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Explaining inflation differentials in the euro area: Evidence from a dynamic panel data model

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Abstract. We try to explain the differences in euro area countries' inflation rates over the period 1999-2006, using a dynamic panel data model. Our results suggest that euro area inflation differentials are partly due to differences in the exposure to exchange rate deviations and oil price shocks. They are also the reflection of remaining cyclical asymmetries amplified by a rather high degree of inflation persistence. On the other hand, "convergence factors", namely the price convergence process and the Balassa-Samuelson effects, do not seem to have played a key role in driving inflation differentials in the EMU since 1999. We conclude by emphasizing the potential consequences of such long-lasting inflation differentials on diverging trends in relative competitiveness of the EMU member countries.

JEL Classification: E31; E32; E58.
Keywords: Inflation Differentials; Inflation Persistence;
Economic and Monetary Union (EMU); Dynamic Panel Data Models.

Résumé. Nous cherchons à expliquer les différences observées entre les taux d'inflation des pays de la zone euro sur la période 1999-2006, en utilisant un modèle dynamique pour données de panel. Nos résultats suggèrent que les écarts d'inflation sont pour partie le résultat de différences dans l'exposition aux variations des taux de change et des prix du pétrole. Ils sont pour une autre part le reflet des asymétries conjoncturelles qui subsistent dans la zone euro, amplifiées par un degré assez élevé de persistance de l'inflation. En revanche, les "facteurs de convergence", c'est-à-dire le processus de convergence des niveaux de prix et les effets Balassa-Samuelson, ne semblent pas avoir joué un rôle majeur dans les écarts d'inflation relevés entre pays de l'UEM depuis 1999. Nous concluons en insistant sur l'impact potentiellement important de tels écarts d'inflation sur les évolutions relatives de compétitivité-prix des pays membres de l'UEM.

Classification *JEL* : E31 ; E32 ; E58.
Mots-clés : Écarts d'inflation ; persistance de l'inflation ;
Union économique et monétaire (UEM) ; données de panel.

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Introduction

After declining steadily over the nineties, the dispersion of national inflation rates within the euro area started to rise again after the launch of the single currency in 1999. Since then, inflation differentials have remained quite pronounced and, above all, very persistent. The relative positions of European countries in terms of inflation have actually changed very slowly since the creation of the Economic and Monetary Union (EMU): Germany and Austria systematically exhibited below-average annual inflation rates, whereas Spain, Greece and Ireland remained among the most inflationary countries (with annualised inflation rates that sometimes exceeded 5%).

How can we explain those disparities between national growth rates of consumer prices? In the early years of the EMU, most of the discussion on potential sources of inflation differentials within a currency area focused on two main factors: the convergence effects entailed by the price-level convergence process and the Balassa-Samuelson hypothesis on the one hand, and remaining cyclical divergence between the member countries on the other hand.[2] More recently, empirical researchers have highlighted the key role played by other factors in explaining inflation differentials in the euro area: structural differences in the wage- and price-settings across countries, different degrees of exposure to fluctuations in the euro/dollar exchange rate, differences in oil dependency, as well as differences in the conduct of fiscal policies.

Understanding the causes of inflation differentials is of major importance, since their implications for relative competitiveness may differ widely depending on the process at works: inflation differentials partly reflect cross-country differences in real variables, such as prices and productivity growth, and are in this respect not only unavoidable but also desirable. Inflation differentials may however also be linked to asymmetric shocks or asymmetric effects of common shocks, which could combine with imperfections in product and labour markets to generate long-lasting inflation differentials. Such inflation differentials would in turn distort relative price-competitiveness between EMU countries.

In this paper, we try to provide evidence on the relative contributions of each of these factors in explaining inflation differentials within the euro area over the period 1999-2006. For that purpose, we construct a dynamic panel data model close to the one used in Rogers (2002) and Honohan and Lane (2003, 2004) and we estimate this model using the "system-GMM" estimator defined in Blundell and Bond (1998). We thus try to deal more explicitly with the effects of inflation persistence (*i.e.* the tendency of inflation to converge slowly towards its long-run value after a shock), which can amplify and enlarge inflation differentials. We also explore in more details the equivocal relationship between relative cyclical positions and relative inflation, and finally take into account the predictions from models with downwardly rigid prices by allowing for potential asymmetries in the effects of our main explanatory variables.

2. *Cf*. for example European Central Bank (1999) and Alberola (2000).

Our results indicate that euro area inflation differentials are mainly driven by two factors. Firstly, they are partly the results of differences in the exposure to nominal effective exchange rates deviations, as well as differences in the exposure to oil price shocks. Secondly, inflation differentials are also the reflection of remaining differences in cyclical positions combined with a rather high degree of inflation persistence. Those "disequilibrium factors" seem to have outclassed the "convergence explanations" related to price and productivity differentials between EMU member countries. Allowing for potential asymmetries in the effects of those explanatory variables, we show that the inflationary effects of a positive output gap are in fact much stronger than the disinflationary impact of a negative output gap. In the same way, exchange rate depreciations and oil price increases seem to have a much stronger effect on inflation differentials than exchange rates appreciations and oil price decreases do.

The paper is organised as follows: the first section describes the main stylised facts related to recent inflation differentials observed within the euro area. Inflation dispersion measured within the United States, a long-standing monetary union of a comparable size, provides a useful benchmark here. Then, we investigate the main theoretical arguments that can explain inflation differentials within a monetary union, before trying to quantify the relative contributions of those potential explanations in driving inflation differentials within the euro area over the period 1999-2006. We finally conclude and provide some insights.

Some stylised facts[3]

A slight increase in the dispersion of national inflation rates after the launch of the single currency

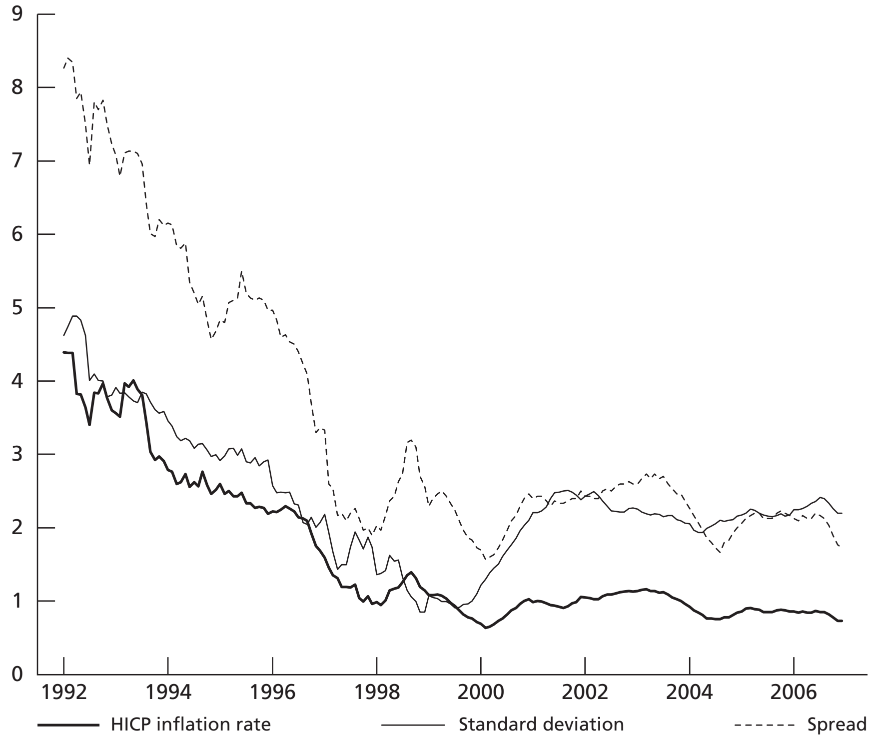
Figure 1 depicts the evolution of the official euro area aggregate inflation rate, which is defined as the annualised growth rate of the Harmonized Index of Consumer Prices (HICP). It also displays the dynamics of two indicators for inflation dispersion within the euro area: the unweighted standard development of national inflation rates and the spread between the average of the three highest and lowest rates.[4]

Inflation dispersion declined steadily all over the nineties, especially during the second stage of the EMU from January 1994 to December 1998. The unweighted standard deviation actually reached its lower level around the first quarter of year 2000, with a standard deviation smaller than one percentage point, while it was higher than four percentage points in 1992. However, figure 1 suggests a slight increase in inflation dispersion since the beginning of the year 2000, which is even more pronounced when looking at the spread. It

3. Readers looking for more details should refer to European Central Bank (2003, 2005).

4. This spread is less sensitive to outliers than a "simple spread" between the highest and lowest inflation rates. We should note however that other measures of dispersion, such as the simple spread or the weighted standard deviation (using official weights defined by the ECB for the calculation of the HICP), deliver a similar picture regarding the dynamics of national inflation dispersion within the euro area.

Figure 1 - Dispersion of national inflation rates within the euro area



Notes: The euro area inflation rate depicted here is the annualised official HICP inflation rate (in %). The dispersion indicators are the unweighted standard deviation of national HICP inflation rates and the spread between the average of the three highest and lowest rates (in percentage points).

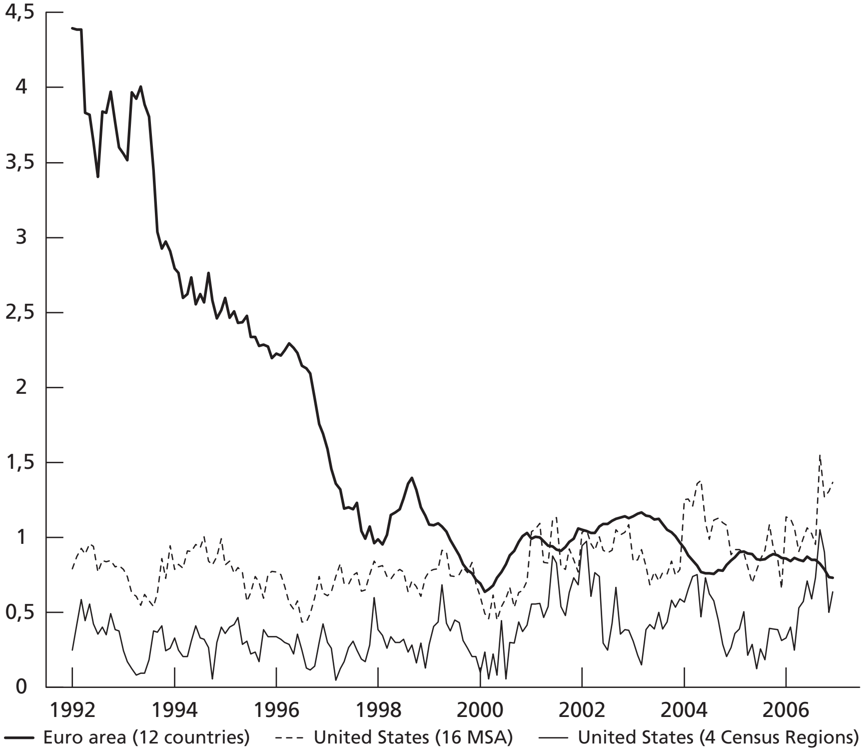
Sources: Monthly data from EUROSTAT.

appears that the downward trend of national inflation dispersion broke off and reversed suddenly after 1999, year of the completion of the euro area: is there a causal relationship between those two facts, or did inflation dispersion simply reach a structural floor?

To assess the specificity of inflation differentials observed in the euro area since 1999, it appears interesting to compare them to those observed simultaneously within the United States, a much older monetary union of a comparable size, which can provide a useful benchmark. FIGURE 2 displays the evolution of the unweighted standard deviation for the inflation rates of the four U.S. Census Regions, as well as the one calculated for 16 U.S. Metropolitan Statistical Areas (MSA).[5] Since the implementation of the single currency in January 1999, inflation dispersion within the euro area has remained slightly higher than the

5. The four U.S. Census Regions are: *Northeast* (including the MSA of New York, Philadelphia, Boston and Pittsburgh), *Midwest* (including Chicago, Detroit, St Louis and Cleveland), *South* (Washington, Dallas, Houston, Atlanta and Miami) and *West* (Los Angeles, San Francisco and Seattle).

Figure 2 - Inflation dispersion in the euro area and the United States



Notes: The dispersion indicator is the unweighted standard deviation of inflation rates (in percentage points).
Sources: Monthly data from EUROSTAT and the U.S. Bureau of Labour Statistics.

one noticed within the Census Regions, but perfectly in line with the one observed within the MSA. As Angeloni and Ehrmann (2004) note, the division of the United States which is the most closely comparable to the euro area national division seems to be somewhere between the Census Regions and the MSA. In any case, there is no evidence that the dispersion of national inflation rates observed in the euro area since the launch of the third stage of the EMU could be of an abnormal size compared to the U.S. dispersion.

A strong persistence of inflation differentials within the euro area

Recent empirical studies, including Angeloni and Ehrmann (2004) and Hofmann and Remsperger (2005), highlight the high persistence level of inflation differentials in the euro area. This is illustrated in TABLE 1, which figures out annual deviations of national inflation rates from the official euro area aggregate inflation rate since the launch of the euro. The relative positions of EMU countries in terms of inflation rates don't seem to have changed

Table 1 - Deviation of annual HICP inflation rates from the official EMU inflation rate

(in percentage points)

	1999	2000	2001	2002	2003	2004	2005	2006	1999-2006
Germany	–0.48	–0.72	–0.53	–0.92	–1.03	–0.36	–0.26	–0.44	**–0.59**
Austria	–0.60	–0.16	–0.14	–0.58	–0.77	–0.20	–0.07	–0.52	**–0.38**
Belgium	0.01	0.56	0.00	–0.73	–0.56	–0.29	0.36	0.20	**–0.06**
Spain	1.12	1.36	0.39	1.31	1.04	0.90	1.21	1.36	**1.09**
Finland	0.19	0.83	0.23	–0.27	–0.76	–2.01	–1.41	–0.92	**–0.52**
France	–0.56	–0.29	–0.65	–0.34	0.11	0.19	–0.28	–0.23	**–0.26**
Greece	1.02	0.77	1.22	1.64	1.38	0.88	1.31	1.21	**1.18**
Ireland	1.35	3.13	1.55	2.45	1.93	0.15	0.00	0.59	**1.39**
Italy	0.54	0.45	–0.11	0.33	0.75	0.12	0.03	0.05	**0.27**
Luxembourg	–0.10	1.66	–0.03	–0.22	0.48	1.08	1.58	1.07	**0.69**
Netherlands	0.91	0.22	2.68	1.59	0.17	–0.77	–0.67	–0.66	**0.43**
Portugal	1.05	0.68	1.97	1.40	1.19	0.36	–0.05	0.91	**0.94**

Sources: Yearly data from OECD Economic Outlook.

much between 1999 and 2006: Germany and Austria systematically displayed HICP inflation rates below the euro area average, whereas Spain, Greece, Ireland and Portugal have almost always been among the most inflationary countries. Those countries often exhibited inflation rates one percentage point above the euro average. In the case of Ireland, the annual growth rate of consumer prices even reached 5.25% in the year 2000 (3.13 percentage points above the euro average). Belgium, Finland, France and the Netherlands are the only member countries that exhibited inflation rates fluctuating around the euro average without being systematically higher or lower.

It is obvious that European inflation differentials have been very persistent since 1999, and this high persistence appears as a specific feature of the euro area: such phenomenon has not been observed within the United States at the same time. None of the MSA exhibited an inflation rate systematically above or below the United States average, and relative positions often reversed over the period 1999-2006. In other words, none of the MSA experienced the same situation as Spain, Greece, Ireland or Portugal, with inflation differentials well above one percentage point and persistent almost over the whole period.

What can explain such a high persistence of inflation differentials within the EMU? Is this a transitory factor or the reflection of a more structural feature of the euro area?

Potential explanatory factors

In this section, we investigate the main theoretical arguments that can explain inflation differentials within a monetary union, and we assess their particular relevance for the inflation differentials observed in the euro area since the launch of the single currency. We make a clear distinction between "convergence" factors and factors related to structural differences. On the one hand, inflation differentials implied by convergence factors (price level convergence as well as income convergence) are not only unavoidable but also desirable. On the other hand, structural differences (such as different levels of rigidities in the wage- and price-setting or different exposure to external shocks) can generate or amplify lasting inflation differentials that may be much more worrying for the ECB as well as for the euro area countries themselves.

The composition effect

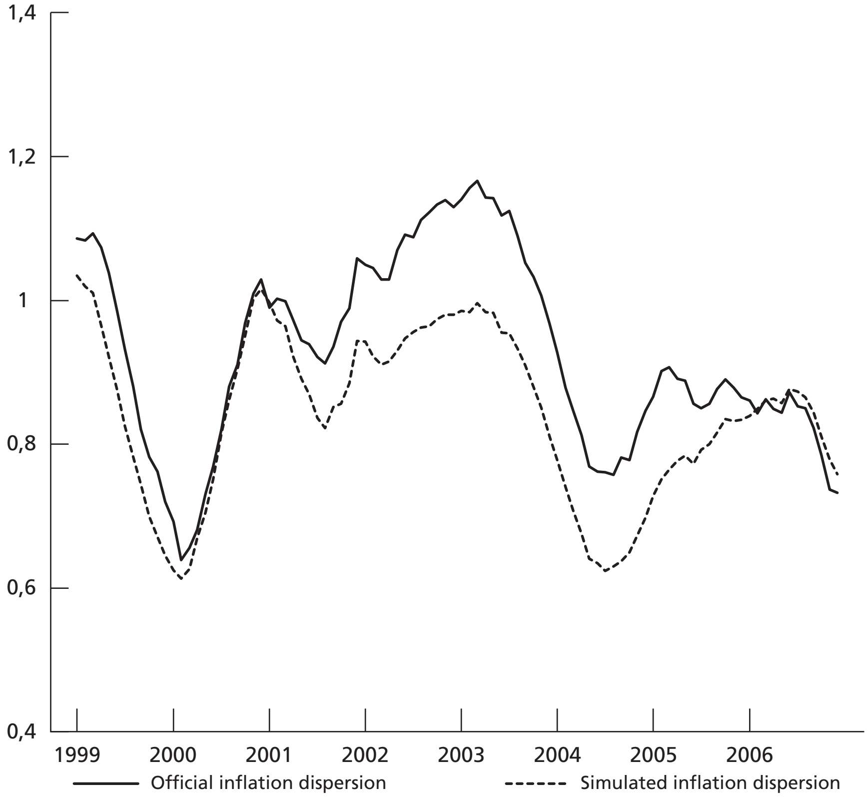
Inflation differentials observed within a currency area may arise partly from a "composition effect", *i.e.* from disparities in the shares of the various goods and services in national consumptions, and thus from differences in the weights of the various sub-indices in the national consumer price indices. In the case of differences across countries in households' preferences, two countries that would have the same sector-based inflation rates could display different aggregate inflation rates.[6] In a recent survey devoted to euro area inflation differentials (European Central Bank, 2003), the ECB stresses the remaining heterogeneity in consumers' preferences across euro area member countries, that seems able to generate such a composition effect. However, a report from the *German Council of Economic Experts* (Sachverständigenrat, 2001), cited by Hofmann and Remsperger (2005), suggests that this composition effect only played a role of secondary importance in explaining inflation differentials in the early years of the EMU.

To go further, it should be useful to compare the observed dispersion of national inflation rates to a simulated dispersion of inflation rates assuming the same euro area average item weights in each country's consumer price index. Results are displayed in FIGURE 3. The similar degree of dispersion for official and simulated inflation rates in 1999 and 2000 is in line with the conclusions from the *German Council of Economic Experts* and suggests that differences in consumption patterns only played a small role in national inflation differentials in the early years of the EMU. However, this role clearly increased between 2002 and 2005: differences in consumers' preferences seem to have induced a systematic "over-estimation" of inflation dispersion. The standard deviation of simulated inflation rates was in fact below 1 percentage point in January 2003, while the observed standard deviation was closer to 1.2 percentage point.[7] Those differences appear to become blurred since the beginning of the year 2006, and the levels of observed and simulated inflation dispersion now match almost perfectly.

6. Inflation differentials resulting from such a composition effect are therefore only the reflection of a statistical aggregation, and have of course no consequence on the relative competitiveness of the member countries.

7. Looking at national simulated inflation rates, it appears that HICP inflation rates seem to have clearly "over-estimated" inflation in Ireland, and to a lesser extent in Greece, Luxembourg and Portugal, due to higher weights on goods and services with high inflation rates (such as food).

Figure 3 - Official inflation dispersion *vs*. simulated inflation dispersion in the euro area



Notes: The dispersion indicator is the unweighted standard deviation of official or simulated inflation rates (in percentage points).

Sources: Monthly data from EUROSTAT and calculations from the author.

Convergence processes

Recent empirical papers, such as Rogers (2002), assign an important role for the process of tradable goods prices' convergence in explaining inflation differentials noticed in the euro area since 1999. The progress towards a single European market, increased transparency following the introduction of the single currency (that permitted enhanced price comparison for European consumers), as well as the harmonisation of indirect taxes such as the VAT, may have strengthened the process of convergence for tradable goods in the euro area countries. European Central Bank (2002) and Rogers (2002, 2007) confirm that the price level dispersion prevailing for goods and services exposed to international competition declined steadily after the creation of the single market in the early nineties, and then more slowly in the end of the decade. Price level convergence seems to have accelerated again since the adoption of the common currency, as documented in Allington *et al.* (2005), and this convergence process may have enlarged inflation dispersion.

Differences in terms of *per capita* income or labour productivity may also create a convergence effect known as the Balassa-Samuelson (BS) effect, explaining that countries with lower *per capita* income usually exhibit higher inflation rates compared to "richer" countries. The theoretical rationale comes from the early works of Balassa (1964) and Samuelson (1964): in a "catching-up" country, labour productivity growth in the tradable sector is normally higher than in a richer country (reflecting the process of convergence in the living standards and the accumulation of capital), which induces a higher growth of real wages in this sector. If labour mobility between sectors is high, wages will also tend to increase more quickly in the non-tradable sector where labour productivity growth is more uniform between countries. This suggests that the catching-up country will exhibit a higher inflation rate in the non-tradable sector and consequently a higher aggregate inflation rate. The BS effect reflects an equilibrium phenomenon: international competition ensures that no substantial price pressure emerges in the tradable sector, and the differences in aggregate inflation rate result only from different growth rates of prices in the non-tradable sector, which has no effect on the relative competitiveness. Many empirical studies, including Sinn and Reutter (2001) and Canzoneri *et al.* (2002), demonstrate the potential relevance of the BS effects in explaining inflation dispersion within the EMU since 1999.[8] Their results suggest that positive inflation differentials observed in Greece and Ireland partly stem from higher than average BS effects, whereas the low difference in productivity growth rates in the tradable and non-tradable sectors may have contributed to the relative weakness of inflation in Germany. However, it should be noted that observed inflation differentials are much higher than those resulting from a simple BS model.

Remaining structural differences

The level and the persistence of national inflation differentials within the euro area are also partly related to different rigidities in the wage- and price-setting. Those rigidities amplify the inflationary effects of demand pressures by delaying the necessary adjustments, as shown in Angeloni and Ehrmann (2004) and Altissimo *et al.* (2005). A recent survey of the ECB (European Central Bank, 2003) suggests that a substantial part of persistent inflation divergence may arise from differences in the wage-setting mechanism (including in some countries the automatic indexation of wages to prices) or in the price-setting mechanism (including disparities in the frequency of price changes, which influences the degree of inflation persistence).

8. Sinn and Reutter (2001) and Canzoneri *et al*. (2002) calculate "equilibrium inflation differentials" implied by a simple Balassa-Samuelson model and compare the results with observed inflation dispersion.

Lasting inflation differentials may also be the result of different degrees of exposure to exchange rates movements or external shocks, which can be explained by two factors. First, openness rates to extra-EMU trade remain very different across euro area member countries: Ireland and the Netherlands are small economies that have large trade shares with countries outside the EMU (extra-EMU imports amount to more than 30% of total GDP in those two countries), whereas imports from non-EMU countries only stand for less than 12% of total GDP in France, Italy and Portugal. That's why the exposure to shifts in bilateral exchange rates (especially the euro/dollar rate) varies widely between EMU countries. Second, even if the bilateral exchange rates are the same for all EMU countries, nominal effective exchange rates may differ due to different patterns of trade. This implies that, even for two countries that display the same extra-EMU openness rate, differences in the geographical or industrial composition of imports can generate differences in the aggregate import price dynamics, and consequently on national inflation rates. Honohan and Lane (2003) explain that much of the inflation differentials observed within the euro area in the early years of the EMU was attributable to differences in the sensitivity to the weakness of the euro on international currency markets. The depreciation of the euro against the dollar may particularly have contributed to the surge in Irish inflation. Honohan and Lane (2004) add that the appreciation of the euro after the year 2002 contributed to the slight reduction of inflation rates dispersion within the euro area observed until 2004, and notably to the cut in Irish inflation.[9]

Finally, it should be noted that oil dependency, *i.e.* the share of oil imports in the national GDP, varies greatly across euro area countries (from about 2.5% in Greece and Portugal to less than 1.5% in France and Germany). Consequently, shifts in the oil price may have asymmetric effects on the evolution of national prices. Égert *et al.* (2004) emphasize that the lasting increase in the crude oil price may partly explain the persistence of inflation differentials in the EMU, since the most inflationary countries are simultaneously those which depend the most on external energy supply and have the more energy-intensive productions.

Cyclical divergence

Inflation differentials in a monetary union may also partly stem from differences in the cyclical position, as measured for example by the output gap (gap between effective and potential production). Recent empirical researches, such as Giannone and Reichlin (2006), suggest that there remain small differences in European business cycles.[10] Égert *et al.* (2004) notice that countries with inflation rates well above the euro area average (Ireland, Greece) have also exhibited positive cumulated output gaps since 1999. The opposite situation has been observed for the countries which displayed the lowest inflation rates (especially Germany).

9. The importance of the exchange-rate pass-through mechanism in the dynamics of inflation rates is confirmed by other recent empirical studies, such as Hofmann and Remsperger (2005).

10. Benalal *et al*. (2006) stress however that the synchronisation has clearly increased since the beginning of the nineties and that business cycles asymmetries are much smaller than inflation differentials.

However, we must emphasize that the empirical investigation of the relationship between cyclical positions and inflation differentials is rather difficult for at least two reasons. Firstly, the measurement of the cyclical position of an economy presents considerable methodological difficulties: this should be a source of misleading interpretation since the countries which exhibit favourable cyclical positions (like Ireland) may also have been those which had the higher trend growth rates.[11] Secondly, it is very difficult to determine the causality between output gap and inflation differentials: countries displaying higher than average inflation rates also face lower real interest rates, which may boost their economic activity and increase again their inflation rates. Arnold and Kool (2003) and Angeloni and Ehrmann (2004) show that this pro-cyclical effect can generate lasting inflation differentials as well as asymmetric cyclical fluctuations in a currency area. The counter-cyclical effect going through the real exchange rate channel and the cumulated loss in price-competitiveness only dominate after a period of three to four years. All these considerations clearly indicate that the relationship between cyclical positions and inflation differentials is particularly equivocal.

Policy-related factors

Fiscal policies may be an other source of inflation and output gap differentials in a monetary union. The survey of the ECB (European Central Bank, 2003) indicate that countries with expansionary fiscal policies, like Ireland and Greece, experienced HICP inflation rates well above the euro area average over the period 1999-2002. Duarte and Wolman (2002) also show that governments can influence the size of inflation differentials by using fiscal policies and public spending. All in all, it appears that the pro-cyclical effects of expansionary fiscal policies may have contributed to increase inflation divergence. Nevertheless, it should be noted that the fiscal stance is partly endogenous to the cyclical positioning, which implies that the causality in the relationship between fiscal policies on the one hand, and output gap as well as inflation differentials on the other hand, is probably much more ambiguous.

Econometric evidence

The typology developed in the previous section indicates that inflation differentials within a monetary union may be driven by multiple factors. In the case of the euro area since 1999, the strong persistence discussed previously suggests that inflation differentials are more likely to be the result of structural factors than of temporary shocks (even if temporary shocks may have asymmetric and lasting effects due to inflation persistence). That's why we focus on structural explanations and now try to identify the relative contributions of the main explanatory factors highlighted in the previous section in driving inflation differentials within the euro area since the launch of the single currency.

11. Benalal *et al*. (2006) suggest that the dispersion of GDP growth rates in the euro area since 1999 has been driven mainly by trend growth differentials, and only slightly by cyclical differentials.

Specification of the dynamic panel data model

A general specification of a model explaining inflation differentials can be written as:

$$\pi_{i,t} - \pi_t^{EA} = \alpha_i + \beta \cdot \left(P_{i,t-1} - P_{t-1}^{EA}\right) + \gamma \cdot \left(X_{i,t} - X_t^{EA}\right) + \varepsilon_{i,t} \quad (1)$$

where $\pi_{i,t}$ is the inflation rate of country i between t-1 and t, π_t^{EA} the aggregate inflation rate for the euro area, α_i an unobserved country-specific effect, $P_{i,t-1}$ and P_{t-1}^{EA} the national and euro area initial price levels respectively, and $X_{i,t}$ and X_t^{EA} the vectors of national and euro area variables that are supposed to have a short-term influence on the inflation rate.

The aggregate euro zone variables can be linearly combined into a time dummy, allowing us to get a simplified expression:[12]

$$\pi_{i,t} = \beta \cdot P_{i,t-1} + \gamma \cdot X_{i,t} + \alpha_i + \varphi_t + \varepsilon_{i,t} \quad (2)$$

with $\varphi_t = \pi_t^{EA} - \beta \cdot P_{t-1}^{EA} - \gamma \cdot X_t^{EA}$.

Explanatory variables introduced in the $X_{i,t}$ vector are chosen on the basis of the typology developed in our previous section: these variables are the productivity growth rate used as a proxy for the Balassa-Samuelson effects,[13] the output gap, a measure of fiscal stance, an indicator for the exposure to exchange rates variations, and finally an indicator for the exposure to oil price deviations. The exchange rate indicator is constructed as the variation in the nominal effective exchange rate weighted by the ratio of imports to GDP, while our oil price variable is defined as the growth rate of the oil price weighted by the ratio of oil imports to GDP.

We thus get a multivariate regression model similar to the one used in Honohan and Lane (2003, 2004). However, our model differs from theirs in two directions. Firstly, we add in the $X_{i,t}$ vector a variable for the exposure to oil price deviations (which appeared in our investigations as a potential important driver for inflation differentials, especially in the recent context of lasting oil price growth) and we weight the nominal effective exchange rate variable by the ratio of imports to GDP (since the exposure to exchange rate appreciations/depreciations is largely related to the openness rate). Secondly, we include a

12. As Honohan and Lane (2003) notice, this specification explains inflation *differentials*, not simply inflation *rates*, since the time dummies capture euro zone common movements in inflation and in the explanatory variables.
13. The use of this proxy is based on the implicit assumption that productivity growth rates in the non-tradable sector are very similar among EMU countries, in accordance with the rationale of the Balassa-Samuelson model. Differences between countries in total productivity growth rates are therefore mainly the reflection of differences in tradable goods productivity growth.

country-specific effect in our baseline model, since country effects appear as a good way to control for unobserved heterogeneity and to limit the omitted variable bias.

But our main difference from the model used in Honohan and Lane (2003, 2004) stands in the treatment of inflation persistence. In fact, a simple Wooldridge-test for AR(1) serial correlation of the residuals in a fixed-effects least squares regression suggests a strong serial correlation in the residuals, which reveals the need to include the lagged dependent variable as an additional explanatory variable. We thus obtain a dynamic panel data model, which can be written as:

$$\pi_{i,t} = \delta \cdot \pi_{i,t-1} + \beta \cdot P_{i,t-1} + \gamma \cdot X_{i,t} + \alpha_i + \varphi_t + \varepsilon_{i,t} \tag{3}$$

Baltagi (2005) shows that standard panel data estimators, such as the *Within* estimator or the random effects GLS estimator, are biased in dynamic panel data models because of the correlation between the lagged dependent variable and the error term. Furthermore, our model may particularly be subject to a bias since some of the explanatory variables are likely to be predetermined or even endogenous.

Arellano and Bond (1991) propose the use of a Generalized Method of Moments (GMM) estimator, that can deal with the bias induced by the lagged dependent variable and allow for the instrumentation of predetermined or endogenous variables. They suggest beginning by first-differencing equation (3) to remove the country-specific effect:

$$\begin{aligned} \pi_{i,t} - \pi_{i,t-1} = \delta \cdot \left(\pi_{i,t-1} - \pi_{i,t-2}\right) + \beta \cdot \left(P_{i,t-1} - P_{i,t-2}\right) + \gamma \cdot \left(X_{i,t} - X_{i,t-1}\right) \\ + \left(\varphi_t - \varphi_{t-1}\right) + \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right) \end{aligned} \tag{4}$$

Then, Arellano and Bond (1991) develop a GMM estimator that treats the model as a system of equations, one for each time period. These equations only differ in their moment condition set, which increases from period t-1 to period t. The predetermined variables in first differences are instrumented by the lags of at least two periods of their own levels, while endogenous variables are instrumented with the lags of at least three periods of their levels.

Thus, Arellano and Bond (1991) use the following moment conditions:

$$\mathrm{E}\left[\pi_{i,t-s} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \tag{5}$$

with $s \geqslant 2$.

$$\mathrm{E}\left[x_{i,t-s} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \tag{6}$$

with $s \geqslant 1$ for a strictly exogenous variable, $s \geqslant 2$ for a predetermined variable and $s \geqslant 3$ for an endogenous variable.

However, Arellano and Bover (1995) and Blundell and Bond (1998) highlight that the "difference-GMM" estimator proposed by Arellano and Bond (1991) suffers from a "weak instruments problem" that induces an important finite sample bias and a low asymptotic precision, since lagged levels of the explanatory variables are often poor instruments for their first differences. That's why Blundell and Bond (1998) construct a "system-GMM" estimator: they suggest adding the original equations in levels to the system of first-differentiated equations to bring additional moments conditions, in order to increase efficiency.[14] In the first-differentiated equations, Blundell and Bond (1998) use the same instruments as Arellano and Bond (1991), while in the level equations, variables in levels are instrumented using their first differences.[15]

Thus, Blundell and Bond (1998) add the following moment conditions to (5) and (6):

$$\mathrm{E}\left[\left(\pi_{i,t-1} - \pi_{i,t-2}\right) \cdot \left(\alpha_i + \varepsilon_{i,t}\right)\right] = 0 \tag{7}$$

$$\mathrm{E}\left[\left(x_{i,t-1} - x_{i,t-2}\right) \cdot \left(\alpha_i + \varepsilon_{i,t}\right)\right] = 0 \tag{8}$$

Data

We use annual data for the twelve euro area countries over the EMU period 1999-2006, as well as over an extended period 1992-2006 which adds the nominal convergence period (enforced by the Maastricht Treaty) to the EMU period.

The inflation rate is constructed as the annual growth rate of the Harmonized Index of Consumer Price (HICP). Initial price level is the lagged Purchasing Power Parity (PPP) factor calculated by the OECD. Our baseline proxy for the Balassa-Samuelson effects is constructed as the annual growth rate of labour productivity in the business sector. The output gap is obtained using the Hodrick-Prescott filter (with a smoothing parameter set to 30) on initial series of GDP at constant price. Our measure of fiscal stance is the cyclically-adjusted primary government balance as a ratio of potential GDP. The indicator for the exposure to exchange rates variations is constructed as the growth rate of the nominal effective exchange rate weighted by the ratio of imports to GDP. Finally, our indicator for the exposure to oil price deviations is defined as the growth rate of the crude oil price in local currency (euro after 1999)[16] weighted by the ratio of oil imports to GDP.

All the data come from the OECD Economic Outlook database, except oil prices and oil imports which are taken from the International Energy Agency (IEA) database.

14. Blundell *et al*. (2000) show, using Monte Carlo simulations, that the system-GMM estimator not only improves the precision of the estimates compared to the difference-GMM estimator, but also reduces the finite sample bias.

15. An important assumption underlying this specification is that the variables in levels must be *mean stationary*. Several recent empirical studies suggest that this assumption has been satisfied in the euro area since 1999. In particular, Busetti *et al*. (2007) use stationarity tests on inflation differentials between EMU countries and show that two separate clusters can be detected: a low-inflation group (with Germany, France, Austria, Belgium and Finland) and a higher-inflation one (including Spain, Greece, Ireland, the Netherlands and Portugal). However, inflation rates seem to fluctuate around the same mean within each cluster.

16. We shall notice that we use a country-specific crude oil price, even after 1999. In fact, differences between the euro area countries in the composition of their oil suppliers result in different crude oil import prices.

Baseline results

We use the system-GMM estimator from Blundell and Bond (1998) to estimate our baseline model. The output gap is treated as endogenous, keeping its lagged value three periods before as instrument in the first-difference equation and its once lagged first difference in the levels equations. The other explanatory variables are treated as pre-determined (lagged inflation, initial price level, productivity growth, fiscal stance) or strictly exogenous (exposure to exchange rate variations and oil price deviations): we use their lagged values one period before (for exogenous variables) or two periods before (for pre-determined variables) as instruments in the first-difference equation and their once lagged first differences in the levels equations.

We choose to keep only a limited subset of instruments. In fact, Roodman (2006, 2007) show that too many instruments can fail to expunge the endogenous components of explanatory variables, thus leading to biased coefficient estimates. Having too many estimates also weakens the power of the Hansen-Sargan test. That's why we limit the lags used in our GMM-system instruments especially regarding our limited number of countries and observations. We also "collapse" instruments as suggested by Roodman (2006, 2007).[17]

TABLE 2 reports the results for various specifications of our baseline model. The first two columns contain results over the EMU period 1999-2006, while the remaining two columns display regression estimates over the extended period 1992-2006. It appears clearly from those estimation results that differences in the output gap, the exposure to exchange rates deviations and the exposure to oil price variations have played a key role in explaining inflation differentials since 1992, and especially over the EMU period.[18]

The output gap is highly significant over the period 1999-2006, even if we add time-fixed effects (column 2), which entails that countries with positive cumulative output gaps tend to experiment inflationary pressures and thus to have higher inflation rates, *ceteris paribus*. The estimated coefficient, close to 0.2, is rather similar to the one obtained in Rogers (2002) over the period 1997-2001 or in Honohan and Lane (2003) over the period 1999-2001. As expected, different exposure to exchange rates variations is a potential cause for inflation differentials within the euro area: the negative coefficient associated with this variable is in line with the estimates of Honohan and Lane (2003) and indicates that a depreciation of the nominal effective exchange rate of a country is associated with a relative upsurge in its inflation rate. The differences in the exposure to oil price variations appear as another important driver for inflation differentials, and this effect is even reinforced if we add time-

17. However, it should be noted that our main results are not very sensitive to (small) changes in the number of instruments.

18. TABLE 2 also reports the p-values of a Hansen-Sargan test of over-identifying restrictions (whether the instruments, as a group, appear exogenous) as well as the p-values of the Arellano-Bond test for AR(2) serial correlation of the residuals. Results don't allow rejecting the null hypotheses of validity of the lagged variables as instruments and of no second-order serial correlation in the residuals.

Table 2 - Euro area inflation differentials – Baseline results[a]

	(1)	(2)	(3)	(4)
	1999-2006		**1992-2006**	
Lagged inflation	**0.528** (4.09)***	**0.540** (3.46)***	**0.781** (7.89)***	**0.722** (5.00)***
Initial price level	–2.099 (–0.60)	–1.171 (–0.68)	–1.552 (–0.89)	–1.311 (–0.59)
Productivity growth	–0.177 (–0.95)	–0.085 (–0.47)	–0.016 (–0.30)	–0.021 (–0.26)
Output gap	**0.211** (2.53)**	**0.193** (2.44)**	**0.126** (2.42)**	**0.179** (2.36)**
Fiscal stance	–0.130 (–0.65)	0.026 (0.18)	0.008 (0.10)	–0.023 (–0.18)
Exposure to exchange rate variations	**–0.218** (–1.95)*	**–0.124** (–2.46)**	**–0.135** (–4.68)***	**–0.122** (–3.22)***
Exposure to oil price deviations	**0.002** (1.90)*	**0.004** (2.95)***	**0.003** (2.17)*	**0.002** (2.32)**
Time effects?	No	Yes	No	Yes
Hansen-Sargan test[b]	[0.511]	[0.376]	[0.339]	[0.167]
Arellano-Bond test[c]	[0.285]	[0.407]	[0.549]	[0.456]
Number of observations	96	96	180	180

Notes:

a. We report two-step GMM results with robust standard errors corrected for finite sample, using the correction defined by Windmeijer (2005). *t*-statistics are in parenthesis. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. The dependent variable is the annual HICP inflation rate. The model is estimated using the system-GMM estimator described in Blundell and Bond (1998). We use the lagged values three periods before (for the output gap), two periods before (for inflation, the initial price level, productivity growth and the fiscal stance), or one period before (for exchange rate and oil price variables) as instruments in the first-difference equations. The once lagged differences of all explanatory variables are used as instruments in the levels equations. We also collapse instruments as suggested by Roodman (2006, 2007).

b. p-value from the Hansen-Sargan test for the null hypothesis of valid instruments.

c. p-value from the Arellano-Bond test for the null hypothesis of no AR(2) serial correlation of the residuals.

recently in Greece (in a context of steady increase in the oil price), since this country has also exhibited positive output gaps and is still relatively oil-dependent.

Besides, we must stress the highly significant coefficient on the lagged dependent variable (above 0.5): this result is totally in line with the estimates displayed in Rogers (2002), and reveals the importance of inflation persistence within the euro area. Angeloni and Ehrmann (2004) and Hofmann and Remsperger (2005) also highlight the key role played by inflation persistence in amplifying inflation differentials across EMU countries.

On the other hand, the price convergence effect does not seem to have played a major role in driving inflation differentials in the EMU since 1999: the lagged price variable is not significant, even when we add time fixed-effects. This result is not in line with Rogers (2002) and Honohan and Lane (2003). However, Rogers (2002) already emphasized that the price convergence mechanism was not the main driver of inflation divergence in the euro area over the period 1997-2001, and he added that this convergence effect may disappear when the lagged dependent variable was introduced (*i.e.* when inflation persistence was taken into account), especially when he used the Arellano-Bond estimator.[19]

As for the productivity growth variable, used as a proxy for the Balassa-Samuelson effects, it does not turn out to be significant over the period 1999-2006. Similarly, the differences in fiscal stance do not seem to have played a key role in driving inflation differentials within the euro area.[20] Those two conclusions are in accordance with the results from Rogers (2002) and Honohan and Lane (2003, 2004).

In columns 3 and 4 of TABLE 2, we examine if the results differ widely over an extended period 1992-2006, and find that they do not. The main difference comes from the coefficient associated to the output gap, which is clearly smaller than the one estimated over the period 1999-2006. This suggests that the pro-cyclical linkage between the output gap and inflation differential has been reinforced by the creation of the EMU, in accordance with the intuitions from Arnold and Kool (2003) and the conclusions from Angeloni and Ehrmann (2004). The other noticeable difference comes from the coefficient on inflation persistence, which is close to 0.75 on the extended period (*versus* 0.5 over the period 1999-2006): inflation persistence within the euro area may have decreased since the launch of the EMU, as suggested by recent results from the "Eurosystem Inflation Persistence Network" synthesized in Altissimo *et al.* (2006).

Robustness checks

In this sub-section, we check if our results are very sensitive to a change in the estimation methodology, in our indicator of cyclical positioning (one of the key explanatory variable) or in the definition of the dependent variable. Results of these robustness checks over the period 1999-2006 are reported in TABLE 3.

Columns 1 and 2 report estimates of our baseline model using a simple fixed-effects panel data estimator (namely the Within estimator) or the difference-GMM estimator introduced by Arellano and Bond (1991). Regarding the Within estimations, the results are globally in line with those reached with the system-GMM estimator, although the significance of the results is clearly weaker: the coefficients associated with the exposure to exchange rate deviations and oil price deviations are not significant any more, even though the signs are unchanged.

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19. Besides, this result does not mean a rejection of the price convergence effect in the euro area. It only suggests that, over the short period spanned by our data, the short-term effects from cyclical positioning or the exposure to external shocks have outclassed the price convergence mechanism which is essentially a long-run mechanism, as Hofmann and Remsperger (2005) note.

20. We also tried with alternative indicators for fiscal stance (first difference of the primary government balance, deviation of the ratio of the primary balance to GDP from its five-year moving average) but the fiscal variable did never turn out to be significant.

Table 3 - Euro area inflation differentials – Robustness checks (1999-2006)[a]

	(1)	(2)	(5)	(6)	(7)	(8)
	Within	**Diff-GMM**	**System-GMM**		**System-GMM**	
	HICP inflation	HICP inflation	HICP inflation	HICP inflation	GDP deflator	Simulated inflation
Lagged inflation	**0.319**	**0.678**	**0.553**	**0.569**	**0.579**	**0.581**
	(2.95)***	(2.73)**	(3.85)***	(3.33)***	(5.56)***	(6.63)***
Initial price level	–3.982	–3.096	–0.680	–2.021	–2.735	–0.201
	(–1.52)	(–0.32)	(–0.36)	(–1.50)	(–0.79)	(–0.08)
Productivity growth	–0.019	–0.022	–0.191	–0.153	–0.171	0.049
	(–0.23)	(–0.08)	(–1.06)	(–0.81)	(–0.83)	(0.39)
Output gap	**0.203**	**0.256**				**0.115**
	(2.19)**	(2.38)**				(2.43)**
Output gap (alternative methodology)			**0.191**			
			(2.48)**			
Unemployment gap				**–0.300**	**–0.266**	
				(–2.41)**	(–2.45)**	
Fiscal stance	–0.042	–0.047	0.044	0.012	–0.065	0.033
	(–0.68)	(–0.30)	(0.31)	(0.10)	(–0.74)	(0.65)
Exposure to exchange rate variations	–0.080	**–0.178**	**–0.078**	**–0.163**	–0.148	**–0.182**
	(–0.90)	(–2.37)**	(–1.96)*	(–2.28)**	(–0.74)	(–4.94)***
Exposure to oil price deviations	0.004	**0.002**	**0.006**	**0.004**	0.001	**0.003**
	(1.09)	(2.55)**	(4.30)***	(3.71)***	(0.22)	(2.25)**
Time effects?	Yes	Yes	Yes	Yes	Yes	Yes
R^2 (Within)	0.53	–	–	–	–	–
Hansen-Sargan test[b]	–	[0.175]	[0.292]	[0.753]	[0.979]	[0.688]
Arellano-Bond test[c]	–	[0.678]	[0.471]	[0.299]	[0.237]	[0.248]
Number of observations	96	96	96	96	96	84

Notes:
a. t-statistics are in parenthesis. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. In column 1, we display the results reached using the Within estimator (with robust standard errors). In columns 2 to 6, we report two-step GMM results with robust standard errors corrected for finite sample, using the correction defined by Windmeijer (2005). We use the lagged values three periods before (for the output gap), two periods before (for inflation, the initial price level, productivity growth and the fiscal stance), or one period before (for exchange rate and oil price variables) as instruments in the first-difference equations. The once lagged differences of all explanatory variables are used as instruments in the levels equations (columns 3 to 6). We also collapse instruments as suggested by Roodman (2006, 2007).
b. p-value from the Hansen-Sargan test for the null hypothesis of valid instruments.
c. p-value from the Arellano-Bond test for the null hypothesis of no AR(2) serial correlation of the residuals.

As expected, the coefficient for the lagged dependent variable is lower than the one obtained using the Blundell-Bond estimator.[21] As for the results reached with the Arellano-Bond estimator, they are very close to those presented in the previous subsection, with only minor changes.

21. Baltagi (2005) indeed shows that the Within estimator of the coefficient associated with the lagged dependent variable under-estimates the true value of this parameter.

Furthermore, since differences in cyclical positioning appeared in our baseline regressions as one of the main drivers for inflation differentials, it seems useful to investigate deeply the robustness of this relationship using alternative indicators for cyclical positioning: the decomposition between trend and cyclical output components is in fact very sensitive to methodological issues, as emphasized by Benalal *et al.* (2006). That's why we replace in column 3 our reference output gap indicator (reached using a Hodrick-Prescott filter) by an alternative indicator obtained by the production function method and provided by the OECD in its *Economic Outlook*. Our results are globally unchanged, and the coefficient associated with the output gap is very close to the one reached with the HP-filtered output gap. We then try with an indicator of cyclical positioning measured on the labour market, which is the gap between the official unemployment rate and the NAWRU ("*Non Accelerating Wages Rate of Unemployment*") calculated by the OECD. Results displayed in column 4 are again very similar, and the coefficient of this gap to the NAWRU is significantly negative. This suggests that pressures on the labour market are associated with an inflation rate above the euro area average, *ceteris paribus*. As a conclusion, our results indicating that cyclical differences have been a major source of inflation divergence since 1999 seem to be quite robust to the methodology used for the decomposition between trend and cycle.

We then run regressions using alternative definitions for our dependent variable. Column 5 of TABLE 3 show the results of regressions using an indicator of "producer prices' inflation rate" (the annual growth rate of the GDP deflator) as the dependent variable. Results are similar to those obtained with the HICP inflation rates, but the GDP deflator seem to be more clearly influenced by domestic inflationary pressures than the HICP: differences in cyclical positioning play a key role in the national differences regarding producer prices, whereas disparities in the exposure to exchange rates or oil price variations do not seem to be important drivers. We thus corroborate the results from Honohan and Lane (2003, 2004). In column 6, we display the results of regressions using the simulated inflation rates described above, assuming a perfect homogeneity of consumers' preferences in all EMU member countries (*i.e.* correcting the national official inflation rates to eliminate the "composition effect"). Results are very similar to those reached using the official HICP inflation rates.

We also performed the regressions using quarterly data over the period 1999:1-2006:4. However, complete quarterly data are only available for six EMU countries: Germany, Finland, France, Ireland, Italy and the Netherlands. The use of quarterly data thus keeps six countries out of the sample: Austria, Belgium, Spain, Greece, Luxembourg and Portugal. We must also notice that fiscal stance data are not provided at the frequency level. That's why results on quarterly data can only provide an interesting point of comparison. Those results, reported in the APPENDIX (TABLE A1.1), are globally in line with those reached using annual data. The main drivers for inflation differentials remain cyclical positioning as well as differences in the exposure to exchange rates and oil price variations.

Table 4 - Euro area inflation differentials – Some asymmetries?[a]

	(1) **1999-2006**	(2) **1992-2006**
Lagged inflation	**0.770** (7.71)***	**0.851** (9.01)***
Initial price level	–1.069 (–1.36)	–1.109 (–0.66)
Productivity growth	–0.099 (–1.05)	–0.041 (–0.79)
Positive output gap	**0.350** (2.69)**	**0.236** (2.51)**
Negative output gap	0.127 (0.61)	0.062 (0.92)
Fiscal surplus	–0.148 (–1.37)	–0.051 (–0.92)
Fiscal deficit	–0.069 (–0.88)	0.092 (1.65)
Sensitivity to exchange rate appreciation	0.040 (0.47)	0.056 (0.80)
Sensitivity to exchange rate depreciation	**–0.298** (–2.30)**	**–0.151** (–2.32)**
Sensitivity to oil price increase	**0.004** (3.69)***	**0.008** (4.13)***
Sensitivity to oil price decrease	–0.007 (–0.89)	–0.011 (–1.71)
Time effects?	Yes	Yes
Hansen-Sargan test[b]	[0.890]	[0.832]
Arellano-Bond test[c]	[0.100]	[0.451]
Number of observations	96	180

Notes:

a. We report two-step GMM results with robust standard errors corrected for finite sample, using the correction defined by Windmeijer (2005). *t*-statistics are in parenthesis. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. The dependent variable is the annual HICP inflation rate. The model is estimated using the system-GMM estimator described in Blundell and Bond (1998). We use the lagged values three periods before (for the output gap), two periods before (for inflation, the initial price level, productivity growth and the fiscal stance), or one period before (for exchange rate and oil price variables) as instruments in the first-difference equations. The once lagged differences of all explanatory variables are used as instruments in the levels equations. We also collapse instruments as suggested by Roodman (2006, 2007).

b. *p-value* from the Hansen-Sargan test for the null hypothesis of valid instruments.

c. *p-value* from the Arellano-Bond test for the null hypothesis of no AR(2) serial correlation of the residuals.

Some asymmetric effects?

In TABLE 4, we go back to our baseline model but now allow exchange rate appreciations and exchange rate depreciations to have asymmetric effects on inflation differentials, as Honohan and Lane (2004) suggest. We also allow for similar asymmetries in the effects of the output gap, the fiscal stance and oil price variations.[22]

The results reported for the EMU-period 1999-2006 (column 1) as well as over the extended period 1992-2006 (column 2) support the idea that positive output gaps have a stronger impact on inflation differentials than negative output gaps do. Obviously, a positive output gap has a strong inflationary impact, whereas a negative output gap does not seem to have significant disinflationary effects. In the same way, nominal effective exchange rate depreciations have a strong inflationary effect, while an appreciation of this exchange rate does not seem to impact the inflation rate. Our results display the same kind of effects for oil price variations: an increase appears to be a potential driver for inflation differentials, whereas a decrease of the oil price does not have a true disinflationary effect. All in all, those results are perfectly in line with the conclusions reached by models with downwardly rigid prices. As for the indicator of fiscal stance, it is still not significant, even after controlling for potential asymmetric effects.

CONCLUSION

In this paper, we show that the dispersion of national inflation rates within the euro area slightly increased after the adoption of the single currency in 1999, and that the relative positions of EMU countries in terms of inflation rates don't seem to have changed much between 1999 and 2006. This high persistence appears as the specific feature of the euro area, since such phenomenon has not been observed within the United States at the same time.

Results based on a dynamic panel data model estimated using the system-GMM estimator defined in Blundell and Bond (1998) suggest that the main sources of euro area inflation differentials are twofold. They partly stem from differences in the exposure to external shocks, *i.e.* nominal effective exchange deviations as well as oil price shocks. This suggests that the weakness of the euro on international currency markets in the early years of the EMU and then the lasting upsurge in the crude oil price should have had various inflationary effects among euro area countries, according to their openness rate to non-EMU countries and their oil dependency. Inflation differentials in the euro area are also the reflection of remaining differences in cyclical positioning, as measured for example by the output gap, amplified by a rather high degree of inflation persistence. Our empirical estimates appear to suggest that a one-percentage-point increase in the positive output gap typically leads to an increase of about 20 basis points in the inflation rate of EMU countries. A deeper investigation also highlights that our main explanatory variables exhibit strongly asymmetric effects: the inflationary impact

22. Honohan and Lane (2004) claim that such asymmetries in the effect of exchange rate deviations can be generated in a variety of theoretical models with downwardly rigid prices. The same kind of models can also produce asymmetric effects of the output gap, the fiscal policy or oil price shocks.

entailed by a positive output gap, a depreciation of the nominal exchange rate and/or an increase in the oil price is much larger than the "disinflationary" effect of a negative output gap, an exchange rate appreciation or a decrease in the oil price. This kind of asymmetric behaviour is perfectly in line with the predictions of models with downwardly rigid prices.

On the other hand, the price convergence mechanism and the Balassa-Samuelson effects (going through the productivity growth differentials between the tradable and non-tradable sectors) do not seem to have played a key role in explaining inflation differentials since the launch of the EMU. The effects of those "convergence mechanisms", which are essentially long-run mechanisms, have clearly been outclassed by the effects of "disequilibrium factors" (according to the distinction introduced in Alberola, 2000) such as cyclical divergence. However, those long-run convergence factors are likely to be more relevant when the new European Union member countries eventually join the euro. The Balassa-Samuelson effects, as well as the process of price level convergence, suggest that those accession countries should experience much higher inflation rates than current EMU members.

Finally, the growing interest of the ECB regarding national inflation differentials within the euro area clearly reveals its concern about the potential implications of such lasting inflation disparities. We have shown that business cycle asymmetries as well as structural differences are able to generate persistent inflation differentials that could induce huge distortion in the relative competitiveness of the euro-area member countries. Lasting inflation differentials may also complicate the task of the ECB for the definition of its single monetary policy: a "one size fits all" policy should thus induce a too restrictive policy for countries exhibiting the lowest inflation rates and simultaneously an excessively accommodating policy for the most inflationary countries. However, our analysis also reveals the key role played by inflation persistence in amplifying inflation differentials. Since the monetary policy of the ECB is geared at maintaining a low and stable inflation, inflation persistence should also decrease and become more homogenous among EMU countries, as suggested by Altissimo *et al.* (2006). Inflation differentials may therefore become less persistent.

J. L.[23]

Appendix 1

Results on quarterly data

All quarterly data are taken from the OECD Economic Outlook database, except oil prices and oil imports which come from the IEA database. The baseline output gap is obtained using a Hodrick-Prescott filter with a smoothing parameter set to 1600 (standard value for quarterly data). We should note that the Arellano-Bond test for AR(2) serial correlation of the residuals suggests the inclusion of four lags of the dependent variable in the regressors.

23. I wish to thank two anonymous referees for very helpful comments and suggestions. I am also grateful to Jean-Jacques Durand and participants at the DIW Macroeconometric Workshop (Berlin – November 30, 2006) and the VIIth Doctoral Meetings of the RIEF (Rennes – February 1st, 2007) for comments on earlier versions of this paper.

The corresponding results are reported in TABLE A1.1. The first two columns display baseline estimates using the "system-GMM" estimator defined in Blundell and Bond (1998) on quarterly HICP inflation rates. The third column reports the results for an alternative output gap indicator obtained by the production function method and provided in the OECD Economic Outlook. Finally, the last column shows the results reached with an indicator of "producer prices' inflation rates" (the annual growth rate of the GDP deflator) as the dependent variable.

Table A1.1 - Euro area inflation differentials – Quarterly data (1999: 1-2006: 4)[a]

	(1)	(2)	(3)	(4)
	Standard model		**Alternative output gap**	**GDP deflator**
Lagged inflation (*t*-1)	**0.829** (8.70)***	**1.015** (11.61)***	**0.919** (9.93)***	**0.419** (7.82)***
Lagged inflation (*t*-2)	–0.016 (–0.15)	–0.201 (–1.92)	–0.205 (–1.83)	0.022 (0.58)
Lagged inflation (*t*-3)	**0.233** (5.93)***	**0.283** (10.63)***	**0.278** (8.98)***	**0.199** (3.10)**
Lagged inflation (*t*-4)	**–0.238** (–2.47)*	**–0.279** (–3.76)**	**–0.333** (–4.36)***	–0.050 (–0.63)
Initial price level	–2.185 (–1.99)	**–4.528** (–3.07)**	–1.546 (–1.48)	**–2.046** (–3.30)**
Lagged productivity growth	–0.010 (–0.42)	–0.046 (–1.09)	**–0.049** (–2.05)*	**–0.126** (–3.85)**
Lagged output gap	**0.151** (6.53)***	**0.198** (5.75)***		**0.337** (5.26)***
Lagged output gap (alternative methodology)			**0.188** (6.39)***	
Exposure to exchange rate variations	–0.032 (–0.88)	**–0.072** (–2.72)**	**–0.016** (–2.35)**	–0.086 (–1.75)
Exposure to oil price deviations	**0.003** (2.17)*	**0.007** (2.66)**	**0.008** (4.50)***	0.011 (1.82)
Time effects?	No	Yes	Yes	Yes
Hansen-Sargan test[b]	[1.000]	[1.000]	[1.000]	[1.000]
Arellano-Bond test[c]	[0.117]	[0.977]	[0.461]	[0.652]
Number of observations	192	192	192	192

a. We report two-step GMM results with robust standard errors corrected for finite sample, using the correction defined by Windmeijer (2005). *t*-statistics are in parenthesis. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. The model is estimated using the system-GMM estimator described in Blundell and Bond (1998). We use the lagged values two periods before (for inflation, the initial price level, productivity growth and the output gap), or one period before (for exchange rate and oil price variables) as instruments in the first-difference equations. The once lagged differences of all explanatory variables are used as instruments in the levels equations. We also collapse instruments as suggested by Roodman (2006, 2007).

b. *p-value* from the Hansen-Sargan test for the null hypothesis of valid instruments.

c. *p-value* from the Arellano-Bond test for the null hypothesis of no AR(2) serial correlation of the residuals.

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