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INFLATION AND INFLATION DIFFERENTIALS IN CORE EUROZONE COUNTRIES

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Abstract: The paper analyzes the convergence of inflation rates in the group of more developed members of the Eurozone (core countries). What are the characteristics and is the inflation process in these countries sufficiently homogeneous? Are the analysed inflation rates converging, so that there is an indication that these countries tend to form the optimal currency area. We used a unit root test to check the stationarity of a series of average inflationary differentials. They are calculated as the difference between inflation rate in a given country and the inflation rate in EMU. If the convergence process took place, the inflationary differentials will decrease and tend to zero. The variance of differentials will also decrease, so the series of average inflationary differentials will be stationary. The analysis showed that there is a unit root in the series, thus it is not stationary, and we cannot conclude that the process of convergence of inflation rates in the core countries happened. The paper also analyzes the autocorrelation functions of inflation rates, to determine the persistence of inflation, i.e. how long it takes for the shock that caused the inflation growth of 1%, to die off. The values of the first autocorrelation coefficients are high, while the next ones fall slowly, so it takes a long time for the impact of the inflation shock to disappear. In addition, the correlograms of inflation rates are quite heterogeneous, which indicates that inflationary processes differ.

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1. Introduction

The main goal of European central bank is price stability, defined as annual growth rate of harmonized consumer price index (HICP) below, but close to 2%, in the medium term. European central bank cannot focus on the level of inflation in each member country, and there are no tools which could be adjusted to variations in the inflation rate among members. In the previous period, the ECB was quite successful in achieving its goal, and there was also a high level of convergence of inflation rates between the member countries, especially when comparing with the period before joining the Eurozone. However, inflation differentials in the Eurozone still exist and they are very persistent. In large currency areas there are often differences in inflation rates. They can be the result of the macroeconomic process of adjusting to asymmetric shocks, which cannot take place through the exchange rate changes and when the labour mobility is low. Such inflationary differentials last relatively short and do not cause major disturbances. However, the causes may be of different nature, when they lead to serious divergent movements.

European monetary union is characterised by a high level of heterogeneity - on labour/financial markets and of inflation rates, which reduces the effectiveness of the common monetary policy. There are several reasons which raise the concern about the existence of inflationary differentials: there is the lack of adequate adjustment mechanism (Mandel mechanism), migration and labour mobility are low, wage flexibility is insufficient; there is no strong single federal fiscal system to supplement common monetary policy. However, the ECB may contribute to some extent to the reduction of long-term differences in inflation rates, although its monetary policy is focused on the whole euro area and cannot be modelled according to regional specifics. But by seeking to minimize deviations from average inflation, it may, in the long run, lower inflation differentials.

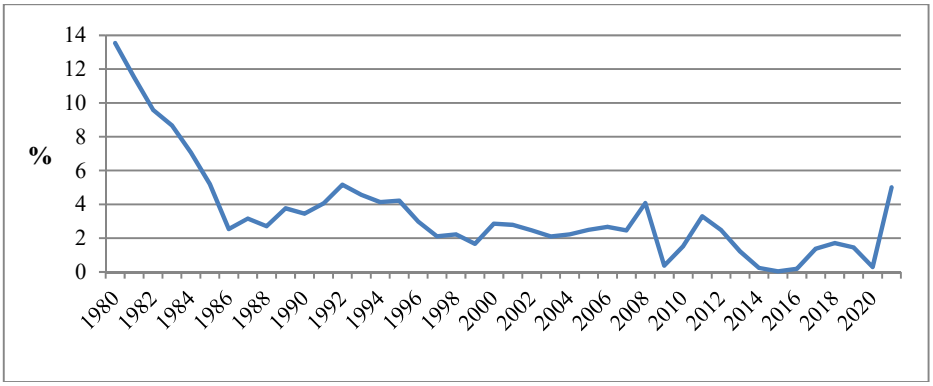
In this paper, the authors will focus on convergence of inflation rates between the core Eurozone countries. The main research question is: do core Eurozone countries move towards the optimal currency area? Is there a nominal convergence (measured by inflation differentials) between them?

2. Inflation and inflation differentials in European monetary union

Establishment of ECB, which is responsible for managing the common monetary policy in Eurozone, had a huge impact on prices and inflation in the member countries. Before 1999, there were differences in monetary policy regimes, exchange rates and significance attached to price stability in monetary policy of independent - national central banks. For some countries the decision to join monetary union reflected their desire to reduce inflation rates and exchange rates instability. It was also expected that prices of comparable goods and services will

converge, due to higher cross-border price transparency, more flexible price-setting and a higher competition in the EU single market. The effect of the introduction of single currency and common monetary policy on HICP is shown in Figure 1.

Figure 1. Annual inflation rates (HICP) in Eurozone countries



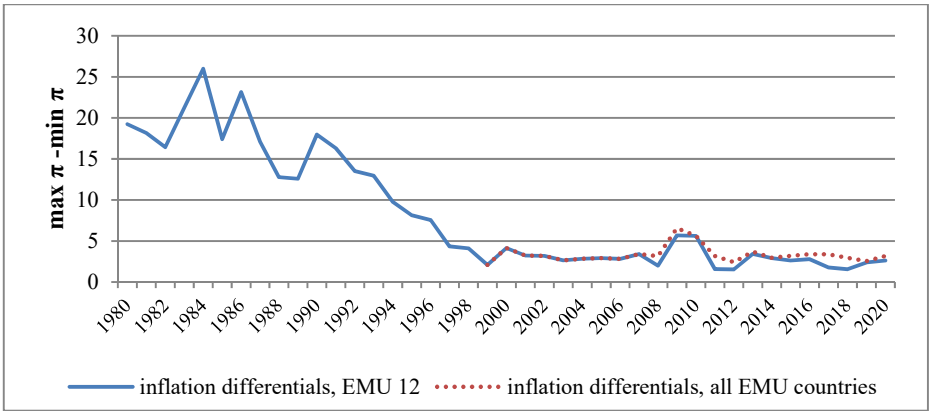
Source: World Development Indicators Database, Worldbank, https://databank.worldbank.org/indicator/FP.CPI.TOTL.ZG/1ff4a498/Popular-Indicators#, 13.11.2021, Data for 2021 are estimations of ECB

The most impressive drop in inflation rates was achieved in the period prior the establishment of monetary union. It is obvious that the member states made a significant effort to fulfil this Maastricht criterion for joining the Eurozone. For some of those countries, European central bank brought stability, independence and credibility, which their national central banks and autonomous monetary policy did not have. This also meant that inflation differentials in the Eurozone were significantly reduced, as showed in Figure 2. The standard deviation of annual inflation rates in EMU 12 countries in 1980 was 19.2% and it dropped to 2.1% in 1999. However, already in the following 2000, it doubled and remained at the levels higher than 1999 level. With the outbreak of financial crisis, the standard deviation of inflation rates rose again, to the 5.7% in 2009. Until 2020, it had periods of growth and decrease, but still the levels are higher than in 1999 (standard deviation in 2020 was 2.6%).

The inflation differentials could be measured in different ways, the simplest measure is the spread between the highest and the smallest rate of inflation in a given year (ECB, 2000). We chose this indicator because we wanted to present a dimension of differences that exists (and existed) between the euro area countries' inflation rates. The period before the single market was characterized by large inflation differentials, even among the leading economies in the Eurozone. During the 1980s, a large number of countries had problems with high inflation, above all: Greece, followed by Portugal, Italy, Ireland and Spain. The highest monetary stability characterized Germany and the countries "tied" to it - the Netherlands and

Austria. Almost all of the observed countries successfully implemented the disinflation process during the 1990s. Greece, again, had the most extensive problems with inflation in this period, and to a much lesser extent Portugal, Spain and Italy. In this period, the inflation rates in all observed countries did not exceeded 4%, inflation differentials were significantly reduced, which means that the member countries achieved a high degree of nominal convergence.

Figure 2. Inflation differentials in Eurozone



Source: Calculation of authors based on the data from Worldbank database, https://databank.worldbank.org/source/world-development-indicators#, 14.12.2021

On the other hand, although the differences in the level of inflation were significantly reduced, inflation differentials still remained and they seem to be very persistent. In the period that followed the advent of Monetary union, there was no further nominal convergence, in some years even inflation differentials rose. The outbreak of financial crisis led to the surge of inflation and inflation differentials in the following 3 years. Debt crisis caused the reduction of inflation rates, in same periods it was even negative. Problematic peripheral economies, that had on average higher level of inflation before the financial crisis, now had to undertake a process of deflation adjustment to decrease their indebtedness and restore competitiveness. Besides, all countries were hit by the same type of shock, so inflation differentials in the Eurozone had a diminishing trend in the period of 6 years, following the end of 2013. However, economic conditions worsened after the corona pandemic started, leading to the new, significant rise of inflation and inflation differentials.

Accordingly, in the long term, inflation differentials remained persistent and just changed the sign between 2000s and 2010s in some countries, because of the creation and enlargement of imbalances in the first decade, which were partially corrected in the second.

One of the Maastricht's criteria is that the inflation rate should not be higher than 1.5 percentage points than the average inflation rate in the three Member States with the lowest rate of inflation. Even though this is a criterion that a country wishing to join the EMU must meet in the previous period, it is evident that inflation differentials in the EMU are higher. This creates problems in formulating a single monetary policy. Greece had the least success in restraining the inflation. It met this Maastricht criterion just before joining the EMU. But immediately after, the inflation rate started to rise and in 2010 reached a very high level. Spain was above the permissible level until the outbreak of the crisis, which affected the calming inflation. In the first half of this period, Ireland had an inflation rate significantly higher than allowed, then it stabilized in 2004, but the crisis affected the emergence of deflation. In the observed period, Germany had the inflation rate below the average.

Financial and debt crisis showed that the introduction of euro influenced inflation differentials with destabilising macroeconomic consequences. Joining the euro area led to a significant decline in interest rates in peripheral - South European member countries causing the rise in credit, indebtedness of all sectors, real estate prices, aggregate demand and thus inflation. Higher inflation led to the real appreciation of peripheral countries' currencies and the loss of international competitiveness, further worsening their balance of payment and indebtedness. This exacerbated the differences in business cycles between the member countries, leading to further rise in inflation differentials in the Eurozone. Thus, the common monetary policy suited them less and less.

3. Literature review

Popović (2013) showed that in the moment of its creation, the Eurozone was not the optimal currency area, and that even all countries did not meet the defined convergence criteria. It was expected, however, that the environment of monetary union will enable the convergence of members' economic performances. That did not happen - there occurred a divergence of economic performances between two groups of countries: groups of countries mainly in Southern Europe - Portugal, Italy, Ireland, Greece and Spain (peripheral members or GIIPS) on the one hand, and countries mainly in Northern Europe - Germany, the Netherlands, Austria, Belgium, Finland, Luxembourg and France (core euro zone economies).

Estrada at al. (2013) discovered that there was a strong β-convergence of inflation rates in the period before the advent of the Eurozone, in two groups of advanced economies. They used β-convergence regression to compare the nominal convergence of countries that joined the euro area and advanced economies outside the euro area (the control group - Japan, Switzerland, Canada, the United Kingdom, Denmark, USA and New Zealand). The research suggests that European monetary union has not been a critical factor that led to the convergence of inflation rates

between the Eurozone countries. The convergence of inflation rates occurred before the advent of the Eurozone also in the group of non-member advanced countries. There are no proofs that the establishment of the Eurozone strengthened or facilitated the nominal convergence, in comparison to other developed countries.

Franks at al. (2018) showed also that before the adoption of euro, there has been a significant convergence of inflation rates, but since then, they did not converge much further. The variation of price levels among member countries did not change significantly in the first 15 years of EMU. Actually, it appears that the countries joined since 2007 and non-Eurozone EU countries witnessed the continued inflation convergence. The authors found especially problematic the fact that inflation differentials appear to be very persistent in the periphery member countries, particularly Ireland, Greece, Portugal and Spain. That decreases their competitiveness with time, and increases gaps in real effective exchange rates.

Consolo at al. (2021) found that there was no sufficient progress in nominal convergence in EMU since 1999. Contrary to this, differences in price levels increased. In the countries that started with higher price level, inflation rates on average are higher, and in countries that started with lower price level, inflation rates tend to be lower. There also has not been strong convergence in goods or services prices. It was expected that with the removal of exchange rates, countries with lower level of prices would face higher demand for their tradable goods and services, which would lead to higher inflation. So, the environment of monetary union would lead to real GDP per capita levels convergence, as well as inflation rate convergence. After the advent of monetary union, the price levels converged slightly, as a result of convergence of goods prices, but the trend reversed in 2010s driven by services prices. The prices of goods did not converge further, and there was a rise in dispersion of services prices, reversing previous convergence. Portugal, Ireland, Greece, Spain and Cyprus had inflation which was permanently above average, in majority it was followed with real GDP growth above average, which was not sustainable.

Anna, Enderlein and Fritz-Vannahme (2015) stress the significance of nominal sigma convergence and, above all, convergence in prices, to avoid drifting apart of the euro area. The Eurozone is a common currency area whose members have different economic and political structures, different sizes, they follow different economic models and are at different stages of economic development. On the other hand, there is no fiscal union (and the support of fiscal transfers) and a completely integrated single market. European central bank sets main refinancing rate based on the average rate of inflation. But if inflation rates vary significantly across the member countries, it will be difficult to ECB to set the interest rate that fits all member countries. Unique interest rate will be too low for higher than average inflation countries and they will receive an inflow of capital. For the countries with lower than average inflation rate, unique interest rate will be too high and they will suffer lower growth rates. This will destabilize the euro area.

Inflation differentials facilitate capital misallocation, recessions and boom-and-bust cycles. According to the authors, the architects of the Eurozone made a mistake, while applied rules failed to create the convergence. The Maastricht criteria apply to the countries wishing to join Eurozone, they are the accession criteria. But after the countries entered the Eurozone, the differences in inflation rates and long-term interest rates were ignored, although they proved to be persistent. There was an expectation that inflation differentials will not exist in the long run. This enabled some countries like Greece, Ireland, Portugal and Spain to have higher than average inflation rates after joining EMU, while France had an average rate of inflation and Germany had below than average rate.

According to Wortmann and Stahl (2016) financial, debt and banking crisis in the Eurozone showed that a unique monetary policy cannot be managed smoothly in current core-periphery environment. Although a lot of economists warned of premature introduction of euro in the group of heterogeneous countries which were not sufficiently prepared, endogenous view on optimal currency area prevailed and EMU was formed[1]. Monetary union environment facilitated macroeconomic imbalances both between and within peripheral and core countries, making a lot of problems for managing common monetary policy. While in the mid of 2010s core countries needed stronger euro and higher interest rates, the opposite was necessary for peripheral countries. During crisis, ECB was forced to manage monetary policy more expansive to support peripheral countries' struggle for recovery and fight against the risk of deflation. Such monetary policy has been heavily criticized by the core countries, because it had negative consequences on domestic savings, price bubbles, ECB's balance sheet (the quantity of money in the circulation) and financing the fiscal debt, which on the other hand influenced negatively the incentives for budgetary discipline and necessary structural reforms.

Bošković at al. (2013) used Anova F-statistic to test for individual and time effects of inflation rates among core and peripheral countries. The results of testing for time effects show that the variation in average inflation for Northern countries, year after year, is statistically significant; however, they found no statistically significant differences between the observed countries with inflation (individual effects). For peripheral countries, the results of testing for both time effects and individual effects show that the variation in inflation averages are statistically significant.

[1] See: Popović, S. (2013) for detailed explanation of endogenous - exogenous debate on optimal currency area.

4. Analysis of inflation rates and inflation differentials in core euro area countries

A number of researches showed that European monetary union is not the optimal currency area, and that the convergence of economic performances of the member countries did not occur, as expected at the beginning. Contrary to this, there has been a process of polarization (divergence) of economic results between the two groups of countries – the peripheral wealthier core countries. The Eurozone is not a homogenous area as a result of that process, and a common monetary policy does not fully suit it. It can have different effects on macroeconomic results of the member countries. The financial, banking and debt crisis accentuated these weaknesses.

In the following part of the paper, the authors will focus on the convergence among the core member countries. It is interesting to understand if they are moving towards the optimal currency area. Is there a process of nominal convergence among them?

We will analyse inflation and inflation differentials between 6 countries: Germany, Austria, the Netherlands, Belgium, France and Finland, that are among the first EMU 12 members. Luxembourg is excluded from the analysis because it is not the typical Eurozone country. Germany and France are especially important because they are the largest economies in the monetary union. Together they make around 50% of GDP in the euro area (Germany makes almost 30% and France around 20% of the Eurozone GDP). So what happens in those two countries largely defines the economic conditions in the euro area. Italy and Spain, which are the third and the fourth economy the in Eurozone (together slightly below 25% of GDP of the Eurozone) (World Bank, 2021) belong to the group of problematic peripheral countries.

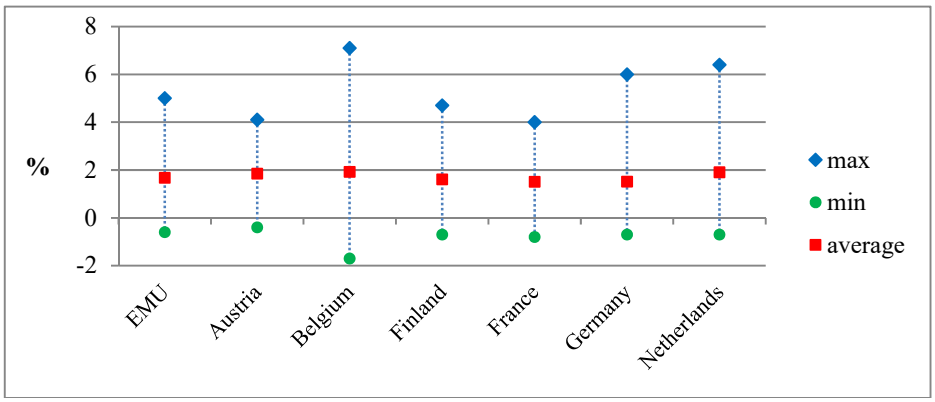
Table 1. Descriptive statistics of inflation rates, January 1999- December 2021

	Germany	France	Austria	Netherlands	Belgium	Finland
Mean	1.52	1.51	1.85	1.92	1.93	1.61
Median	1.5	1.6	1.8	1.8	1.9	1.4
Maximum	6	4	4.1	6.4	7.1	4.7
Minimum	-0.7	-0.8	-0.4	-0.7	-1.7	-0.7
Std.Dev.	0.98	0.92	0.88	1.29	1.32	1.12
Skewness	0.85	-0.02	0.25	0.86	0.67	0.44
Kurtosis	6.39	2.85	3.23	4.24	5.16	2.66

Source: Calculation of authors based on the data from European central bank, Statistical data warehouse, https://sdw.ecb.europa.eu/browse.do?node=9691209,

Germany and France are the countries with the highest monetary stability, but also for other countries, mean inflation is not significantly higher. Data are less dispersed around that mean for Austria and the same two countries. On the other hand, although average and median inflation rates seem to be very uniform, they tend to be volatile. Those variations - ups and downs, are not much synchronized.

Figure 3. Extreme and average inflation rates



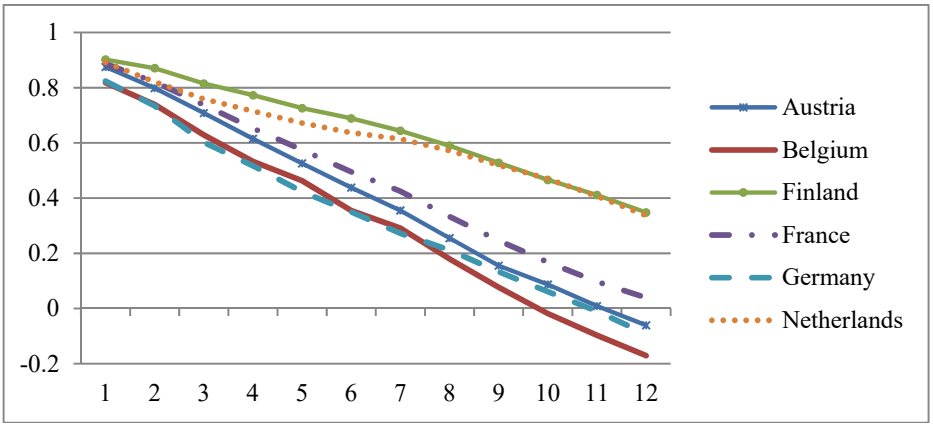
Source: Calculation of authors based on the data from European central bank, Statistical data warehouse, https://sdw.ecb.europa.eu/browse.do?node=9691209

The majority of the observed countries witnessed maximal values of inflation rates at the very end of 2021 - November or December. Also from Figure 3, it is observable that the range of inflation rates is pretty high. In November 2021 Germany reached the highest level of HICP of 6%, after six months of rise, which it did not measure for almost 30 years. A number of reasons explains this, including low prices in previous year (value added tax was temporary reduced in the second half of 2020, prices of oil mineral products were also very low). Besides, corona measures caused material shortages and supply bottlenecks, while energy costs surged in 2021 (for more than 22%) (Destatis, 2021), and especially the prices of domestic heating oil which doubled. In Belgium, a very high level of inflation rate in November of 7.1% is dominantly a consequence of energy price rises (almost 42%). The prices of natural gas almost doubled, the prices of other fuels increased for more than 57%, while the price of electricity rose 44% (Statbel, 2021). The rate of 6.4% presents the inflation rate the Netherland has not encountered for 40 years. The main reasons are energy price increase as in previous case, and also rising food costs. Gas and electricity are 75% more expensive in this country (Netherlands New Live, 2022). Rising food and energy prices were the main factors that caused the rise of inflation in Austria, which reached maximum in November 2021 of 4.1%. In Finland and France the ongoing energy crisis also influenced the rise in prices, but not so high as in previous countries. In Finland,

inflation reached its maximum level in September 2008 and in France couple of months earlier. In Austria, Belgium, France and Germany the lowest level of inflation was reached in July 2009, mainly due to a sharp decline in the energy and food prices and because of the economic slowdown (ECB, 2009). Although their inflation rates were lower in the same period, Finland and the Netherlands reached the minimum of inflation rates in 2015. So we can say that inflation rates in the group of core countries do not respond in the same manner to the same shocks. So their inflation processes are not homogenous.

To further characterize the dynamics of inflation rates we will analyze the inflation persistence. It could be defined in different ways, but it refers to the duration of shocks to inflation rates. We can define it as the "speed with which inflation converges to equilibrium after a shock" (Robalo, 2004). If inflation rate is hit by a shock, so that it increases today by 1%, how long it takes for the effect of the shock to fade out. When the speed is low that means that the inflation is (highly) persistent, and when the speed is high the inflation is not (very) persistent. There are different measures and approaches to study the inflation persistence, one of them which is often used, are autoregressive coefficients (like in: Correa-Lopez at al., 2019). We will analyze the inflation persistence by calculating correlograms for each country inflation data for the first 12 lags, which is presented in Figure 4.

Figure 4. Autocorrelation coefficients of core Eurozone countries inflation rates



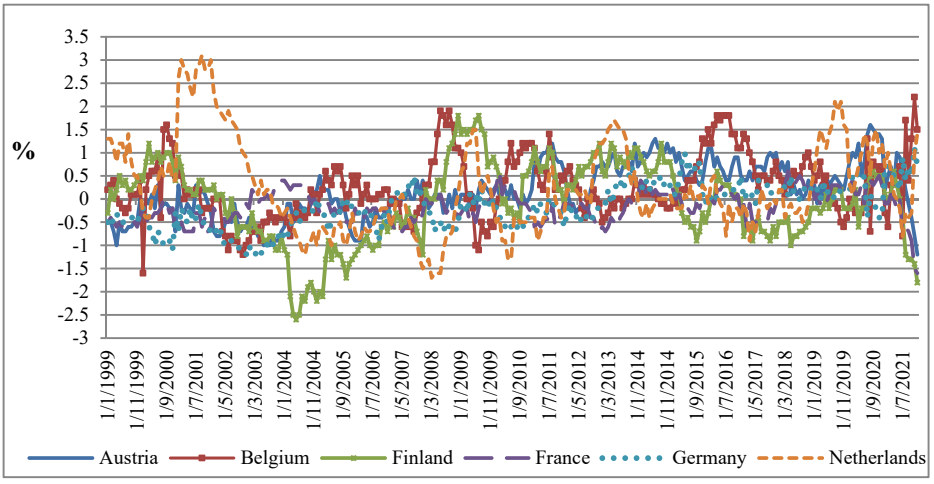
Source: Calculation of authors based on data from European central bank, Statistical data warehouse, https://sdw.ecb.europa.eu/browse.do?node=9691209

Figure 4 indicates that the inflation processes in the observed countries expresses a significant level of persistence. The first autocorrelation coefficient is large for all countries, and the succeeding autocorrelation coefficients gradually decline. This means that a temporary shock to inflation is likely to take more time to disappear. We can also observe the heterogeneity of correlograms between the

countries, which suggests that the inflation processes in those countries differ. Inflation is more persistent in Finland and the Netherlands. That is in line with the findings of Consolo at all (2021). They found that cyclical developments had a key role in inflation dispersion in the Eurozone, and a significant part of this is linked to a dispersion in more persistent inflation trends.

Figure 5 shows inflation differentials in core euro area countries. They are calculated as the difference between the inflation rate in a given country and in the Eurozone. We used monthly data, annual rate of change of HICP for all the observed countries and EMU. Data are neither seasonally nor working day adjusted.

Figure 5. Inflation differentials in core euro area countries



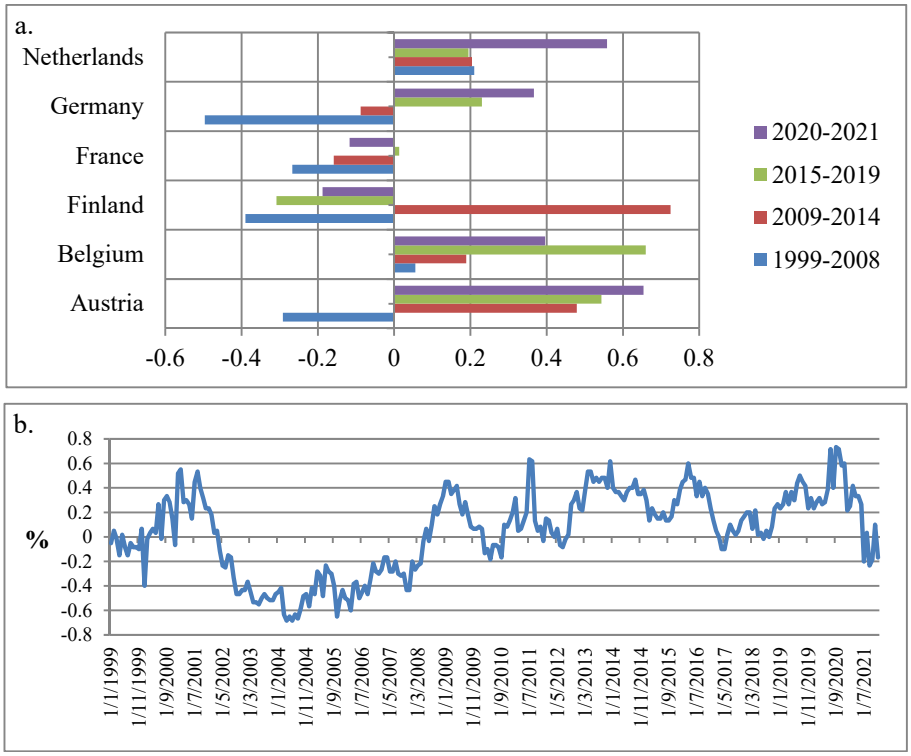
Source: Calculation of authors based on the data from European central bank, Statistical data warehouse, https://sdw.ecb.europa.eu/browse.do?node=9691209, 12.1.2022

Average inflation differentials for the observed countries are relatively limited. They range from -0.2 % in Germany and France to 0.3% in Belgium and 0.2% in Austria and the Netherlands. Again their dispersion is higher, ranging from maximal 3.1% in the Netherlands to -2.6% in Belgium.

We can distinguish several periods in the development of inflation differentials, depending on the conditions in general environment - Figure 6 (panel a.), so we can see that the countries differently responded to the same shocks. Also we can see which countries had on average higher inflation rates and which had lower than average inflation and how differences were influenced by the latest corona crisis. In the Netherlands inflation rates were slightly above average until 2020, when their increase was significant. During the first decade of the euro zone, Germany had a significantly lower than average inflation, during the financial and debt crisis its inflation was slightly below average, but then it started to rise, especially at the

end of 2021. Inflation in Finland was more severe fueled by the financial and debt crisis, as well as Austria. In the last two years, the inflation in Finland and France remained below average. So pandemic affected differently inflation processes across core Eurozone countries.

Figure 6. Average inflation differentials



Source: Calculation of authors based on the data from European central bank, Statistical data warehouse, https://sdw.ecb.europa.eu/browse.do?node=9691209, 12.1.2022

Having in mind that inflation rates in the member countries should move towards the average rate in monetary union over time, we would expect that inflation differentials for all countries will tend to zero. However, that is not what we can observe from Figure 5. Inflation differentials tend to move volatile, there are ups and downs, but they do not seem to converge.

We statistically tested the significance of inflation differentials in the group of observed countries. A unit root test was performed for a series of average inflationary differentials in the group of core countries (variable *x*). Inflation differentials are calculated as the difference between the inflation rate for a given country and inflation at the EMU level. We want to determine whether there has

been a convergence in the group of core countries. If the convergence process took place, inflationary differentials will decrease and tend to zero. So we would expect the data to oscillate around zero, as well as the variance to decrease over time. If this is true, the series of average inflationary differentials will be stationary.

The testing has shown that there is a unit root in the series of inflation differentials. It was found not to be stationary. The decision was made on the basis of Augmented Dickey-Fuller test which tests the null hypothesis that a unit root is present in a time series. ADF(12) τ_t statistics was found to be equal to - 2.317, while the critical value (with intercept and trend) of τ_t^k = -3.426 at 5% confidence level. Thus, we could not reject the null hypothesis that the series x has a unit root. Results of testing are given in Table 2:

Table 2. Unit root test in levels for the series: Inflation differentials in core Eurozone countries

Dependent Variable: DX
Method: Least Squares
Date: 01/12/22 Time: 13:08
Sample (adjusted): 2000M02 2021M12
Included observations: 263 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.013252	0.018515	-0.715722	0.4748
@TREND	0.000126	0.000124	1.014059	0.3115
X(-1)	-0.074080	0.031973	-2.316960	0.0213
DX(-1)	-0.190766	0.063035	-3.026353	0.0027
DX(-2)	-0.122919	0.064438	-1.907542	0.0576
DX(-3)	0.025684	0.064151	0.400373	0.6892
DX(-4)	-0.029095	0.064416	-0.451682	0.6519
DX(-5)	0.117211	0.064260	1.824019	0.0694
DX(-6)	0.232166	0.065773	3.529798	0.0005
DX(-7)	0.065913	0.067017	0.983520	0.3263
DX(-8)	0.049152	0.067151	0.731954	0.4649
DX(-9)	-0.010609	0.067056	-0.158211	0.8744
DX(-10)	-0.111399	0.066856	-1.666254	0.0969
DX(-11)	0.052290	0.065721	0.795635	0.4270
DX(-12)	-0.205225	0.063784	-3.217490	0.0015

R-squared	0.200587	Mean dependent var	0.000887
Adjusted R-squared	0.155459	S.D. dependent var	0.131020
S.E. of regression	0.120406	Akaike info criterion	-1.340549
Sum squared resid	3.595416	Schwarz criterion	-1.136814
Log likelihood	191.2822	Hannan-Quinn criter.	-1.258672
F-statistic	4.444832	Durbin-Watson stat	1.931669
Prob(F-statistic)	0.000000		

Additionally, we used Stock-Watson test to examine the significance of the trend. It examines the statistical significance of the mean of the first differential of series. If the time series has a unit root, the presence of a constant in the first difference represents a constant increment over time, so that there is a linear trend at the level of a given series. Stock-Watson test showed that trend is not statistically significant (p=0.94). However, from Figure 6 (panel b.) it is clear that there is a rising trend, with few structural brakes. Unit root test with intercept only, gives the critical value of τ_t^k = -2.87 at 5% confidence level, so the result is the same, there is a unit root test in the series of inflation differentials in core Eurozone countries. Thus we cannot say that there was a convergence of inflation rates among the observed group of core Eurozone countries. Their inflation processes are not sufficiently homogenous.

5. The main drivers of inflation differentials

After more than two decades of monetary union, the dispersion of inflation rates across member countries remained more or less the same. Germany, France and Finland are the countries that dominantly had below average inflation rates, while Greece, Ireland and Spain are countries with the highest inflation levels. There are different reasons which can lead to inflation differentials in EMU, like Balassa-Samuelson effect, structural differences in the wage and price settings, different exposure to fluctuations in the euro-dollar exchange rate, differences in oil dependency, fiscal policies or productivity. They could also be the consequence of asymmetric shocks or different reactions to the same shock, which in the presence of nominal rigidities and imperfections in labor and goods markets can lead to inflation differentials persistence.

Licheron (2007) found out that two factors dominate. Inflation differentials are partly the consequence of different exposure to nominal effective exchange rate deviations and oil price shocks. Exchange rate depreciation and oil price growth have stronger influence on inflation differentials than exchange rate depreciation and oil price decrease. Different effects of exchange rate changes arise because of the different levels of openness to international trade, different structure of import and impact of changes in import prices on inflation rates. Angeloni & Ehrman (2014) found out that there is a positive correlation of inflation rates with the level of extra-EMU trade openness and with the changes of import prices. For example, the Netherlands and Ireland are small open economies with a large share of extra-EMU trade. Import from non-EMU countries is around 30% of GDP, while in France or Italy it is only around 12% (Licheron, 2007). That is why changes in exchange rates, especially euro-dollar rate will not have the same effect on the inflation process across the member countries. And even in the case of countries with the same extra-EMU trade, there are differences in geographical or industrial structure of imports, which can lead to different import prices dynamics and thus

national inflation rates. Honohan and Lane (2003) found that significant part of inflation differentials in early years of monetary union were due to different sensitivity to depreciation of euro against dollar. Also oil dependency (the share of oil import in GDP) varies between the member countries, which means that oil price changes can have heterogeneous effect on the national inflation rates. Egert at al. (2004) discovered positive and significant impact of oil price changes on inflation rates. In countries that have higher dependence on external energy supply and more energy intensive production, the oil price effect on inflation will be higher.

Inflation differentials also arise because of remained differences in cyclical positions and high inflation persistence. Licheron (2007) discovered that positive output gap has much stronger inflationary effect than what is the disinflationary effect of negative output gap. ECB research (2012) also founds that different positions in business cycle probably have influenced inflation differentials in three ways. First, periods of economic booms were linked with positive inflation differentials, while negative output gaps were associated with lower or even negative inflation differentials. Second, positive output gap periods were characterized also with the growth in unit labor costs, rising overall inflation rate. And the third, positive output gap periods may be correlated with inflation expectations. Higher inflation expectations reduce the costs of borrowing for households and companies. Higher demand, consumption and investment can cause a temporary rise economic activity and thus inflationary pressures. They also found high correlation between 1 year differentials in inflation expectations and inflation differentials. A very important cause of output gap differentials could be unsustainable low risk premium for poorer countries after the advent of monetary union, which decreased interest rates. Households and firms used the opportunity to borrow at lower costs, which lead to strong increase in consumption and investments, rising consumer prices. In some countries, housing prices and securities prices rose sharply fueling domestic demand even more. After the crisis started, peripheral countries witnessed strong increase in interest rates due to rise in risk premium, which soothed the growth of credit and domestic demand. Also for some of them, negative output gap led to a decrease of inflation rates.

It was expected that Balassa-Samuelson effect would be the main driver of inflation differentials after the advent of Monetary union, due to faster growth of wages (in tradable and non tradable - service sector) in less developed countries[2]. However, some researches show that Balassa-Samuelson effect was not present (Honohan at al., 2003; Consolo at al., 2021), or that differences in the labour productivity differently influenced the inflation rates across the member countries, but that influence was not so large (ECB, 2005). Inflation differentials were largely the consequence of unsustainable growth in poorer member countries. In those countries, wage growth was quite high, for instance in Greece and Ireland before

[2] See: Popović, S., (2013), p.170 for detailed explanations

crisis, wages grew up around 35%, in Spain and Italy around 30%, while productivity was weak or even decreasing. On the other hand, until 2008, cumulative nominal wage growth in Germany was around 0% (Popović, 2013). High nominal wage growth and low productivity led to the loss of competitiveness and increase of current account deficits in peripheral countries. So in the 2010s they had to reduce the imbalances and regain competitiveness which led to the reversal of inflation differentials. Now, they had lower than EMU average rates of inflation which was paid with higher unemployment. According to Consollo at al. (2021), Balassa-Samuelson effect was important in 2000s for Baltic countries, Slovenia and Slovakia in the period before joining EMU, but not for the countries already in monetary union. In the 2010s the importance of this effect declined.

Inflation differentials could also be the consequence of structural differences and changes in consumer baskets of the member countries, because different categories of goods and services have different inflation dynamics. So when the households' preferences differ, two countries with the same sectorial inflation rates can have different overall inflation rates because of different weights for the same subindexes. However, this effect does not appear to have a significant role in explaining inflation differentials neither in thheearly period of monetary union (Licheron, 2007), nor later, with the exception of Ireland and Latvia (Consolo at al. 2021).

According to Licheron (2007), the rigidities in wage and price setting extend inflationary consequences of demand pressures because they delay necessary adjustment. ECB survey (2012) confirmed that a significant part of inflation differentials can be the result of different wage or price setting mechanism. Structural reforms in labor or product markets probably influenced negative inflation differentials in Germany, Austria and the Netherlands, while relatively modest reforms can explain higher inflation in Greece, Portugal and Spain. Also real wage rigidities could influence the inflation differentials persistence in Spain, Belgium and Luxembourg, because of wage indexation clauses. In Germany and Finland until 2008, unit labor costs and profits (the gross operating surplus) contributed to negative inflation differentials. In Spain and Greece, both factors led to positive inflation differentials, while in Ireland and Portugal only unit labor costs, until 2008. The crisis brought changes, labor costs were reduced in Spain, Greece, Portugal and Ireland. Italy did not significantly cut unit labor costs, although it witnessed strong rise in wages before crisis.

Higher inflation differentials could have been the result of the process of real convergence - in countries with higher growth rates. Angeloni & Ehrmann (2004) found out that in the initial years, there was a positive correlation between the national inflation rates and growth rates, suggesting that aggregate demand fluctuations were one of influential factors. However, the catching-up process in poorer countries during 2000s was unsustainable, and because of the rise in wages and weak productivity it led to decrease in competitiveness. Stronger growth was mainly the result of stronger domestic demand, financed by the credit.

Unsustainable high current account deficits reflected unsustainable high demand, and caused severe macroeconomic imbalance and the need to restore competitiveness, and undertake structural reforms in product and labor markets. In 2010s that rebalancing process had an important influence on price level dispersion. Price levels in Ireland, Greece, Portugal and Spain decreased, so now they had lower than average inflation rates, but that was very costly. Unemployment increased, because wages are rigid downwards, which means that there was an adjustment in quantities and not in prices (Consolo at al., 2021).

Governments, their fiscal policies and public spending also can be the source of inflation and output gap differentials. Angeloni & Ehrmann (2004) found that countries with expansive fiscal policies had higher than average interest rates, like Greece and Portugal. Different changes in administered prices between the member countries also caused inflation differentials. Before 2008 Ireland, Portugal and Luxembourg increased administered prices more than others and faced positive inflation differentials. After 2008 Spain, Italy, Portugal, Ireland and Finland increased indirect taxes significantly above average, while in Belgium, the Netherlands and Germany they rose below average (ECB, 2012). Some countries introduced changes in indirect taxes causing temporary changes in inflation differentials. For instance, in Germany, where those taxes were significantly raised in 2007, which led to rise in inflation differentials, next year they turned again to negative. On the other side, in Greece, Portugal, Spain, Italy and Finland it seems that indirect taxes will continue to be an important part of government budget policies in the process of fiscal consolidation, so their impact on inflation differentials will be long lasting.

6. Concluding remarks

Although it was expected that the monetary union environment would facilitate the convergence of members' economic performances, this did not happen. Periods in which there was some convergence of inflation rates did not last. They were the consequence of unsustainable catching-up process in poorer countries in 2000s. There has been a polarization of economic performances between richer core member countries and poorer peripheral members. That creates serious problems in managing a single monetary policy, because it is conducted at an average level and cannot be adjusted to the specific needs of each country. European central bank has often been accused of tailoring monetary policy to the needs of the richest members, while during the debt crisis it was forced to pursue more expansionary monetary policies to support troubled peripheral members in their struggle for recovery. This had consequences for domestic savings and price formation in the group of core countries, a huge growth of the ECB's balance sheet (and the quantity of money in circulation), as well as financing the public debt and negatively affected the motivation to undertake necessary structural reforms and achieve budgetary discipline.

The authors wanted to understand if among the core Eurozone countries there was some convergence of inflation rates, if there was a tendency for their inflation processes to be more homogenous. The stylized features of inflation, in terms of volatility and persistence, showed the changing nature and the cross-country heterogeneity across this group of countries as well. Dickey-Fuller test showed that there is a unit root in the series of average inflation differentials. This means that we cannot say that average inflation differentials tend to oscillate around zero (which we would expect in the case of convergence).

Higher level of inflation convergence will not be real in the following years, due to a number of factors. Understanding the size, persistence and determinants of inflation differentials is important to properly evaluate area-wide inflation dynamics and optimally design the monetary policy. Monetary policy cannot control area-wide inflation and national inflation differentials separately. However, insisting that inflation is close, but below 2% can prevent member countries to have in longer period too high or too low, and especially negative, inflation rates. Minimising the deviations from targeted level of inflation and maintaining low differentials are complementary tasks. Also ECB monitors the monetary policy transmission process in the member countries to prevent some distortions.

On the other hand, the ECB cannot provide a high level of convergence with its measures. This requires measures of other policies, dominantly national fiscal and economic policies, as well as structural reforms primarily of the labour market in order to reduce nominal and wage rigidities, and to increase labour productivity. There is also a need for greater convergence of fiscal policies, i.e. insisting on fiscal rules.

Removing the existing rigidities in labour and goods markets should reduce the persistence of inflation differentials. Some countries which undertook labour market reforms managed to increase downward flexibility of wages, however in the non-tradable sector competitiveness still needs to be improved.

Undertaken structural reforms and changes in economic governance in the euro area should help avoiding a significant rise in macroeconomic imbalances again, and especially problematic inflation differentials. The excessive fiscal policies should be avoided due to stricter budgetary rules, to prevent procyclical economic influence and inflationary pressures which lead to rise in inflation differentials.

On the other hand we have to note that statistical measures suggest that inflation dispersion in EMU has on balance been comparable to inflation dispersion between regions of the United States. Inflation differentials in the euro area were persistent, a lot of member countries systematically maintained either positive or negative inflation differentials. The question remains: whether inflation differentials have reached some sort of “natural” lower bound exactly in 1999, so they cannot be decreased more?

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INFLACIJA I INFLATORNI DIFERENCIJALI U BOGATIJIM ČLANICAMA ZONE EVRA

Rezime: Rad analizira konvergenciju stopa inflacije u grupi razvijenijih članica zone evra. Koje su karakteristike i da li je inflatorni proces u ovim zemljama dovoljno homogen, da li se te stope inflacije približavaju, tako da možemo reći da postoji indicija da one teže da formiraju optimalno valutno područje. Primenjen je test jediničnog korena kako bi se proverila stacionarnost serije prosečnih inflatornih diferencijala. Inflatorni diferencijali su računati kao razlika između inflacije u datoj zemlji i stope inflacije u EMU. Ako se proces konvergencije odvijao, inflatorni diferencijali će se smanjivati i težiti nuli. Varijansa diferencijala će se takođe smanjivati, serija prosečnih inflatornih diferencijala će biti stacionarna. Analiza je pokazala da u seriji postoji jedinični koren, tako da ona nije stacionarna, odnosno ne možemo da zaključimo da se odvijao proces konvergencije stopa inflacije u zemljama centra. U radu su analizirane i autokorelacione funkcije stopa inflacije, kako bi se utvrdila perzistentnost inflacije, odnosno koliko vremena je potrebno da šok koji je izazvao rast inflacije od 1% odumre. Vrednosti prvih autokorelacionih koeficijenata su visoke, dok naredni sporo opadaju, tako da je potrebno duže vreme da nestane uticaj šoka inflacije. Takođe, korelogrami stopa inflacija su prilično heterogeni, što ukazuje na to da se inflatorni procesi razlikuju.

Ključne reči: inflacija, inflatorni diferencijali, nominalna konvergencija, homogenost inflatornih procesa, optimalno valutno područje, Evrozona

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