	0.11	0.35
ES	Mean	11.89	2.88	−0.77	3.10	5.38	28.80	65.83	2.90	11.48	9.49	54.96
	Std.dev	4.38	0.34	0.53	0.55	3.83	7.79	9.28	4.70	17.90	0.21	4.85
	Corr	−0.52	0.54	0.08	0.32	−0.14	0.43	−0.31	0.09	0.03	0.52	−0.08
FI	Mean	11.08	–	−0.27	1.71	5.59	33.01	61.41	0.74	1.80	9.61	49.15
	Std.dev	2.87	–	0.39	0.10	3.22	4.57	4.87	0.50	0.65	0.16	3.69
	Corr	−0.27	–	−0.62	0.36	0.23	−0.46	0.28	−0.43	−0.51	−0.11	−0.72
IT	Mean	10.55	–	−0.43	2.71	3.66	26.51	69.84	2.44	5.22	9.73	29.84
	Std.dev	7.40	–	0.47	0.40	1.48	6.53	6.07	4.59	7.68	0.27	4.77
	Corr	−0.30	–	−0.17	0.55	−0.59	0.30	−0.18	−0.13	0.00	0.46	−0.28
PO	Mean	5.12	4.73	−0.28	2.83	7.36	22.57	70.07	1.97	7.38	9.32	42.60
	Std.dev	1.58	0.66	1.11	0.60	5.72	9.26	10.47	2.55	10.82	0.20	14.60
	Corr	0.11	0.01	0.60	0.67	0.12	0.21	−0.26	−0.29	−0.25	0.17	−0.55

Note: Table 2 reports means and standard deviations of the respective regional variables. Moreover mean correlations with the respective regional inflation rates are reported for all real variables for all regions as well as for the respective countries. *U*: Unemployment rate; *DW*: Year-on-year changes in quarterly monthly wages; *DULC*: Change in unit labour costs; *DP_HOUS*: Year-on-year change in COICOP index 'Housing, water, electricity, gas and other fuels'; *AGR*: Percentage of Agriculture in Gross value added at basic prices; *IND*: Percentage of Industry in Gross value added at basic prices; *SERV*: Percentage of Services in Gross value added at basic prices; *DENS_D*: Number of local units (Manufacturing)/Total population; *DENS_G*: Number of local units (Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods)/Total population; *AR1*: Persistence of inflation measured as estimated coefficient in AR(1) model; *Y_95*: (Log of) PPP 1995 GDP per inhabitant; *DY*: Growth of PPP GDP per inhabitant. See the Data Appendix for more details.

Moreover, initial income levels are on average associated with higher consecutive growth rates. This holds both across and within countries. However, whereas there is a clear negative (positive) correlation between initial income at a regional level (consecutive growth rates) with inflation area-wide (as suggested by theory), the correlation patterns within countries are less clear-cut. However, inflation differences due to the convergence process are benign and are not a major concern from a policy point of view, since they will become less pronounced over time and ultimately disappear.

4.2. A more formal evaluation

After the descriptive analysis, we now present the results of a more formal cross-sectional regression based approach to explain average (over time) regional inflation, see Table 3 (see also Box 1 for the overall econometric framework considered in this paper). We focus on a specification that does not include all the variables listed in Table 2. The selection of the variables was based on the following criteria: First, we omitted average wage changes (DW) since we do not have data for Finnish and Italian regions on this variable. Second, we dropped variables that created collinearity problems due to the presence of national dummy variables.

The results indicate that, contrary to our intuition and the descriptive analysis, labour market variables do not play an important role in explaining long-lasting regional inflation differentials. Both unemployment and unit labour costs are insignificant, unit labour costs even have the wrong sign. The results do not change if we repeat the analysis for the smaller set of regions where DW is also available. Moreover, for these regions DW is also not statistically significant. This result suggests that differences in labour market institutions do not seem to have caused long-lasting differences in inflation rates due to their impact on marginal costs.

Table 3. Regression of mean inflation rates on mean economic structural variables

Area wide analysis			
Variable	Estimate	Std. Error	
U	–0.00679	0.005798	
DULC	–0.02321	0.036111	
DP_HOUS	0.227631	0.064476	
DENS_D	–0.01197	0.005862	
SERV	–0.00723	0.0034	
DY	0.002051	0.004318	
R-squared:	0.952	Obs.	66
Rbar-squared:	0.943		

Note: National fixed effects included. White HAC standard errors. *U*: Unemployment rate; *DULC*: Change in unit labour costs; *DP_HOUS*: Year-on-year change in COICOP index 'Housing, water, electricity, gas and other fuels'; *SERV*: Percentage of Services in Gross value added at basic prices; *DENS_D*: Number of local units (Manufacturing)/Total population; *DY*: Growth of PPP GDP per inhabitant.

Likewise, we do not find evidence in favour of the Balassa–Samuelson effect. Even though our proxy for this effect, the average per-capita income growth rate, has the correct sign it does not turn out to be significant. We have also used initial per-capita income, the results were, however, also not supportive for the Balassa–Samuelson effect. Our results on the empirical relevance of the Balassa–Samuelson hypothesis is similar to findings of Rogers (2007), who concludes that the process of price level convergence does not explain much of observed inflation rates differentials across European cities.

However, we find strong evidence for the importance of the costs of non-wage input factors. Our proxy for the cost of this variable (DP_HOUS) has the expected positive sign and is highly significant. This result suggests that prices of some input factors such as rents, gas or electricity have risen systematically more in some regions than in other regions. Since we do not find evidence in favour of the Balassa–Samuelson effect which would justify increases in non-traded input factor prices, we can conclude that the observed differences in non-wage input factor prices have led to changes in the competitive structure of our sample regions: High inflation regions have experienced considerable competitiveness losses whereas low-inflation regions have experienced considerably competitiveness gains. Unfortunately, the available data do not allow the identification of the factors that have played a particularly important role.

The extent of competitiveness of the economy also seems to play an important role for inflation differentials. The sign for our proxy of the extent of competitiveness (*DENS_D*) is negative and significant at a 5% level. Given our discussion of this variable in the previous section, this result suggests that markets in which there are more suppliers experience relatively lower inflation rates. Our discussion on the implications of nominal rigidities suggests that regions which are more competitive thus experience relatively smaller welfare losses through inflation.

The results in Table 3 also show that the economic structure of a region plays a significant role for inflation differentials. Our proxy for sectoral specialization, the size of the service sector (*SERV*), is statistically significant. This finding shows that asymmetric shocks caused by sectoral specialization also seem to be one source of inflation differences across regions. However, as we argued in the previous section, this type of inflation differentials is not worrisome from a welfare-theoretic point of view.

It should also be remarked that our results are based on a specific and fairly short sample period, with limited business cycle fluctuations, so that it could be that labour market variables become relevant over a longer horizon, or when using producer rather than consumer prices.

However, overall, our regression results indicate that the observed long-lasting inflation differentials are the outcome of different developments in the costs of non-wage input factors and are due to differences in the competitive and economic structure of the regions. Therefore, as previously discussed, we think that a reduction in the potentially damaging long-lasting regional inflation differences can be achieved by policy reforms which aim at increasing competition in non-wage factor input and goods

markets. Our analysis suggests that these measures would help to reduce long-lasting welfare-impeding inflation differentials in the future.

5. CO-MOVEMENT AND HETEROGENEITY IN EURO AREA REGIONAL INFLATION DYNAMICS

In the econometric analysis of the previous section we have focused on long lasting (average) inflation and argued that the detected long-lasting differences in inflation rates across the member countries/regions of a monetary union are mostly harmful because they lead to competitiveness losses of high-inflation regions and relative price distortions. In this section we turn our attention to another aspect of the behaviour of inflation rates that is of interest from a welfare-theoretic aspect, namely, the variation of inflation rates over time. In the presence of nominal rigidities, policy should aim at stabilizing not only economic activity, i.e. the output gap, but also inflation rates (see Woodford, 2003, ch. 6). Across regions, as we argued above, nominal rigidities and inflation differentials similarly imply relative price distortions which are welfare-reducing. Recent evidence on the degree of nominal rigidities for the euro area suggests that prices are changed on average every 13 months.[26] This considerable nominal rigidity implies that stabilization of inflation rates is an important policy objective.

Our discussion of the various determinants of regional inflation variation in Section 3 suggests that the variables which are responsible for movements in inflation rates differ with respect to their geographical impact. It is therefore useful to group the different variables into three groups, namely into area wide, national and region specific variables. The objective of this section is to provide some insights into the relative importance of these three groups of factors for the dynamics of regional inflation rates. The results of the analysis will provide important guidelines for a policy aiming at stabilizing inflation rates.

As Forni and Reichlin (2001) have done for the analysis of regional European output volatility, we use a factor model and represent the standardized regional inflation rates as a linear combination of one (or several) area-wide factor(s), one (or several) national factor(s) and a region-specific component. The common, national and regional factors are assumed to be uncorrelated, while their effects on the inflation rates are unconstrained. While there can be economically interesting correlations between the different types of factors, our assumption is needed to identify the factor model and make its parameters and the factors estimable. Other identification restrictions are feasible, as in any simultaneous equation model, but orthogonality of the factors is the standard choice in the factor literature. The econometric factor model that we use as well as a more detailed motivation underlying this approach are presented in Box 1.[27]

[26] See, e.g., Dhyne *et al.* (2006).

[27] For a more technical discussion of the approach the reader is referred to Beck *et al.* (2006).

In the first two subsections the decomposition of regional inflation dynamics into area wide, national and regional components is presented. Since we find that there are significant differences in the extent to which regional inflation dynamics are explained by area-wide and national factors, in the third subsection we assess alternative potential reasons for the observed differences. In the final subsection, we evaluate whether and why the monetary union has had a substantial impact on the extent of commonality. We post-pone to Section 6 a discussion of whether the determinants of long lasting inflation differentials that we have discussed theoretically in Section 3 and empirically in Section 4 could also play a role in shaping the temporal evolution of inflation variations.

Box 1. Econometric framework

We model the inflation rate in region i of country j at period t, denoted by x_{ijt}, as follows:

$$x_{ijt} = \mu_{ij} + q_{ijt},$$
$$q_{ijt} = \lambda_{ij} f_t + \eta_{ij} g_{jt} + e_{ijt}, \quad (1)$$
$$i = 1, \ldots, N_j, j = 1, \ldots, 6, t = 1, \ldots, T.$$

Therefore, each regional inflation rate is decomposed into a region specific mean (a fixed effect), μ_{ij}, and a term that represents the deviation of inflation from its mean, namely, $q_{ijt} = x_{ijt} - \mu_{ij}$.

The deviation of inflation from the mean, q_{ijt}, can be further decomposed into a common component, $\lambda_{ij} f_t$, a nation specific component, $\eta_{ij} g_{jt}$, and a region specific (idiosyncratic) component, e_{ijt}. The common component is driven by few factors common to all regions, f_t, which represent economic forces such as the common monetary policy within the euro area (and similar monetary policies across countries in the convergence to the euro), and common external developments such as oil prices and the exchange rate. Notice that the common factors can have a differentiated impact on different regions, measured by the loadings λ_{ij}. The national component is driven by few factors common to all regions in a nation, g_{jt}, which can be related for example to fiscal policy and remaining labour and goods markets heterogeneity within the euro area members. The residual purely region specific component, e_{ijt}, is related to regional variables such as local labour market conditions, which could matter even more than their national counterparts due to the low labour mobility across European regions.

In order to identify the model for q_{ijt}, we assume that the common and national factors are orthonormal (namely, orthogonal, with zero mean and unit variance), and orthogonal to the idiosyncratic component e_{ijt}. Under these assumptions, it is possible to estimate each region specific mean μ_{ij} as the sample average (over time) of x_{ijt}; the common factors f_t as the principal components of the

standardized x_{ijt}; the national factors g_{jt} as the principal components of the residuals of a regression of the standardized x_{ijt} on the estimated common factors; the loadings λ_{ij} and η_{ij} as the coefficients in a regression of each standardized x_{ijt} on the estimated common and national factors; the residuals of these regressions represent the estimated regional components e_{ijt}. See Stock and Watson (2002b) and Beck *et al.* (2006) for details. In particular, Stock and Watson (2002b) show that the principal component based estimators of the factors have good properties even in the presence of a rather short temporal dimension of the sample, given a rather large cross-sectional dimension, as in our case. While more sophisticated factor estimation techniques are available, see e.g. Forni *et al.* (2000, 2005b), the differences are usually minor both in simulation experiments and in empirical applications, see e.g. Kapetanios and Marcellino (2004), Favero *et al.* (2005).

The choice of the number of common and national factors, say p and v, can be made either based on specific information criteria, such as those introduced by Bai and Ng (2002), or using less formal methods, such as the fraction of variance of all series explained by the first p principal components. In our case, the information criteria suggest one common and one national factor, while the less formal methods would favour three factors of each type. We present results based on the former choice in the main text, but qualitatively the findings do not change with more factors, see Beck *et al.* (2006) for details.

It is worth mentioning that a more common modelling approach is the regression of the regional series on macroeconomic variables, possibly at different levels of disaggregation, rather than on the unobservable factors. However, this approach is empirically dominated in our application by the factor specification, in terms of both explanatory power and properties of the resulting residual component e_{ijt}, see Beck *et al.* (2006) for details.

Finally, besides evaluating the decomposition of q_{ijt} into euro area level, national and regional components, it is also interesting from an economic point of view to try and explain the heterogeneity both in the mean regional inflation rates, μ_{ij}, and in the loadings of the common factors, λ_{ij}. This can be achieved by means of cross-sectional regressions, where (the estimated values of) these variables are regressed on nation specific effects, d_j, and on temporal averages of regional macroeconomic characteristics, z_{ij}. Hence the regression models are

$$\mu_{ij} = d_j + az_{ij} + u_{ij}, \tag{2}$$

and

$$\lambda_{ij} = d_j + bz_{ij} + \varepsilon_{ij}, \tag{3}$$

with $i = 1, \ldots, N_j$, $j = 1, \ldots, 6$. The parameters a and b can be estimated by OLS, and we compute HAC standard errors around the point estimates in order to account for possible heterogeneity and correlation in the errors u and ε.

5.1. How much co-movement is area wide?

The starting point of our empirical analysis is the estimation of the area wide and national common factors, which are denoted by f_t and g_{jt} in Equation (1) of Box 1. Stock and Watson (2002a) proved that, under mild regularity conditions that also allow for temporal correlation in the idiosyncratic regional errors, the factors can be consistently estimated by principal components of the variables. Therefore, to estimate the area wide factors, we extract the principal components from the pooled regional dataset, which contains a total of 70 time series.

To decide on the number of area wide factors to be used in our analysis we use the statistical information criteria for the selection of the number of factors proposed by Bai and Ng (2002). These criteria suggest that one factor is sufficient. This is a common finding in this type of analyses, see e.g. Forni and Reichlin (2001), Kose *et al.* (2003), and Ciccarelli and Mojon (2005). We therefore assume there is one area wide factor, and estimate it by the first principal component of the regional inflation rates.[28]

The first panel of Table 4 reports the proportion of the variance in all inflation rates that is explained by the first area wide factor. It turns out that almost 50% of the overall variance in regional inflation rates is due to movements in this factor. We consider this number to be a lower limit, since other selection criteria than the one by Bai and Ng (2002) might suggest using more than only one area wide factor.

When the area wide factor is regressed on area wide variables such as the short-term interest rate, M3 growth, the exchange rate and the growth in oil prices, these variables have, as expected, a good explanatory power. However, it is not possible to associate this factor with a single, specific, area wide macroeconomic variable. Additional insight into the economic interpretation of the factors could be provided by a structural factor approach along the lines of Forni *et al.* (2005a). However, our data set is not rich enough for such an approach to be implemented, since most real variables are not available on a monthly basis on the regional level.

To obtain a better understanding of the underlying structure of our common factor and the area wide inflation rate that would be computed based on our sample data we have compared the weights of each regional inflation rate in the first principal component with the economic weight of the respective region based on its GDP.[29] The results show that there are large differences between these two types of weights.

[28] More precisely, the criteria suggested by Bai and Ng (2002) can produce unreliable results in medium size samples with enough heterogeneity. Under these conditions, the information criteria tend to indicate either just one or the maximum pre-specified number of factors. Therefore, we also performed our econometric analysis based on alternative, less formal, methods for the selection of the number of factors. These methods suggest that three area wide factors should be used rather than only one. The results are qualitatively comparable to those based on one factor. Basically, as expected, there is an increase in the importance of the area wide factor, and a corresponding decreasing role for the national and regional factors, which remain important though. The interested reader is referred to Beck *et al.* (2006), where the results from both analyses are reported and compared.

[29] The results are available from the authors upon request.

Table 4. Variance explained by euro-area, national and idiosyncratic factors

	All regions					
Proportion of variance explained	48.46					
	Austria		Germany		Spain	
	National	Regional	National	Regional	National	Regional
Proportion of variance explained	30.36	21.18	37.11	14.43	26.88	24.66
	Finland		Italy		Portugal	
	National	Regional	National	Regional	National	Regional
Proportion of variance explained	48.80	2.74	28.73	22.81	34.78	16.76

Note: The area wide factor ('All Regions') is estimated as the first principal component extracted from a dataset with the inflation rates of all the regions of all countries, over the monthly sample 1996–2004. Each national factor is estimated as the first principal component extracted for each country from the residuals of a regression of regional inflation rates on the area wide factor, over the same sample period. We report the proportion of variance explained by the area wide factor (that is the same for all countries) and, for each country, the proportion of variance explained by the national factor and the residual idiosyncratic regional contribution.

This is to be expected since the principal component analysis maximizes the explained variance rather than representing the relative economic importance of a region. Thus, Spanish regional inflation series, for example, obtain a relatively large weight in the first principal component, whereas German regional inflation series obtain a relatively low weight. Nevertheless, there is a very high correlation between the area wide factor and the euro area HICP inflation rate (about 0.90). We will also discuss in the next subsections how the relative importance of the area wide, national and regional components differs geographically.

5.2. National factors and regional heterogeneity

After having obtained the area wide factor, we now discuss estimation of the national factor.

For each country, we clean the regional series from the common area wide effects by regressing them on the estimated area wide factor. The principal components of the resulting residuals can be used to estimate the national factors. This procedure is justified by the assumed orthogonality of the area wide, national and regional components.

Again we use the information criteria by Bai and Ng (2002) and find that for all countries one national factor seems to be sufficient. In the lower panels of Table 4 we report the proportion of the (overall) variance in regional inflation rates of a specific country that is explained by the national factor. We additionally report the

proportion of the variance in regional inflation rates that is not explained by either the area wide or the national factor and is thus region-specific.

The results show that the national factors play an important role in explaining regional inflation rates. The proportion of variance in regional inflation rates that is explained by the national factor ranges from about 25% for Spain to almost 50% for Finland. These differences are partly due to economic reasons, such as the economic size of the regions and the different degree of policy decentralization/independence, and partly purely to the lower number of regions in smaller countries. The low value for Spain, for example, can probably be explained by the high degree of independence that Spanish communities enjoy. On the other hand, the large value for Finland can be explained by the fact that the individual provinces have little significance.

On average, 32% of regional inflation variation is explained by the national factors. This result shows that national policies are still very important for regional inflation rate dynamics despite the fact that monetary policy is no longer conducted at the national level and despite the fact that fiscal policy is considerably constrained by the Growth and Stability Pact. The strong influence of the national factor very likely results both from nationally conducted fiscal policy and nationally determined labour market institutions. As for the area-wide factor, our data is unfortunately not rich enough to associate the national factor with a single, specific, national macroeconomic variable. However, labour market variables such as unit labour costs or unemployment have a good explanatory power for the national factors in simple regression analysis.

The results of Table 4 also show that there remains a relevant regional component in all countries, except Finland. In particular, the proportion of region specific inflation variance ranges from about 14% for Germany to about 25% for Spain.

5.3. Do common area-wide and national factors affect inflation symmetrically across regions?

In the previous subsections we found that at least 50% of the variance in regional inflation rates can be attributed to area wide factors and that at least another 25% can be attributed to national factors. An interesting question that arises in the context of this analysis is whether the estimated area wide and national factors have the same effects across all regions. From an econometric point of view, this requires examining whether the loadings of the factors, denoted by λ_{ij} in Box 1, are equal across regions. If this is not the case, deviations of regional inflation from a common average value can partly be attributed to developments that affect the euro area as a whole, such as monetary policy or oil price shocks.[30]

A graphical illustration of the different loadings of the area wide and the national factors is given in Figure 3, which reports the regional loadings of the area wide

[30] Potential reasons for asymmetric effects of area wide developments are discussed in Section 3.

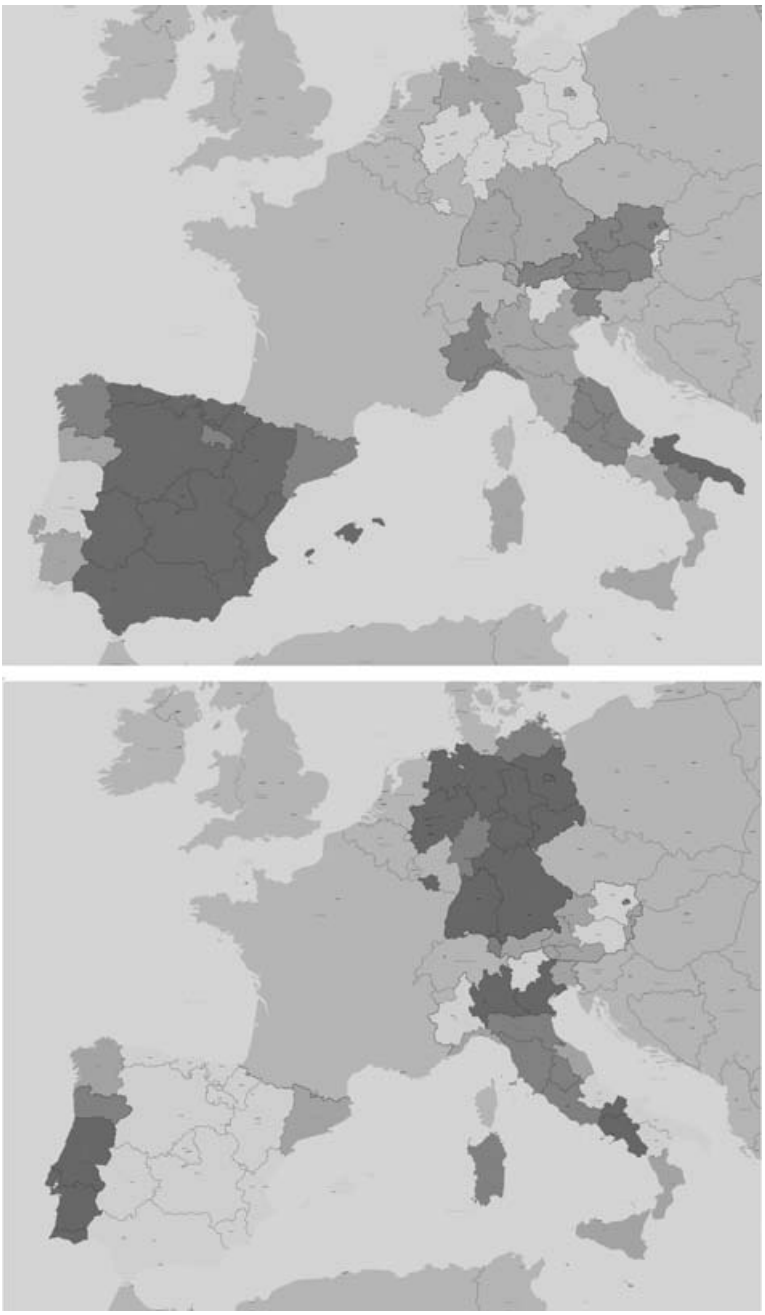

Figure 3. Percentage of inflation variance explained by the area wide component (upper panel) and national factors (lower panel)

Note: Figure 3 plots the percentage of inflation variance that is explained by the euro area wide component (upper panel) and national component (lower panel). The darker a region the higher is the percentage of explained inflation variance. Limits for colour changes are 30%, 50% and 70% (upper panel) and 20%, 30% and 40% (lower panel).

factor in the upper panel, and those for the national factors in the bottom panel. The upper panel shows that there is a lot of heterogeneity in the effect of the euro area component within nations, except in Spain and Portugal (see Forni and Reichlin, 2001, for similar findings for output growth). In particular, in Spain the euro area wide component is quite large in all regions. The lower panel shows that there is also a lot of heterogeneity in the effect of the national component within nations. One can see that the lighter areas in the bottom panel correspond roughly to the dark areas of the upper panel, that is, a region with larger area wide component of inflation will have a smaller national component. Overall, Figure 3 shows that there are large differences across regions in the proportion of overall variance explained either by the area wide or national factors.

The observed differences in the extent to which regional inflation rate dynamics are determined by area wide, national and regional factors are very likely due to asymmetries in the regional input factor prices, the economic structure and the business cycle position and the convergence of the respective regions. To obtain some intuition for the potential causes of the observed differences in the relative importance of the area wide and national factors we follow Kose *et al.* (2003), and relate the observed differences across regions to structural characteristics of the respective economies in a more formal econometric analysis.

More specifically, to characterize the relationship between the structural characteristics of economies and the relative importance of the area wide factors, we regress the loading of each region associated either with the area wide or the national factor on a set of explanatory variables that are related to regional characteristics.

In Table 5, the panel labelled 'Area wide analysis' reports results when the loadings of the area wide factors are used as the dependent variable, while the panel labelled 'Country analysis' reports analogous results when the loadings for the respective country specific factors are used as dependent variables. For each region, we consider five explanatory variables: the unemployment rate (*U*), the change in the COICOP housing cost index (*DP_HOUS*), the market density (*DENS_D*), the share of service production in overall production (*SERV*), and the GDP growth (*DY*).[31] The choice of these variables is based on data availability and on their economic relevance according to the discussion in Section 3. There we grouped the variables that can cause differences in inflation rates across regions into different classes. For our econometric analysis we decided to choose at least one variable from each group in Section 3.

Our discussion in Section 3 suggests that market density (*DENS_D*) should have a positive sign, whereas all the other variables should have a negative impact on the loadings of a region. This intuition is fully confirmed in the upper panel of Table 5, and mostly confirmed in the lower panel of Table 5. However, based on the *t*-statistics of the

[31] See the Data Appendix for a more detailed description of how the individual variables are constructed.

Table 5. Regression of regional loadings on economic structural variables

Variable	Estimate	Std. Error	
Area wide analysis			
U	–0.02009	0.302386	
DP_HOUS	–5.79983	4.468402	
DENS_D	0.160733	0.291991	
SERV	–0.17253	0.204821	
DY	–0.23461	0.185649	
R-squared:	0.709	Obs.	66
Rbar-squared:	0.656		
Country analysis			
U	0.046803	0.389653	
DP_HOUS	–3.91473	3.616188	
DENS_D	0.345413	0.495333	
SERV	–0.43577	0.425553	
DY	–0.13273	0.224306	
R-squared:	0.068	Obs.	66
Rbar-squared:	–0.009		
Regional analysis			
U	–0.08519	0.486083	
DP_HOUS	–5.94433	3.737456	
DENS_D	–0.45333	0.665835	
SERV	0.734198	0.519539	
DY	–0.24208	0.251536	
R-squared:	0.157	Obs.	66
Rbar-squared:	0.087		

Note: The upper panel of Table 5 results (estimated coefficient, White HAC Standard Error, *t*-test for non-significance and associated *p*-value) from regressing the proportion of variance explained by the area-wide factor on the unemployment rate (*U*), the growth rate of the COICOP index (*DP_HOUS*), the market density in the manufacturing sector (*DENS_D*), the share of the service sector in total production (*SERV*), and output growth between 1996 and 2003 (*DY*). The middle panel results from regressing the proportion of variance explained by the national factor and regional factor on the same variables as in the upper panel. The lower panel results from regressing the residual regional proportion of variance on the same variables as in the upper panel. The regression equation of the area wide analysis includes national dummy variables in addition to the variables listed above. The regression equation for the country analysis additionally includes a constant. An overview on the sources of the data and how they are constructed is given in the Data Appendix.

estimated coefficients, no variables are statistically significant at the conventional level.[32] Overall, the coefficients in the lower panel of Table 5 are somewhat more significant than those in the upper panel, and in this respect our results are similar to those in Kose *et al.* (2003). A major reason for the poor estimation results might be the poor quality of the available regional data.

In summary, the results of this subsection show that there is considerable heterogeneity in the economic structures of euro area regions such that even symmetric impulses such as a monetary policy shock can have heterogeneous effects.

[32] Similarly, Kose *et al.* (2003) only get indicative results when regressing the fraction of variance of output, consumption and investment attributable to a world, regional or country-specific factor on a variety of country characteristics.

5.4. The effects of the EMU

The introduction of the euro in 1999 and the associated delegation of monetary policy to the ECB represent major institutional changes that can have a large impact on inflation dynamics. In particular, we would expect a larger area wide component for inflation and a decline in dispersion in the long run. However, since the formation of a European Monetary Union was to some extent expected since the early 1990s, the convergence process has been a continuous, slowly evolving process such that there could be no major changes in regional inflation dynamics after the formal introduction of the euro.

A nice feature of the econometric model and estimation procedure we adopt is that it requires a large longitudinal dimension rather than a large temporal dimension. Therefore, we can split our already short sample into two subsamples, and evaluate whether the figures before and after 1999 differ. In particular, we consider the samples 1996–1998 and 1999–2004.

The main result is that the fraction of variance of regional inflation rates explained by the first area wide factor remains constant over 1999–2004 in comparison with 1996–1998, at about 54%. In each country, the role of the national factor is also fairly stable over the two subsamples. On this basis, we believe that our full sample results are reliable and not affected by major structural breaks.

6. HAVE NATIONAL BORDERS BECOME LESS IMPORTANT FOR INFLATION DYNAMICS?

The analysis we have conducted so far assumed that the dynamics of regional inflation rates is caused by an area wide, a national and a region-specific factor. However, in Sections 3 and 4 we have seen that the economic characteristics of a region play a relevant role for long-lasting inflation differentials. Hence, it could be that they are also relevant to shape inflation dynamics. To assess whether this is the case, now we investigate whether grouping the regions on the basis of other criteria than nationality could increase the homogeneity of the resulting aggregates, enhancing the relevance of the common component of inflation in a given group and, more generally, highlighting different schemes of inflation dynamics. For example, regions that experience high wage or unit labour cost growth or tight labour market conditions (low unemployment) might experience high inflation rates. The same can be expected when the prices of other input factors such as renting costs experience relatively high growth. From an economic point of view, it is also interesting to consider whether higher inflation persistence is associated with a larger role of the common component of inflation or with a more important regional component. Moreover, regions that grow faster or have lower per capita income can be expected to experience higher increases in prices and higher inflation.

Therefore, we will now repeat our analysis of the determinants of regional inflation variation by grouping the regions on the basis of either their average unemployment

Table 6. Proportion of total variance explained by first principal component when inflation rates are grouped by economic variables

		U		*DW*		*DULC*	
	National	Low	High	Low	High	Low	High
Variance explained	34.17	20.37	16.56	18.64	24.16	17.76	16.51
	DP_HOUS		*AR1*		*Y_95*		*DY*	
	Low	High	Low	High	Low	High	Low	High
Variance explained	22.55	16.62	16.55	16.47	16.59	23.17	21.01	20.92

Note: Low (High) indicates the group of one-third of regions characterized by the lowest (highest) values of the economic variable used for the grouping. The economic variables used for the groupings are: average unemployment rate (*U*), wage growth rate (*DW*), unit labour cost growth rate (*DULC*), growth rate of the COICOP index (*DP_HOUS*), degree of inflation persistence (*AR1*), per capita income in 1995 (*Y_95*) and growth rate over the period 1995–2001 (*DY*).

rates, wage growth rates, unit labour cost growth rates, housing cost growth rates, their degree of inflation persistence, their growth rate over the period 1995–2001 and their per capita income in 1995. For each category, we will consider six groups, containing each one-sixth of the regions.

In Table 6 we present the results of the principal component analysis for groupings based on the variables discussed above. For each variable, we report the proportion of variance that is explained by the first common component, focusing on the groups with the lowest and highest values for the economic variable used for the grouping. As a comparison, the average proportion of the variance that is explained by the national factors is about 34%, with the lowest value of 26.88% for Spain and the highest value of 48.8% for Finland.

The main feature that emerges from Table 6 is that the fraction of variance of the inflation rates in each group explained by the first factor is lower than the corresponding figure based on the national grouping. This implies that national features of a region, related, for example, to the institutional and social environment, generate more commonality than the economic features we consider.

It is also worth mentioning that the economic groups with the highest commonality are those characterized by low wage changes, unemployment, and low growth in unit labour costs.

In summary, the results we have obtained with the national grouping of the regions appear to be robust also to changes in the grouping criterion. In particular, aggregating the regions on the basis of various economic characteristics does not increase the commonality of the variation in their inflation rates or the explanatory power of the group specific factors. Therefore, these regional characteristics appear to be more related to the level of inflation than to its variation. These findings imply that, despite

strong political efforts to create a Europe of regions and despite delegation of powers to the European Commission and Parliament, national policies still play an important role for the dynamics of prices in their country.

7. WHAT ARE THE DIFFERENCES BETWEEN THE EURO AREA AND THE UNITED STATES?

To benchmark and compare our results with a long established common currency area, we have examined disaggregate inflation series for the United States. Unfortunately, consumer price data at the state level are not available over a comparable period, and those for the main metropolitan areas also present several problems of availability. We will base our analysis on a bi-monthly dataset for the same sample as for the euro area regions, 1995–2004, for eleven metropolitan areas, see the Data Appendix for details.

Average inflation over the period 1995–2004 is somewhat higher for US areas than for euro area regions, 2.50% compared to 2.18%. However, the major difference between the euro area and the United States is in the measured degree of inflation dispersion, which is about twice as large in the euro area than in the United States. This suggests that the degree of segmentation across European regional markets is considerably larger than that across US regional markets. National policies are the candidate variable to explain the larger degree of heterogeneity across euro area inflation rates, since we have seen that a national component is still very relevant to explain regional inflation in the euro area. However, the euro area data set contains a much larger number of regions, which can also contribute to the higher dispersion.

For the United States, the first principal component explains a large fraction of the variance of the metropolitan areas inflation rates, 57% versus 48% for the euro area. Therefore, we will assume that one common factor is driving all the metropolitan areas' inflation rates, and estimate it by the first principal component of the data.

When the estimated factor is used to explain the inflation dynamics in the different US areas, it is strongly significant, the average adjusted R^2 is about 0.72, and there are basically no signs of misspecification of the models, which provides support for the factor model representation of disaggregate inflation dynamics also for the United States.

In summary, with respect to the euro area, in the United States there is less dispersion in inflation rates, but this is likely due to the smaller sample available, and only a rather small increase of about 10% in the relevance of the common area wide component. Therefore, overall, the results for the euro area and for the United States are fairly similar.

8. CONCLUSIONS

In this paper we analyse regional inflation dynamics in the euro area using a novel disaggregate dataset. It contains CPI data at a regional level within euro area countries,

on a monthly frequency, covering two-thirds of the euro area in terms of economic activity. The additional regional dimension of our data allows us to gain useful insights which cannot be obtained in this form from national data only. Only by using regional data we are, for example, able to identify the empirical importance of the national factor for within country inflation rates. Moreover, the regional perspective enables us to evaluate the relative importance of national borders versus region-specific economic characteristics for within euro area inflation dynamics.

We use this regional dataset to provide insights into a variety of issues and assess whether the existing inflation differentials within the euro area have potentially welfare-damaging implications. Therefore, we provide results of interest both from an economic and a policy point of view.

In the first part of the paper, we show that there exist large and long-lasting differences in inflation rates across European regions, implying changes in the real exchange rate across individual regions of up to 25% over our sample period from 1996 to 2004. Since inflation differences even of this size and persistence can be part of a benign adjustment process, particularly if they reflect convergence in per-capita income across regions, we then examine the empirical significance of a variety of factors that can be made responsible for the observed inflation differences. Our results indicate that these differences are not related to business cycle or income growth dynamics. Somewhat surprisingly, neither our labour market related variables nor our proxy variables for the Balassa–Samuelson effect turn out to be significant in our regression analysis. Rather, our results suggest that the observed differences in regional inflation rates are primarily caused by increases in non-wage input factor prices, which do not reflect market-driven forces, and by limited competition in goods markets. From a normative point of view these results imply that the observed inflation differentials are associated with welfare losses. Whereas the first mechanism negatively impacts the competitiveness of high-inflation regions, the second one can give rise to relative price distortions due to nominal price rigidities. A welfare improving policy should aim at increasing competition in both non-wage factor and goods markets. We also find that sectoral specialization plays a significant role for the existence of regional inflation differentials.

Therefore, the key conclusion of the first part of the paper is that the main sources of long-lasting inflation differentials within the euro area are factor market distortions and other structural characteristics, which implies that inflation differentials within the euro area are welfare affecting and should be addressed by policy-makers. Moreover, in the absence of policy interventions, there should be an increase in inflation dispersion across regions in response to external shocks, such as the pronounced changes in the value of the euro or in the price of energy as recently observed in the euro area.

In the second part of our paper we analyse the role that area-wide, national and purely regional factors play for inflation variations. This is important because those factors may originate in policy-making at the three levels, and because variations in inflation rates are harmful for economic welfare in the presence of the empirically well documented rigidities in nominal goods prices. We find that about 50% of

regional inflation variation is explained by the common area-wide factor, which can be related to the common monetary policy in the euro area and to external developments, such as changes in oil prices, and the euro exchange rate. Our results further suggest that national policies still have a very significant impact on within-country inflation variations despite the constraints imposed on fiscal policy by the Growth and Stability Pact and the delegation of the conduct of monetary policy to the European Central Bank. The national factor explains on average 32% of regional inflation rate variance. This large contribution is very likely due to nationally determined fiscal policies and labour market institutions. These results on the sources of inflation variations over time imply that both a stability-oriented area-wide monetary policy and national fiscal policy can considerably contribute to a reduction in welfare-affecting inflation volatility.

The importance of the national factor is confirmed when we compare its role with that of other economic characteristics. In particular, we find that being within the national borders of a particular country is still more important for regional inflation developments than economic characteristics such as the unemployment rate, wage changes, unit labour cost changes, or output growth. We also show that the relative importance of area wide and national factors for explaining regional inflation developments is heterogeneous across euro area regions. This result implies that regional inflation rates respond differently even to a common area wide or common national impulse.

Our findings do not differ substantially before and after the formal introduction of the euro in 1999, even though the average level of regional inflation has changed. This indicates a limited effect of EMU on inflation dynamics from the mid 1990s onwards. However, both the average level of inflation and the regional dispersion were substantially higher in the early 1990s, suggesting that convergence has largely taken place before the mid 1990s.

Finally, to benchmark and compare the results for the euro area with a long established common currency area, we examined disaggregate inflation series for the United States. Apart from smaller dispersion in the United States, which could be a smaller sample problem, the results regarding heterogeneity and co-movements are similar to those for the euro area.

Discussion

Klaus Adam

Mannheim University and CEPR

The paper by Beck, Hubrich and Marcellino is a welcome study of a new data set on regional inflation rates. The data covers approximately two-thirds of the euro

area (in terms of GDP), starts 4 years prior to the creation of the euro and extends 6 years beyond its creation. One of the most compelling findings of this paper is that the introduction of the euro area seems to have had no discernible impact on regional inflation dynamics, both in terms of the cross-regional dispersion of inflation over time and in terms of the cyclical behaviour of regional inflation rates along the time series dimension. This suggests that the concerns that have been expressed prior to the creation of the euro area regarding the loss of the nominal exchange rate as a potentially important adjustment mechanism fail to receive support in the data to date.

The analysis of the data set proceeds in two meaningful steps. The first part of the analysis documents differences in regional-specific inflation means and makes an effort to link these differences to a number of regional economic indicators that proxy for a variety of economic factors giving rise to inflation differentials. Some of these factors are associated with benign and desirable relative price adjustments across regions, while others point more towards potential inefficiencies in product or factor markets. The main conclusion drawn from this part of the analysis is that it is unlikely that the observed mean inflation differences are the outcome of benign relative price adjustments. Instead, they rather reflect inefficiencies in non-labour factor input markets, while labour market factors (unemployment, wage growth) show surprisingly little explanatory power for the regional variation of mean inflation. While I generally agree with the conclusions that are reached, the interpretation of inflation differentials as non-benign and indicative of inefficiencies in non-labour factor input markets appears a bit stretched. I will suggest below that a possibly more plausible interpretation of the evidence is that the long-lasting inflation differentials are mainly the result of benign relative price adjustments in non-traded goods.

In a second step, the authors provide a comprehensive analysis of the time series behaviour of regional inflation rates (in deviation from their region-specific means) and decompose it into an aggregate, a national and a region specific 'factor'. The paper documents that prior to and after the introduction of the euro, there is strong area wide comovement in regional inflation dynamics explaining roughly 50% of the time series variability at the regional level. Another 30% of regional inflation variability is attributable to a common national factor and only about 20% of regional inflation variability is region specific. This is an intriguing set of facts and highlights that a substantial part of regional inflation might be attributed to some national component.

Which relative prices to look at?

A main task of the paper is to assess whether the observed inflation differentials can be attributed to benign relative price adjustments or whether they are due to inefficiencies or frictions in factor or product markets that should be addressed by policy. To assess this issue the paper studies differentials in CPI inflation across regions. In a currency

union, inflation differentials give rise to movements in the real exchange rate, so that the paper effectively studies regional real exchange rate movements in the euro area. One issue with the real exchange rate is that it is simply not an economically relevant relative price because the CPI contains a large share of non-traded components, including housing and local service inputs. Ideally, one should thus focus on relative price adjustment in traded goods to be able to assess whether or not relative price adjustments across regions are efficient. Relative price adjustments for traded goods could potentially point towards inefficient relative price movements. Yet, even when narrowing down the analysis to traded goods, this conclusion is not foolproof: since the initial relative price of traded goods may be distorted as well, inflation differentials in traded goods can be benign to the extent that they reduce these initial price distortions. It is important to keep these issues in mind, even if data availability appears to require using CPI data to determine the causes and desirability of regional inflation dispersion.

A crude first look at the inflation data

To illustrate the concerns mentioned above let us compare the country in the sample with the highest average inflation rate (Spain) to the one with the lowest mean inflation (Germany). Looking at the Harmonized Index of Consumer Prices (HICP) for all items, see Table 7, reveals a real exchange rate appreciation for Spain of 16% over the considered sample period. Decomposing this real exchange rate movement into the goods and services category reveals, however, that the real exchange rate appreciation in services, which tend to be less tradable than goods, was 24% and thus twice as high as that for the goods category. This suggests that a large part of the real exchange rate appreciation occurred in a sector with relatively more non-tradable components. Indeed, for housing services – a particularly non-tradable service – the Spanish appreciation was 31% and thus even larger than for the services category at large. Such an appreciation of the relative price of Spanish homes may have many economically plausible reasons, including increased demand from the Spanish population for a second home due to rising incomes, or the increased popularity of Spain as a holiday resort among foreigners. The relative price adjustments induced by such demand shifts are hardly the result of inefficiencies in the national (housing) markets.

This is not to say that there was no Spanish appreciation in traded goods prices at all. Table 7 reveals that within the goods category the price of industrial goods – a relatively more tradable goods subcomponent – still appreciated by 9% versus Germany. This is considerably less than the 16% appreciation recorded for all items and may not even be a sign of inefficiency because industrial goods likely contain a sizeable non-tradable service component as well (e.g. retail services). Moreover, one cannot rule out the possibility that Spanish industrial goods were underpriced by roughly 10% in 1996.

Table 7. Cumulative HICP inflation (1996(1)–2004(10))

	Germany	Spain	Differential
All items	+12%	+28%	+16%
Goods	+11%	+23%	+12%
– Food	+11%	+29%	+18%
– Industrial goods	+11%	+20%	+9%
Services	+14%	+38%	+24%
– Housing	+14%	+45%	+31%

Non-traded goods are significant drivers of inflation differentials

When it comes to relating the cross-regional variation in mean inflation rates to a number of economic variables, the paper documents that the change in the COICOP 04 price index (capturing the price of housing, water, electricity, gas and other fuels) is by far the most significant explanatory variable for regional variation in mean inflation (see Table 3). For Germany, the expenditure weight for housing and housing repairs in the COICOP 04 index is close to 70% (as of 2005). Other non-tradable services account roughly for an additional 10% in the index, so its tradable component (mainly fuels and electricity) is just below 20%. This index is thus largely an index of housing costs. Given the importance of housing in the overall price index, it is hardly surprising that it captures well regional variation in inflation. Moreover, this finding is just another indication that regional inflation differentials are well associated with relative price changes in non-tradable goods. In the light of this evidence, the call for national policies that aim at reducing regional inflation differential is slightly surprising. It cannot be welfare improving if national policies interfere with the relative price adjustment between non-tradable and tradable goods and services for the sake of stabilizing the real exchange rate between regions.

Overall, the picture emerging from the paper is rather reassuring: variation in regional inflation rates appears to be associated with fluctuations in non-tradable goods and there is nothing wrong with that. Of course, whether and to what extent goods and services are tradable is partly endogenous to the policy framework and it is possible that policies that aim at increasing the tradability of goods and services may improve welfare, as well as reduce real exchange rate fluctuations.

Panel discussion

Kevin O' Rourke argued that the finding that the Balassa–Samuelson effect does not play a role in terms of income levels does not necessarily dismiss the effect itself: it might have been simply absorbed by the services component, housing prices, and

other control variables. Julia Darby suggested looking at inflation differentials across sectors for countries. She also noticed that disaggregating by type of goods and considering the role not only of housing but also of energy and food prices may be more relevant than disaggregating by region. Philippe Martin asked whether price index baskets are the same in different regions.

DATA APPENDIX

Regional euro area data

- *U*: Unemployment rates by sex and age, at NUTS level 3 (%, 15 years and over, total). Reported number is average unemployment of the years 1999 to 2003. Source: Eurostat.
- *DW*: Year-on-year changes in quarterly monthly wages from national statistical offices (Missing data: Spain (data start in 1996, no data for ES Ceuta), Portugal (data start in 1998), Finland (no data), Austria (data start in 1996), Italy (no data)). Reported number is average year-on-year wage change monthly of the years 1995 to 2004. Sources: National statistical offices.
- *DP_HOUS*: Year-on-year change in COICOP index 'Housing, water, electricity, gas and other fuels'. Reported value is the average between January 1996 and October 2004 (Austrian data start in 2001, Italian data start in 1997). Sources: National statistical offices.
- *DULC*: Change in unit labour costs. Unit labour costs are computed as the growth rate of the ratio: compensation per employee in current prices divided by GDP in current prices per total employment. Source: Eurostat.
- *DENS_D*: Number of local units, NACE D, (Manufacturing)/Total population. Reference year: 2003. Source: Eurostat.
- *DENS_G*: Number of local units, NACE G, (Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods)/Total population. Reference year: 2003. Source: Eurostat.
- *AGR*: Gross value added at basic prices at NUTS level 2 – Agriculture, hunting, forestry and fishing (NACE A-B, millions of euro (from 1.1.1999)/millions of ECU (up to 31.12.1998)/Gross value added at basic prices at NUTS level 2 – All NACE branches – Total (excluding extra-territorial organizations and bodies, millions of euro (from 1.1.1999)/millions of ECU (up to 31.12.1998). Reported number is average between 1995 and 2003. Source: Eurostat.
- *IND*: Gross value added at basic prices at NUTS level 2 – Industry (NACE C–F, millions of euro (from 1.1.1999)/millions of ECU (up to 31.12.1998))/Gross value added at basic prices at NUTS level 2 – All NACE branches – Total (excluding extra-territorial organizations and bodies, millions of euro (from 1.1.1999))/millions of ECU (up to 31.12.1998). Reported number is average between 1995 and 2003. Source: Eurostat.

- *SERV*: Gross value added at basic prices at NUTS level 2 – Services (NACE G-P, millions of euro (from 1.1.1999)/millions of ECU (up to 31.12.1998))/Gross value added at basic prices at NUTS level 2 – All NACE branches – Total (excluding extra-territorial organizations and bodies, millions of euro (from 1.1.1999)/millions of ECU (up to 31.12.1998)). Reported number is average between 1995 and 2003. Source: Eurostat.
- *AR1*: Estimate of AR(1) coefficient of regional inflation rate time series (Estimated model: $\pi_{ijt} = a + \pi_{ijt-1} + \varepsilon_{ijt}$). Source: Own computation.
- *Y_95*: (Log of) Gross domestic product (GDP) at current market prices at NUTS level 2, purchasing power parities per inhabitant. Reference year: 1995. Source: Eurostat.
- ΔY: Log change of gross domestic product (GDP) at current market prices at NUTS level 2, purchasing power parities per inhabitant between 2003 and 1995. Source: Eurostat.
- *AW*1: Squared loadings of first area-wide PC ($\lambda^2_{ij,1}$). Source: Own computation.

Regional US data

US consumer price index data: Monthly CPI data are available for Chicago–Gary–Kenosha, New York–Northern New Jersey–Long Island, and Los Angeles–Riverside–Orange County. For Detroit–Ann Arbor–Flint, Houston–Galveston–Brazoria, Miami–Fort Lauderdale, Philadelphia–Wilmington–Atlantic City, and San Francisco–Oakland–San Jose CPI data are released in even-numbered months. For Boston–Brockton–Nashua, Cleveland–Akron, and Dallas–Fort Worth data are available in odd-numbered months. For US areas for which data are available monthly only even month data are used. Also, at the beginning of the sample, data for Philadelphia–Wilmington–Atlantic City and San Francisco–Oakland–San Jose were monthly, but switched to even month. For Dallas–Fort Worth data were released in even-numbered months at the beginning of the sample, while the reverse is true for Miami–Fort Lauderdale.

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