Regional Inflation Divergence in the Context of EMU

Maarten Hendrikx and Bryan Chapple

Abstract: We find that regional inflation dispersion has not markedly increased since the start of EMU, although it is somewhat higher than in other monetary unions (US and Germany), and that the distribution of member states’ rates of inflation around the euro area HICP inflation rate is characterised by a few outliers. In addition, an analysis based on economic weights suggests that roughly 60 percent of euro area consumer spending experiences an inflation rate that is within a range of 0.5 percentage points of the euro area HICP inflation rate. This suggests that in the first three years since the start of EMU regional inflation dispersion has not posed problems for the adoption of the single monetary policy for the majority of member states.

Keywords: Regional economics, European Monetary Policy, European Monetary Union (EMU), Inflation

JEL codes: E31, E52

1. INTRODUCTION

Since January 1999, responsibility for formulating European monetary policy has shifted from national central banks to the European Central Bank (ECB) in Frankfurt. Currently, one central bank sets the monetary policy stance for the entire euro area. However, the regional inflation rates in European Monetary Union (EMU) are not uniform. In particular, since Ireland’s inflation rate rose above five percent, concerns have been expressed that inflation differentials caused by the high degree of Europe’s heterogeneity might pose a problem for the formulation of the single monetary policy (Alesina et al., 2001). However, a single monetary policy cannot address regional economic dispersion in its policy making (European Central Bank, 1999 or Maier, 2001). Just as the Dutch Central Bank ignored regional inflation dispersion between the twelve Dutch provinces in conducting monetary policy for the Netherlands before 1999, the ECB also ignores inflation differentials between the twelve member states of EMU. As a consequence, monetary policy might become less optimal for a member state when the

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† This paper uses the expression ‘regional inflation’ to describe an EMU member state’s national rate of inflation.
national inflation rate deviates from the aggregate euro area inflation rate. In other words, when differentials between regional inflation rates widen, there may be an increasing divergence between actual monetary policy and the desired one based on the national inflation rate of an individual member state.2

Conversely, economic theory suggests that regional inflation dispersion in a monetary union is principally an adjustment mechanism through which regional economic imbalances are corrected. Consequently, regional inflation divergence should be a temporary phenomenon. However, in addition – or, rather counter – to this corrective mechanism, economic theory does not preclude the possibility that regional inflation might have a pro-cyclical impact on regional economic activity, via the real interest rate (Arnold and Kool, 2001 and Cecchetti et al., 2000). If this is true, regional inflation could propagate itself via diverging economic activity, increasing the inflation dispersion in the EMU.

This ambivalence regarding the consequences of regional inflation dispersion and its potential to diminish the appropriateness of the single monetary policy for an individual member state motivates the current study of the role that regional inflation plays in a monetary union. The next section presents an overview of the different causes and effects of regional inflation dispersion. In Section 3 we empirically examine current EMU inflation dispersion. We employ an indicator based on the distribution of member states’ inflation rates around the aggregated euro area inflation rate to compare the relative appropriateness of the single monetary policy for the individual member states to that of other monetary unions. The paper ends with a conclusion.

2. CAUSES AND EFFECTS OF REGIONAL INFLATION DIVERGENCE

2.1 CAUSES OF REGIONAL INFLATION DIVERGENCE

Inflation rates in EMU member states might diverge from the aggregate euro area inflation rate for a variety of reasons. We group the causes of regional inflation divergence in three categories: differences with respect to national policies, differences in structural factors and finally, differences with respect to the timing of cyclical factors between the member states of a monetary union.3

Member states might experience a divergence of the national inflation rate due to national policies. Put differently, member states’ governments may design and implement national policies that could move the national inflation rate away from the aggregate euro area inflation rate. A prime example is national fiscal policy that – although its scope is limited by the Stability and Growth Pact – can put pressure on a member state’s rate of inflation. For instance, VAT and energy tax increases in the Netherlands in 2001 led to an increase in the national inflation rate of approximately 1 percentage

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2 The danger of diverging monetary policy requirements might be of particular relevance for the discussion about EU enlargement to include East-European countries, as the economic differences between the current EMU member states and the candidate countries are considerable. For further discussion see Maier and Hendrikx (2002).
Nonetheless, changes in VAT rates should have a temporary effect on the national annual inflation rate as they represent a one-off change in the national price level, the inflationary effect of which should cease in one year, at least in the absence of wage indexation mechanisms.

Secondly, regional inflation divergence might originate from the heterogeneity in member states’ economic, institutional and financial structures. Should the European Monetary Union be hit by an economic shock – take for example the oil price shock of 1999 – it is likely that its effect on member states’ national rates of inflation will differ, as the national industries differ in their dependency on oil. The same reasoning can be applied with respect to the single European monetary policy. As the transmission channels of monetary policy differ between member states, due to differences in, for example financial structures, it is to be expected that the single monetary policy can have a different impact on individual member states.\footnote{De Nederlandsche Bank (2001).}

Another ‘shock’ that could invoke regional inflation divergence as result of structural differences, is the process of economic integration between member states, which is likely to spur nominal and real convergence by the less developed countries towards the European average (Alberola, 2000, Maier, 2000 and Rogers, 2000). However, this would imply that some member states – those that entered the EMU with a lower price level – would temporarily experience higher inflation than member states with a higher absolute price level, ceteris paribus.\footnote{The transmission of monetary policy and its working on individual member states has been subject to intense scrutiny. For a comprehensive study of monetary transmission in the euro area, see e.g. Angeloni et al. (2001).} Another spin-off of economic integration that can account for regional inflation divergence between member states is the Balassa-Samuelson effect (Balassa, 1964 and Samuelson, 1964). The effect is based on the assumption that increased economic integration is likely to result in the level of productivity in the tradable goods sector becoming more similar between member states. This implies that tradable goods productivity in lower-productivity countries catches up to the productivity level in other countries. Lower-productivity countries may therefore experience relatively higher wage growth in the tradables sector, which could spill over to the non-tradables sector of those countries. As it is assumed that productivity in the non-tradables sector does not increase at the same rate as in the tradables sector, higher inflation in the non-tradables sector results, boosting aggregate inflation. Thus, as a result of catching-up, member states with a less advanced economy (in terms of the level of productivity) might experience higher inflation than advanced member states.\footnote{Rogers (2000) finds evidence that there is price level convergence between the EMU member states, although the effect on regional inflation is only very small. For a comprehensive discussion of regional inflation differentials due to real and productivity-related convergence, see Alberola (2000).}

Finally, due to divergence in cyclical factors, fluctuations in national inflation rates might not be synchronised. In economic terminology: one member state might have output above trend, which tends to put upward pressure on inflation, while simultaneously another member state might have output

\footnote{Several studies have found evidence for the existence of the Balassa-Samuelson effect in the EMU, see e.g. Gregorio et al. (1994), Maier (2001) or Sinn and Reutter (2001).}
below trend and experience downward pressure on inflation. Correlation analysis applied to European business cycles indicates that, after a long period of increasing correlation, the process of increasing business cycle synchronisation slowed after the German reunification (Vijselaar et al., 1999). Discrepancy between the timing of business cycles might therefore remain an important explanatory factor for (temporary) regional inflation dispersion in EMU.

2.2 EFFECTS OF REGIONAL INFLATION DIVERGENCE

According to conventional economic theory, regional inflation divergence within a monetary union should initiate a corrective change in the interregional real exchange rate. Berk and Swank (2002) provide a formal treatment of this. That is, regions with high inflation will lose competitiveness relative to regions with low inflation, ceteris paribus. In the long run, therefore, regional inflation differentials should gradually cease to the extent that adjustment of the real exchange rate slows economic activity in regions with relatively high inflation and stimulates economic activity in regions with relatively low inflation. This could be further strengthened by wage adjustments in the labour market. When labour unions possess considerable bargaining power and seek to maximise nominal wages, higher regional inflation could lead to higher wage demands that could further increase prices. This would further undermine a region’s price competitiveness and reduce its economic activity. Regional inflation divergence is thus counter-cyclical and helps restore economic equilibrium between regions that experience inflation divergences. This may come at a cost, however, especially if there is hysteresis in the labour market.

However, in the short run, regional inflation might have a pro-cyclical effect on regional economic activity. As the European Central Bank decides on a single policy interest rate for the entire monetary union, regions with different inflation rates might experience different real interest rates as implied by the Fisher equation (see Arnold and Kool, 2001 or Cecchetti et al., 1999). When regional inflation expectations rise (e.g. due to higher regional growth), the regional ex ante real interest rate will fall, potentially giving these regions an additional economic boost. Note that this pro-cyclical outcome requires some critical assumptions: first that increasing regional inflation leads to growing regional inflation expectations – so that regional real interest rate differentials widen – and second that the costs of the loss in competitiveness associated with the appreciation of the real exchange rate do not fully offset the pro-cyclical impact of lower real interest rates. Arnold and Kool (2001) examine regional inflation dispersion in data from the USA. Their findings indicate that the pro-cyclical impact of a lower real interest rate dominates the counter-cyclical impact of the real exchange rate for a period of one year. These results imply that when regional inflation divergence develops, it will initially tend to increase.

8 This is exactly what Arnold and Kool (2001) argue: in a stage of high economic growth, authorities should let wages increase so as to slow disproportionate economic developments via an adjustment of the real exchange rate.

9 The speed at which economic balance between regions is restored will partly depend on the degree of factor mobility between regions. More flexibility in the labour and capital market would reduce the costs of transition towards equilibrium (De Grauwe, 2000).
Finally, regional inflation dispersion might have an impact on financial stability in the euro area. Financial instability can be defined as occurring when shocks to the financial system interfere with information flows and the financial system is unable to channel funds to those with productive investment opportunities (Mishkin, 1999). Regional inflation dispersion might increase uncertainty regarding future economic conditions, thereby impeding balanced risk-return decision making and increasing financial risks. Since monetary authorities have no instruments at their disposal to deal with regional disparity, there might be risks to local financial stability when regional inflation diverges from the euro area average. Nonetheless, with the introduction of the single currency and the elimination of nominal exchange rates between member states, an important cause for financial destabilisation has been removed. Therefore, the risk of any adverse impact from a monetary union on financial stability may in the end be limited.

The next section examines current inflation dispersion in the EMU. One of issues discussed above is that if the real interest rate effect dominates the real exchange rate effect, inflation dispersion might initially intensify inflation divergence between regions. This could then lead to an increasing divergence between the single European monetary policy and the policy that would be followed based on the inflation rate of an individual member state. In what follows we try to empirically examine whether or not these effects exist.

3. **Current Inflation Divergence in the EMU**

3.1 **The Historical Context**

To analyse current inflation dispersion in the EMU it is helpful to evaluate current dispersion in its historical perspective. We use two measures of regional inflation dispersion, namely:

1. the absolute spread between the highest and the lowest observation, and
2. unweighted standard deviations.

First we compare inflation differentials in the euro area with inflation differentials observed in other monetary unions to check whether EMU inflation dispersion is higher or lower than that of other monetary unions. Table 1 summarises regional inflation dispersion in four different monetary unions for which regional data are available.

Although the available data do not allow us to choose equal intervals, the derived averages indicate that regional inflation dispersion in the EMU is relatively high when compared to the USA and Germany. Note however, that these are unweighted measures and the table therefore gives only a partial picture of inflation dispersion.

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10 For more information about these and other measures of regional inflation dispersion, see European Central Bank (2000) and (2001). See also Fase (2002) for a principal components analysis of euro area regional inflation divergences.

11 We could not compute a weighted standard deviation, as at the time of writing we did not have information about the weights of the economic entities within Germany, the US and Spain.
Table 1 Comparing regional inflation dispersion

<table>
<thead>
<tr>
<th></th>
<th>EMU i</th>
<th>USA ii</th>
<th>Germany iii</th>
<th>Spain iv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average absolute spread</td>
<td>3.15</td>
<td>2.01</td>
<td>1.25</td>
<td>4.13</td>
</tr>
<tr>
<td>Average unweighted std.dev.</td>
<td>0.96</td>
<td>0.61</td>
<td>0.40</td>
<td>0.96</td>
</tr>
</tbody>
</table>

i Calculations are based on annual inflation data (on a monthly frequency) over the period 1999-2001, excluding Greece. Source: Eurostat.


iii Calculations are based on annual inflation data (on a monthly frequency) for the nine German Bundesländer over the period 1996-1998. Source: de Haan et al. (2001).

iv Calculations are based on annual inflation data (at an annual frequency) from 50 Spanish provinces over the period 1996-1998. Source: Alberola and Marqués (2000).

Figure 1 shows the evolution of euro area HICP inflation and the two measures of dispersion: the absolute spread and the standard deviation based on the underlying member states’ inflation rates. The upsurge of euro area HICP inflation in early 2000 seems not to have been accompanied by an increase in dispersion measured by the unweighted standard deviation. However, the absolute inflation spread has risen considerably from its low in 1999.12

Figure 1 Stable inflation dispersion – Figure 1 relates Euro area HICP inflation to the dispersion between underlying inflation rates. Despite higher euro area HICP inflation, the unweighted standard deviation remained virtually unchanged. Source: Eurostat.

Figure 2 plots the highest and lowest inflation countries of the EMU. We see that as result of a sharp increase in the Irish inflation rate, the absolute spread between the highest and lowest inflation rates increased from 1.5 percentage points in 1999 to almost 4 percentage points in the second half of 2000. In 2001, Dutch inflation exceeded 5 percent, keeping the inflation spread in the EMU at approximately 3 percentage points. In other words, the increase in the absolute spread that we saw earlier in Figure 1 is primarily related to the sharp rise in inflation in Ireland (in 2000) and the Netherlands (in 2001). However, these countries are relatively small, and so are their effects on euro area HICP inflation. Moreover, the unweighted standard deviation has not been markedly affected by the higher absolute inflation spread.

12 Note that European Monetary Union only began in January 1999.
The main cause for the recent increase in the inflation spread can thus be traced back to two outliers: Ireland and The Netherlands. Additional analysis of the respective national HICP components shows that the major causes for the increase in dispersion were (1) external shocks (high oil prices, food-and-mouth disease, BSE, bad weather conditions), (2) changes in national tax policies and (3) the cyclical positions of the member states. It seems likely that the upsurge of inflation in Ireland and the Netherlands has therefore been caused by temporary factors.\(^\text{13}\)

In addition to the fact that the outliers belong to the group of smaller member states (Greece, Ireland and the Netherlands, respectively) we observe that their position in the distribution of inflation rates changes. In other words, based on Figure 2, recent developments do not provide immediate evidence that individual countries deviate structurally from the European average inflation rate or that the inflation dispersion is uniform across the EMU. However, Berk and Swank (2002) find that euro area regional inflation rates are not significantly affected by deviations in the real exchange rate from steady-state levels, casting doubt on the role of the real exchange rate in forcing rapid inflation convergence. It may be that, thus far, the outliers within EMU have been countries with relatively flexible economic structures. Future divergence by less flexible countries may be longer lasting.

To summarise, aggregate HICP inflation has increased since 1999, but the underlying regional variability, as measured by the unweighted standard deviation does not seem to have increased.\(^\text{14}\) In addition, the absolute spread between member states’ inflation rates has been mainly determined by small member states that faced inflation divergence due to idiosyncratic shocks. The next subsection extends the analysis of current inflation dispersion in the EMU by assessing more accurately the distribution of member states’ inflation rates around the euro area HICP inflation rate.

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\(^{13}\) For further analysis, see also European Central Bank (2001).

\(^{14}\) This finding is consistent with earlier findings by the European Central Bank (2001).
3.2 The Distribution of Countries

As we have argued in the introduction, increasing regional inflation dispersion could lead to a divergence between the monetary policy stance of the ECB and the one appropriate for individual member states. It is therefore instructive to examine the position of the member states around the euro area HICP inflation rate, so as to gauge the extent to which the euro area inflation rate represents individual member states’ inflation rates. We therefore compare the actual distribution of member states’ inflation rates to two extreme theoretical distributions (Figure 3). The first assumes that regional inflation dispersion is caused solely by two outliers and that all other member states are located at the average HICP inflation rate. In this scenario, there is only a limited chance that monetary policy based on the euro area HICP inflation rate will be different from that desired by the average member state. The second distribution assumes that the regional inflation differential is caused by two groups of countries at each end of the observed absolute inflation spread, in which case the single monetary policy will probably be less appropriate for any individual member state. In the latter situation, monetary policy would likely be too loose for the group of countries above the euro area HICP inflation, and too tight for the group of countries below euro area HICP inflation. To examine the distribution of countries around the euro area HICP inflation rate, we construct an indicator that gives information about both the distribution and the spread of regional inflation rates underlying the aggregate euro area inflation rate.

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Figure 3 Two theoretical distributions – When the individual member states would have an independent monetary policy aimed at the national inflation rate, the left figure presents the most optimal situation for the EMU, as most member states are closely located around the aggregate euro area inflation rate. The right figure represents a ‘worst-case’ scenario, as none of the member states would be close to the euro area HICP inflation rate.

In order to measure the distribution, we use the unweighted coefficient of variation of the member states’ national rates of inflation. The intention is to compare the actual distribution of the member states to the two hypothetical distributions illustrated by Figure 3. This can be done by the calculation of a corridor in which for each specific moment, the hypothetical distributions of Figure 3 are derived on

15 This section draws on Maier (2002) and Maier and Hendrikx (2002).
16 We compare here the single monetary policy of the ECB to the theoretical situation in which a member states’ own central bank would target the equivalent national inflation rate and would therefore be capable of choosing a policy stance more appropriate to national circumstances than the ECB can. This assumption can offer insight into the ‘appropriateness’ of the current single monetary policy of the ECB relative to that of a national monetary policy, ceteris paribus.
basis of the observed absolute spread between the highest and lowest inflation rates. In other words, using the actual inflation spread in each period, it is possible to compute a theoretical minimum and maximum for the unweighted coefficient of variation: the maximum corresponds to the situation in which half of the countries are at the highest and the other half of the countries are at the lowest observed inflation rate. The value for the minimum coefficient of variation is obtained when all countries, except those two with the highest and lowest inflation rates, are at the average (i.e. the case of only two member states with different positions). In this way we can derive the actual ($\chi_t$), the minimum ($\chi_t^{\text{min}}$) and maximum ($\chi_t^{\text{max}}$) coefficients of variation. Note that as we use the unweighted coefficient of variation, we assume all member states have the same economic size.\(^{17}\)

$$\chi_t = \sqrt{\frac{\sum_{i=1}^{N} (y_{i,t} - \bar{y}_t)^2}{N}} \times \frac{1}{\bar{y}_t}$$

$$\chi_t^{\text{min}} = \sqrt{\left(\frac{\min(y_{i,t} - \bar{y}_t)^2}{N} + \frac{(\max(y_{i,t} - \bar{y}_t)^2}{N} + \frac{(N-2)(\bar{y}_t - \bar{y}_t)^2}{N}} \times \frac{1}{\bar{y}_t}$$

$$\chi_t^{\text{max}} = \sqrt{\alpha_t N(\min(y_{i,t} - \bar{y}_t)^2) + (1-\alpha_t)N(\max(y_{i,t} - \bar{y}_t)^2) + \frac{(N-2)(\bar{y}_t - \bar{y}_t)^2}{N}} \times \frac{1}{\bar{y}_t}$$

Figure 4 presents the corridor for the twelve EMU member states since 1992.\(^{18}\) The position of the actual coefficient of variation is markedly closer to its theoretical minimum value than to the theoretical maximum, implying that most member states are positioned closely around the euro area HICP inflation rate. A drawback of our measure of inflation dispersion is that we are not able to test quantitatively the significance of the distance between the actual dispersion and the theoretical boundaries.

Figure 4 Corridor for the Euro area – The actual coefficient of variation of the different national HICP rates is on average close to its theoretical minimum. Note that the corridors are based on the member states’ national HICP inflation rates (including Greece). Note that ‘covar’ stands for coefficient of variation. Source: Eurostat.

Figure 5 shows the corridors for Germany and the US. One notable difference between Germany and the US is that the values of the theoretical minimum and maximum coefficient of variation are higher

\(^{17}\) For the derivation of the formulas for the corridor see the appendix.

\(^{18}\) Note that the graph shows a ‘hypothetical EMU’ before 1999.
for the US than for Germany, which indicates that, at least on this measure, the US had more regional inflation dispersion than Germany.

Figure 5 Germany and the US – The inflation corridors for Germany and the US since 1975. The spread of the corridor was in
general smaller in Germany than in the USA, indicating that Germany had less outliers than the US. Furthermore, the German Bundesländer
seem to be distributed closer to the average inflation rate than their American counterparts, since the actual coefficient of variation is on
average closer to its theoretical minimum. Source, Germany: de Haan, J. Berger H. and Inklaar, R..(2001), USA: Wynne, M. A. and Koo, J
(2000).

Until this point, our study into the distribution of member states around the euro HICP inflation rate
has been based on unweighted figures, which limits the interpretation of the results. Therefore, and to
check the robustness of the previous analysis, we now integrate economic weights in the analysis. To
this end we construct a band of $\alpha$ percentage points around the euro area HICP inflation:

$$\text{Band} = \pi_t^{HICP} \pm \alpha.$$ 

Next, we count the number of EMU member states and their corresponding aggregate economic weight within the euro area (based on their share of consumption spending) within this band. This allows us to compute the percentage of economic weight represented by these member states relative to
the area as a whole. The latter observation shows us how – in terms of economic weights – the member
states are distributed around the euro area HICP inflation rate.

Figure 6 shows the percentages of economic mass for $\alpha = 1$ and $\alpha = 0.5$. The dark grey area
indicates that since 1997, on average, inflation rates for 90 percent of the euro area economy lie within a
two percentage point band centred around the euro area HICP inflation rate ($\alpha = 1$). When the band is
narrowed to $\alpha = 0.5$, the level of the euro area covered by this band falls to approximately 60 percent,
with a marked trough in 1998 and early 1999. The bold line represents actual euro area HICP inflation

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19 The corridor cannot be computed with economic weights and therefore may place too much (or too little) weight on outliers (see also Maier and Hendrikx, 2002)
20 The economic weights are derived from national consumer expenditure in 1999.
21 Since member states as Germany, France and Italy represent substantial portions of the consumer spending in the euro area, each time one of
these member states crosses the border of the band, the graph will show a peak or a trough.
rate. The worsening of the distribution at the beginning of 1999 – shown by a fall in the light grey area – is in line with the upsurge of the actual coefficient of variation relative to its corridor in Figure 4.

Figure 6 – The grey areas (left axis) represent the percentage of euro area consumer expenditure covered by the bands. The bold line is the actual euro area HICP inflation (right axis). Source: Eurostat.

Figure 7 shows the number of countries within the band. For $\alpha = 1$ the band comprises on average eight or nine member states, while for $\alpha = 0.5$, on average, five member states fall within the boundaries. Together with Figure 6, this suggests that the five member states that have been located most closely around the euro area HICP inflation (within 0.5 percentage points) represented on average 60 percent of euro area consumer spending since 1999.

Note, however, that the analysis strongly depends on the level of alpha. Since we do not have a reference value for alpha to determine which levels of alpha are ‘good’ or ‘bad’, only a limited degree of inference is possible. Nonetheless, it seems that the inflation rates of member states with largest economic weight are on average located rather close to the euro area HICP inflation rate. That is, inflation rates of countries comprising on average 60 percent of euro area consumer spending are located within a range of 0.5 percentage points of the euro area HICP inflation rate.

Figure 7 – Plotted are the number of EMU member states that fall within the borders of a specific band around the euro area HICP inflation. As there are 12 EMU member states, the maximum number of countries within the corridor is 12. Source: Eurostat.

To summarise, the current distribution of the inflation rates of the EMU-12 member states is reasonably close to the theoretically optimal distribution, calculated on the basis of the absolute inflation
spread underlying the actual euro area HICP inflation rate. The inflation distributions in the US and Germany can serve as something of a benchmark, and similar results are obtained for these monetary unions. Overall, the unweighted analysis, i.e. the earlier analysis using the corridors, suggests that in the first three years since the start of the EMU the distribution of regional inflation rates around the euro area HICP inflation rate has predominantly been characterised by 'outliers' instead of 'groups'. Extending the analysis by including economic weights of the member states, we find that since 1999, on average five countries have been located at no more than half a percentage point from the euro area HICP inflation rate. Moreover, these countries represent roughly 60 percent of total euro area consumer spending.

4. CONCLUSION

Regional inflation dispersion in a monetary union can originate from various sources. It principally performs an equilibrating role through adjustments of the real exchange rate that can help balance unequal economic developments between regions. Nevertheless, regional inflation dispersion has the potential to widen economic divergent processes via its inverse effect on the real interest rate. However, given the long run equilibrating role of the real exchange rate, there is no reason to believe – from a theoretical point of view – that member states will experience structurally higher or lower inflation than the euro area average.

When analysing regional inflation dispersion in the euro area, we find that it tends to be higher than in the US or Germany. However, when we look closer at the available data, we see that much of the euro area dispersion can be explained by outliers that result in a high absolute spread of inflation rates. In addition, the outliers tend to alternate with each other, as the divergence typically results from idiosyncratic shocks that have only temporary effects on inflation.

Monetary policy in the euro area is based on the supposition that ‘one-size-fits-all’. Yet, as the single monetary policy cannot address regional divergence, a discrepancy can arise between the policy conducted by the ECB and the policy appropriate for a member state with a diverging inflation rate. To measure the overall appropriateness of the single monetary policy for different member states, we analysed the distribution of the national inflation rates around the euro area average. Most of the time the actual spread of regional inflation rates closely resembled a theoretically ‘benign’ distribution derived from the observed inflation spread. This has been verified by an analysis based on economic weights, demonstrating that inflation rates in countries comprising approximately 60 percent of euro area fall within a range of half a percentage point from the euro area HICP inflation rate.

As theory argues that the counter-cyclical nature of regional inflation dispersion should reduce economic divergence (at least in the long run), and empirical data show that there are no clear signs of member states structurally deviating from the euro area HICP inflation rate, this gives some confidence that the ‘one-size-fits-all’ policy of the ECB has been appropriate for most member states. Combining theory and data – even though the latter is only partially available – suggests that in the first three years
since the introduction of the single currency, regional inflation dispersion in the EMU has not posed problems for the operation of the single monetary policy.

5. APPENDIX

To derive the theoretical minimum coefficient of variation, we assume that of the 12 EMU member states, exactly ten are at the observed average inflation rate. From the two countries remaining, one country is located on the minimum inflation rate and one country is positioned on the maximum observed inflation rate. Since we assume that all countries have equal weights, the formula for the minimum coefficient of variation is as follows:

\[ \chi_{\text{min}} = \frac{\sqrt{(y_{\text{min}} - \bar{y})^2 + (y_{\text{max}} - \bar{y})^2}}{N} \times \frac{1}{\bar{y}} \]

Note that since we assume that there are only two outliers, these two outliers determine the coefficient of variation given that all other countries are exactly at \( \bar{y} \). By the same token, we can construct the theoretical maximum coefficient of variation: given the observed maximum and minimum inflation rates, we position half of the countries on the minimum and half of the countries on the maximum inflation rate, inflating the coefficient of variation to its maximum. One could also think in terms of two groups of countries that lie exactly on the outer observations. Therefore, the formula for the theoretical maximum coefficient of variation is as follows:

\[ \chi_{\text{max}} = \frac{\sqrt{0.5N(y_{\text{min}} - \bar{y})^2 + 0.5N(y_{\text{max}} - \bar{y})^2}}{N} \times \frac{1}{\bar{y}} \]

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Applied to the EMU, the maximum coefficient of variation implies six countries at the minimum observed inflation rate and six countries at the maximum observed inflation rate. Visually, the minimum and maximum coefficient of variation form the boundaries of a corridor that functions as reference point for the actual coefficient of variation. Hence, in one graph we are able to evaluate current regional inflation dispersion with respect to the best and worst case scenarios given the actual absolute spread between the highest and lowest inflation rate.22

Until now we did not take into account in the formulas the actual value of the average inflation rate, but instead assumed that the actual average inflation rate would be the mid-point of the maximum and minimum inflation rates. This is not necessarily the case. When in reality the aggregate euro area HICP inflation rate is close to the minimum observed inflation rate, the average inflation rate that is implied by the minimum coefficient of variation is higher than the actual euro area HICP inflation rate and therefore the formula would give a minimum coefficient of variation that is too low. The formula for the theoretical maximum coefficient of variation would equally imply an average inflation rate that is too high and subsequently the maximum coefficient of variation would be too high. This can be corrected by adjusting the two hypothetical extreme distributions in such a way that they equate the average

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22 Note that as the spread increases the ‘corridor’ for the maximum and minimum standard deviation also becomes wider.
implied inflation rate to the actual euro area HICP inflation rate. In other words, the actual euro area
inflation rate can work as an anchor to determine the two extreme distributions.

In order to correct the minimum coefficient of variation it is necessary to insert an inflation rate \( y_t^* \) that corresponds to the inflation rate faced by the \((N - 2)\) countries. Depending on the value of the actual average inflation rate with respect to the minimum and maximum observed values, this rate \( y_t^* \) is slightly higher or lower than the actual average inflation rate. The formula for the minimum coefficient of variation changes to:

\[
\chi_t^{\min} = \sqrt{\frac{(y_t^{\min} - \bar{y}_t)^2 + (y_t^{\max} - \bar{y}_t)^2 + (N - 2)(y_t^* - \bar{y}_t)^2}{N}} \times \frac{1}{\bar{y}_t}
\]

Where \( y_t^* \) is the inflation rate experienced by \((N-2)\) countries. To derive \( y_t^* \) the actual average inflation rate is used as anchor:

\[
\bar{y}_t = y_t^{\min} + y_t^{\max} + (N - 2)y_t^*
\]

and after some rearranging, we find the third rate of inflation on which all but two member states are positioned:

\[
y_t^* = \frac{\sum_i y_t^{\min} - y_t^{\max}}{(N - 2)}
\]

The correction in our formula slightly raises the minimum coefficient of variation, since we enter
another constraint in the formula. This reflects the positioning of the actual coefficient of variation in
the corridor in a more realistic way.

The correction for the maximum coefficient of variation is as follows:

\[
\chi_t^{\max} = \sqrt{\frac{\alpha_t N(y_t^{\min} - \bar{y}_t)^2 + (1 - \alpha_t)N(y_t^{\max} - \bar{y}_t)^2}{N}} \times \frac{1}{\bar{y}_t}
\]

Instead of dividing the sample in two equal groups of countries, the alpha allows us to determine exactly
the proportion of countries that is grouped at the lowest inflation rate and at the highest inflation rate. In
this way, the ‘worst-case’ distribution will return the actual average inflation rate:

\[
\bar{y}_t = \frac{\alpha_t N y_t^{\min} + (1 - \alpha_t)N y_t^{\max}}{N}
\]

and subsequently,

\[
\alpha_t = \frac{(\bar{y}_t - y_t^{\max})}{(y_t^{\min} - y_t^{\max})}
\]

Assuming all countries have equal size, \( \chi_t^{\max} \) returns the theoretical maximum coefficient of variation
leaving the actual average inflation rate unchanged.
6. REFERENCES


— *Box 3: Rising HICP inflation has been accompanied by moderate changes in inflation dispersion across Euro area countries*, Monthly Bulletin, no. 7, 2001.


