Economic Research-Ekonomska Istraživanja

ISSN: 1331-677X (Print) 1848-9664 (Online) Journal homepage: http://www.tandfonline.com/loi/rero20

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To cite this article: Piotr Misztal (2017) The investigation of inflation persistence in Croatia in the period of 2005–2013, Economic Research-Ekonomska Istraživanja, 30:1, 273-289, DOI: 10.1080/1331677X.2017.1305788

To link to this article: http://dx.doi.org/10.1080/1331677X.2017.1305788

Published online: 07 Apr 2017.

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA, 2017
VOL. 30, NO. 1, 273–289
http://dx.doi.org/10.1080/1331677X.2017.1305788

The investigation of inflation persistence in Croatia in the period of 2005–2013

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ABSTRACT

The aim of this article is to analyse the inflation persistence phenomenon in the theory of economics and in Croatian economy. In the economic literature there are only few studies on the phenomenon of inflation persistence in Croatia. That is why we try to fill the gap in this area by analysing the phenomenon of inflation persistence in the Croatian economy, with particular emphasis of this phenomenon for different groups of goods and services. In this article we use a research method based on literature studies in the field of macroeconomics and international finance and econometric methods (Bayesian Vector Autoregression Model [BVAR]). All statistical data used in this article were monthly data and covered the period from January 2005 to December 2013 (108 months) and their source was United Nations Economic Commission for Europe (UNECE) Statistical Division Database. It provides detailed statistical information on countries in Europe, North America and Central Asia. The calculated inflation persistence coefficient in Croatia stood at 0.88 in the period 2005–2013, which apparently confirmed the occurrence of high inflation persistence in this economy. High inflation persistence means a slow return of inflation to its long-run value after a shock. A high degree of inflation persistence should be a signal for the economic authorities of a country to initiate indispensable institutional and labour market reforms which usually increase flexibility of domestic economy and lead to a reduced degree of inflation persistence.

ARTICLE HISTORY
Received 7 March 2014
Accepted 5 February 2016

KEYWORDS
Inflation rate; consumer prices; producer prices; Croatia

JEL CLASSIFICATIONS
F37; P24; P44; E31

1. Introduction

Efficacy of monetary policy in price stabilisation depends on many factors including, in particular, inflation dynamics, central bank credibility, the coordination degree between monetary and fiscal policies, exchange rate system and the degree of monetary policy intensity. On the other hand, one of the factors affecting inflation dynamics is the way in which domestic enterprises establish prices. If a large number of enterprises establish their prices on the basis of information derived from the past, then the country deals with

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the phenomenon of inflation persistence (Gali & Gertler, 1999), which means that after a shock inflation tends to adjust slowly to its long-term equilibrium value. Thus, inflation persistence indicates a strong and positive correlation between current inflation and that from the preceding periods. This phenomenon poses a problem for monetary authorities of a country in restricting inflation to the set inflation target after the period of its growth, and indispensable adjustments take more time and cause a greater production and employment variability. Evidence concerning inflation persistence in countries with varied level of economic development indicate that in a stable inflation economies, where the inflation targets of central banks do not modify and where the consumer perception of this inflation targets are well anchored, the degree of inflation persistence is relatively low.

The aim of this article is to analyse the inflation persistence phenomenon in the theory of economics and in Croatian economy. In this article we use a research method based on literature studies in the field of macroeconomics and international finance and econometric methods (BVAR). BVAR uses Bayesian methods to estimate a vector autoregression (VAR). In that respect, the difference with standard VAR models lies in the fact that the model parameters are treated as random variables, and prior probabilities are assigned to them. All statistical data used in this article were monthly data and covered the period from January 2005 to December 2013 and their source was the UNECE's Statistical Division Database.

2. Persistent inflation and its types

It is commonly believed that inflation is often vulnerable to multiple macroeconomic shocks which may lead to deviations of the current inflation rate from it average value which is usually defined by the central bank's inflation target. The above-mentioned economic shocks can be of permanent nature or they can have permanent effects for inflation, for example due to the occurrence of the nominal price rigidity which leads to lasting deviations of inflation from its target. This is why the knowledge concerning permanence of these shocks and the degree of inflation deviation from the established target play an important role from the point of view of the central bank which finds its prominent goal in attaining price stability. Adjustment of current inflation to its long-term value after the occurrence of a shock can be characterised by the speed with which inflation returns to its average value. The higher this speed is, the less complicated the central bank's pursuit of maintaining price stability can be (Darvas & Varga, 2007). Thus, one of the most important characteristics of inflation dynamics is its degree of the so-called persistence. Willis (2003) defines the inflation persistence phenomenon as the 'speed with which inflation returns to baseline after a shock'.

In economic literature two main methods of measuring inflation persistence are used, namely, parametric measures and structural measures. Among parametric measures different autoregression models are distinguished, whereas among structural measures we find methods based on the New Keynesian Phillips curve.

The concept of inflation persistence refers to a relationship between a current inflation rate and past inflation rates. What is more, Fuhrer (2009) distinguishes here intrinsic inflation persistence and inherited inflation persistence connected with the persistence of factors determining inflation.

Batini (2002) distinguishes three types of inflation persistence, i.e.: persistence resulting from a positive correlation of the variables taken into account to calculate inflation, persistence resulting from time lags between a systematically implemented monetary policy of the central bank and its effect on inflation and finally persistence which results from a delayed reaction of inflation to non-systematic actions of a country's financial authorities.

On the other hand, according to Altissimo, Ehrmann, and Smets (2006) there are three types of inflation persistence, namely: extrinsic inflation persistence which is a result of sustained changes in marginal costs; intrinsic – being a relationship of current inflation and its past values and eventually expectation-based inflation persistence which is an inflation rate anticipated on the basis of historical trends.

In order to analyse the persistent inflation phenomenon, Angeloni, Aucremanne, and Ciccarelli (2006) use the Hybrid Phillips Curve which is represented by the equation below:

$$\pi_t = \omega_b \pi_{t-1} + \omega_f \mathrm{E}_t \pi_{t+1} + \gamma y_t + \varepsilon_{\pi,t} \quad (1)$$

What is more, the above-mentioned economists divide inflation persistence into: intrinsic inflation persistence, expectation-based inflation persistence and error-term inflation persistence.

According to the authors of this approach, intrinsic inflation persistence concerns the mechanism of price and wage setting (ω_b) and it results from a slow adjustment of inflation to the long-run equilibrium value. On the other hand, expectation-based inflation persistence results from the way in which inflation expectations are formulated ($\mathrm{E}_t\pi_{t+1}$), their gradual adjustment to the inflation target set by the monetary authorities of a country, while extrinsic inflation persistence refers to persistence of other variables (y_t) determining inflation. Error-term inflation persistence regards a random error ($\varepsilon_{\pi,t}$) which may be subject to auto-correlation.

3. Inflation persistence in view of the selected empirical analysis results

Results of numerous empirical studies indicate that post-war inflation, to a large extent, was and still is determined by inflation persistence in the economically well-developed countries. A variety of reasons can account for the said persistence of inflation, among others, structural changes in particular countries, modification of inflation targets by central banks, changes in the exchange rate regimes or price shocks (Levin & Piger, 2004).

Mishkin (2007) claims that inflation persistence leads to higher costs of the monetary policy implemented to stabilise inflation. These costs are connected with greater variability of production and unemployment. The research carried out by Cogley and Sargent (2006) as well as Stock and Watson (2007) revealed, that in the US in the period connected with changes in the monetary policy regime a substantial variation in inflation persistence occurred. Benati (2006) was the one who analysed the evolution of inflation persistence in selected countries and in different monetary regimes. He noted that the degree of inflation persistence was changing significantly over time and it was lower in the periods in which a nominal anchor was not clearly defined.

Levin and Piger (2004) prove that the occurrence of a high degree of inflation persistence may be related to the changes in average inflation which, in turn, reflect changes over time with reference to the central bank's inflation targets. In their studies, the above-mentioned authors confirmed that inflation persistence measured by the sum of autoregression coefficients is significantly below one in almost all analysed countries. What is more, they confirmed that inflation persistence is not exclusively a characteristic of economically well-developed countries.

Franta, Saxa, and Šmidkova (2009) carried out a comparative analysis of the inflation persistence degree in the so-called 'new' member countries of the European Union and selected Euro area member countries for the period 1993–2008. Research results indicate that from the point of view of the inflation persistence degree, the 'new' member countries can be divided into two groups. The group consisting of Bulgaria, Cyprus, Czech Republic, Malta Rumania and Slovakia is characterised by inflation persistence similar to that of the analysed Euro area countries (Belgium, Germany, Portugal and Spain), whereas the second group, in the authors' opinion, comprises Estonia, Hungary, Lithuania, Latvia, Poland and Slovenia. In the latter case the rate of intrinsic and expectation-based inflation is clearly higher than in the remaining 'new' EU member countries (Franta, Saxa, Šmidkowa 2010).

On the other hand, Benati (2004) while analysing 20 OECD member countries and the eurozone countries did not provide us with sufficient evidence for the occurrence of a high degree inflation persistence in these countries. Alogoskoufis and Smith (1991) claim that inflation is less persistent in the countries with fixed exchange rate regimes. Other authors, for example, Burdekin and Siklos (1999) maintain that also other factors, such as, wars, supply-side shocks or reforms of the central bank can affect the inflation persistence degree. However, the studies conducted by Bratsiotis, Madsen, and Martin (2002) in Australia, Canada, Finland, New Zealand, Spain, Sweden and Great Britain at the turn of the 1980s and 1990s, indicate that inflation persistence depends on the rules of the implemented monetary policy. And thus, the more emphasis on the monetary policy goal being price control is placed, the lower the inflation persistence degree is. Consequently, inflation is less persistent when the central bank carries out the strategy of direct inflation targeting. Moreover, Davig and Doh (2009) claim that monetary policy can curb inflation persistence by a more aggressive adjustment of nominal interest rates in response to inflation changes.

Research results achieved by Meller and Nautz (2009) point to a significant decrease in the inflation persistence degree in the majority of the Euro area countries. A decline of long-term inflation persistence is not only particularly visible in such countries as France and Italy but is equally significant in Germany (Meller & Nautz, 2009).

Batini and Nelson (2001), while analysing economies of the UK and the US, showed the occurrence of a significant time lag in the monetary policy impact on inflation rate changes in these countries. Results of their research show that the maximum effects of monetary policy actions in the form of reduced inflation were achieved a year after they had been implemented (Batini & Nelson, 2001).

De Oliveira and Petrassi (2010) analysed the phenomenon of inflation persistence in group of 23 industrial and 17 emerging economies. Results of research indicated that inflation persistence is decreasing over time for the great majority of industrial.

economies. On the other hand, in many emerging economies (Argentina, Peru, Bolivia, Hungary and Czech Republic) they revealed increasing inflation persistence.

4. Inflation persistence in Croatia

The literature on the topic uses a great variety of econometric models in order to estimate the inflation persistence degree in selected countries. To analyse the problem of inflation persistence in Croatia in this article we used a model put forward by Andrews and Chen (1994) which is represented by the following equation:

$$\pi_t = \mu + \sum_{j=1}^{k} \alpha_j \pi_{t-j} + \upsilon_t \tag{2}$$

where:

π- consumer price index (*CPI);*
μ – constant;
α – autoregression coefficient;
υ – random error;
t – period,
j – the number of time lags between variables.

In turn, the rate of inflation persistence (ρ) can be calculated according to the following expression:

$$\rho = \sum_{j=1}^{k} \alpha_j \tag{3}$$

A coefficient defining the inflation persistence degree can take the values from zero to one [0;1]. At the same time inflation persistence is high if the current inflation is, to a large extent, determined by past inflation. In such a case the coefficient defining the inflation persistence rate is close to one. On the other hand, inflation persistence is low if the current inflation is little dependent on past inflation. In this situation, the inflation persistence rate is close to zero.

The model proposed by Andrews and Chen (1994) and used in this article takes into consideration an additional determinant of consumer price inflation in the form of a production price index (the so-called producer price inflation) in the country. The ultimate form of the model is expressed by the following equation:

$$\pi_t = \mu + \sum_{j=1}^{k} \alpha_j \pi_{t-j} + \sum_{j=1}^{k} \beta_j p_{t-j} + \upsilon_t \tag{4}$$

where:

p_t – producer price index (*PPI*).

All the above-mentioned time series had a monthly frequency and covered the period from January 2005 to December 2013. From the time series a season factor was also isolated in order to eliminate the influence of seasonal fluctuations on the examined processes. To this end the X12-ARIMA procedure was employed. Ultimately, in the period 2005–2013 changes in indicators used for the model looked as in Figure 1.

Additionally, all analysed variables underwent the procedure of logarithming which enabled us to obtain a linear estimator in regard to parameters. Before the BVAR model estimation it was necessary to specify the stationarity of the analysed time series. For this purpose, the Augmented Dickey-Fuller Test (ADF) was used (see Appendix 1). The ADF test has its own critical value which depends on the size of the sample. The null hypothesis is that there is a unit root, [$\delta = 0$]. The test has low statistical power in that they often cannot distinguish between true unit-root processes ($\delta = 0$) and near unit-root processes ([δ] is close to zero). This is so-called the 'near observation equivalence' problem.

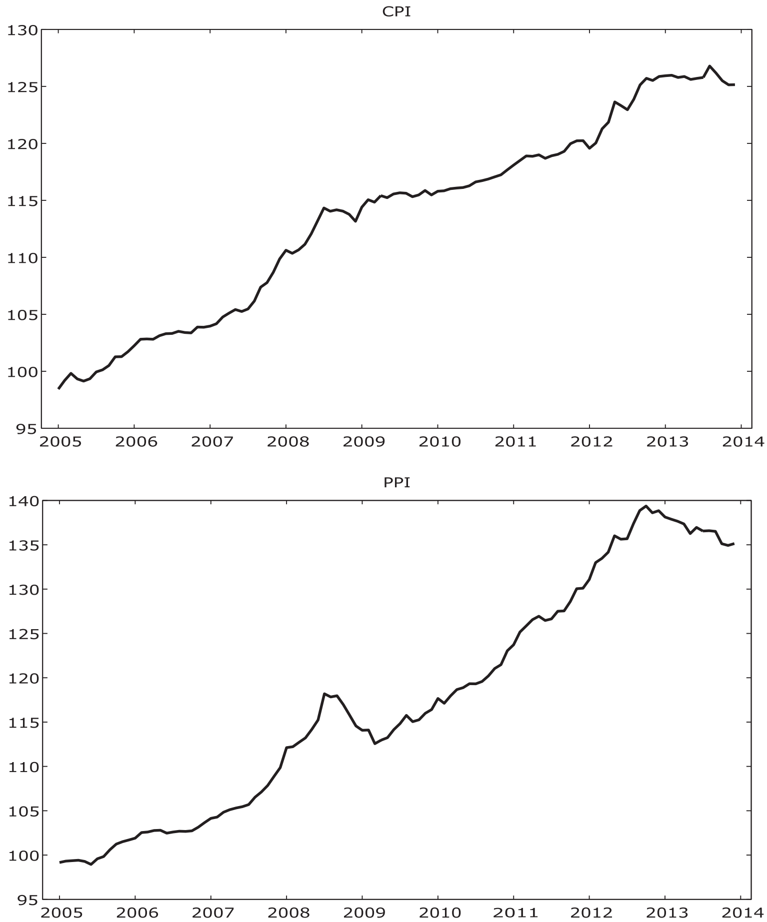

Figure 1. Consumer price index and producer price index in Croatia in the period of 2005–2013 (2005 year = 100, seasonally adjusted).

The last stage of the analysis of time series was co-integration estimation. Having a set of integrated variables of order 1, a co-integration test was carried out according to the method put forward by Johansen (see Appendix 2). The choice of the lag lengths for co-integration testing was made on the basis of the results of the Akaike, Schwartz-Bayesian and Hannan-Quinn information criteria. According to Schwartz-Bayesian and Hannan-Quinn criteria, the largest information capacity characterised the model with two lags (see Appendix 3).

Then the model was estimated by means of the BVAR proposed by Sims (1980). This approach was first used by McCarthy (1999), when he studied different macroeconomic correlations in the countries belonging to the Organization of Economic Cooperation and Development (OECD). In the BVAR method the given phenomenon is analysed by means of a system of equations, which, in accordance with Sims' postulations (1980) eliminates also the problem of exogeneity of independent variables. In this case the estimation of interactions between different factors and inflation in the model is isolated from the influence of other factors which inflation can be correlated with (Table 1).

Table 1. Bayesian VAR Estimates, lag order 2, OLS estimates, observations 2005:03–2013:12 (T=108).

Included observations: 106 after adjustments
Prior type: Litterman/Minnesota
Initial residual covariance: Univariate AR
Hyper-parameters: Mu: 0, L1: 0.1, L2: 0.99, L3: 1
Standard errors in () & t-statistics in [ ]

	CPI	PPI
CPI(-1)	0.80	0.10
	(0.04)	(0.06)
	[17.27]	[1.62]
CPI(-2)	0.08	-0.02
	(0.04)	(0.05)
	[2.17]	[-0.44]
PPI(-1)	0.08	0.85
	(0.03)	(0.04)
	[2.66]	[19.02]
PPI(-2)	-0.01	0.09
	(0.02)	(0.04)
	[-0.64]	[2.22]
C	5.06	-1.91
	(1.19)	(1.68)
	[4.23]	[-1.13]
R-squared	0.99	0.99
Adj. R-squared	0.99	0.99
Sum sq. resids	39.13	80.16
S.E. equation	0.62	0.89
F-statistic	4,674.49	5,403.22
Mean dependent	113.83	117.88
S.D. dependent	8.32	12.81

ρ= 0,88

Mean dependent var	4.73	S.D. dependent var	0.07
Sum squared resid	0.00	S.E. of regression	0.00
R-squared	0.99	Adjusted R-squared	0.99
R-squared	0.99	P-value(F)	1.8e
F(4, 101)	12,125.93	Durbin-Watson	1.95
rho	0.02		

F-tests of zero restrictions:
All lags of CPI F(2, 101) = 1,279.1 [0.00]
All lags of PPI F(2, 101) = 1.27 [0.28]
All vars, lag 2 F(2, 101) = 3.00 [0.05]

On the basis of the model estimation results it can be noted that in the examined period inflation was significantly determined by inflation from the two consecutive months preceding the research. The calculated inflation persistence coefficient stood at 0.88 in the period 2005–2013, which apparently confirmed the occurrence of high inflation persistence in Croatia. These results are convergent with the results presented, among others, by Franta, Saxa, and Šmídková (2007), and Mladenović and Nojković (2012) (Figure 3).

The next stage of the analysis involved measurement of the impact of the analysed factors on the inflation rate in Croatia in the period 2005–2013. This measurement was carried out with the use of the so-called impulse response function, i.e. the inflation rate response function to an impulse in the form of a unit change of consumer and production prices in Croatia (Figure 2).

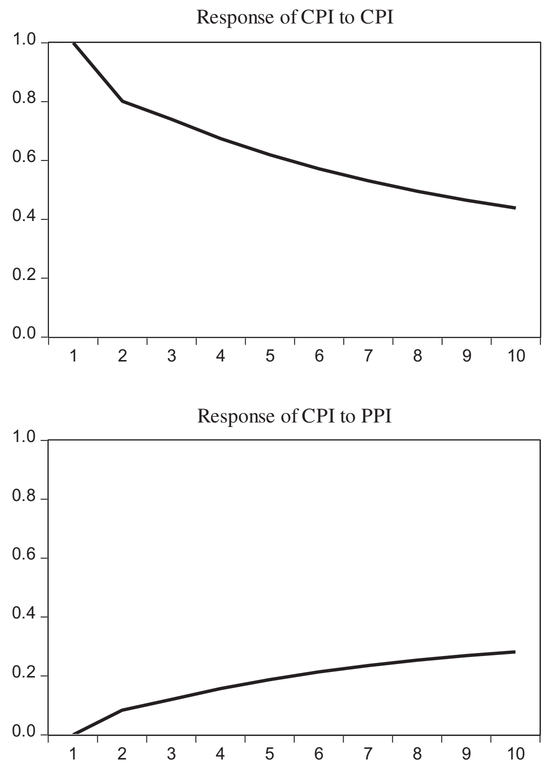

Figure 2. Impulse response function of the inflation rate in Croatia. Source: Own calculations.

On the basis of the above figures one can easily notice that dramatic growth in the consumer price index led to an immediate increase in the consumer inflation within the first month from the moment of a price shock and then to gradual stabilisation of consumer prices in Croatia. However, an increase in the production price index led to gradual increase in the consumer price index in Croatia from the very first month after the occurrence of the price shock. In order to obtain data concerning the number of months necessary to absorb 50% of the inflation shock before inflation returns to its baseline in a given period, Gujarati (2003) put forward the following formula of calculations:

$$h = \frac{\rho}{1 - \rho} \tag{5}$$

where:

h - the number of months necessary to absorb 50% of the inflation shock before inflation returns to its baseline in a given period;

ρ - inflation persistence coefficient.

Index (h) calculated in accordance with the above formula was 7.3 which meant that the period needed by inflation to absorb half of the price shock in Croatia equaled more than seven months.

The subsequent stage of the analysis was variance decomposition of the residual component of the consumer price index in the period 2005–2013 to estimate the effect of changes of the analysed factors on inflation variability in Croatia.

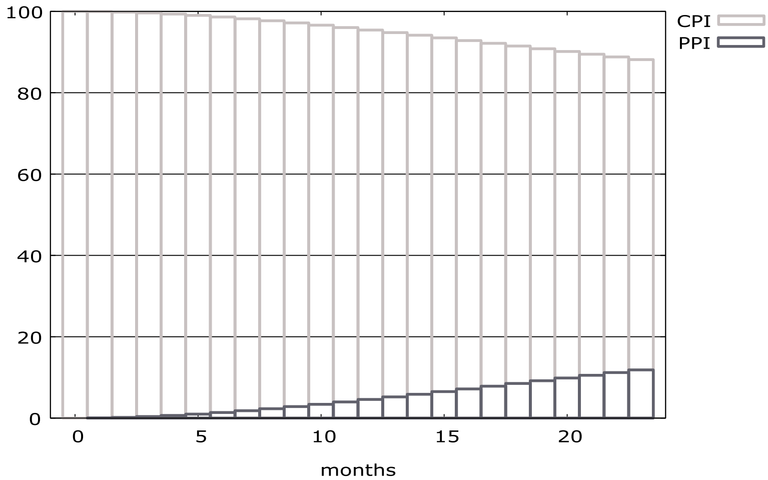

Figure 3. Variance decomposition of for CPI in Croatia in the period of 2005-2013. Source: Own calculations.

On the basis of data included in the above Figure 3 one can notice that changes in the consumer prices accounted for more than 90% of variability of consumer price index in Croatia over a year following the price shock. On the other hand, producer prices accounted for the consumer price index over the first year following the shock to a much lesser degree (below 10%).

To analyse the problem of inflation persistence in Croatia in more depth, we also examined inflation persistence for particular groups of commodities and services which are used for constructing the consumer price index. To this end the inflation index was employed for 12 groups, such as food and non-alcoholic beverages, alcohol and tobacco products, clothing and footwear, housing, the use of the dwelling and public utilities, transport, communications, recreation and culture, education, restaurants and hotels and other goods and services.

As in the case of the consumer price index, all time series had a monthly frequency and covered the period from January 2005 to December 2013. A seasonal factor was isolated from a particular time series in order to eliminate the impact of seasonal fluctuations on the analysed variables. To this end the X12-ARIMA procedure was employed. As a result, in the period 2005–2013 changes in the indices used for the model looked as Figure 3 depicts.

As Figure 4 shows, the price dynamics in particular groups of consumer goods and services was diversified. In the examined period the biggest impact on changes in the consumer price index was noted in the case of expenditure related to housing, rising prices of alcohol and tobacco products as well as rising prices of food and non-alcoholic beverages.

Inflation persistence in Croatia looked different for different groups of goods and services used for the construction of the consumer price index. The Table 2 outlines the model estimation results for particular groups and services.

On the basis of the data included in the Table 2 it can be noticed that the highest degree of inflation persistence appeared in such groups of goods as 'food and non-alcoholic beverages', 'furnishings, household equipment and routine household maintenance', 'health', 'communication', 'recreation and culture' and 'miscellaneous goods and services'. Here current inflation was totally determined by past inflation since the index defining inflation persistence was close to one. On the other hand, the lowest inflation persistence

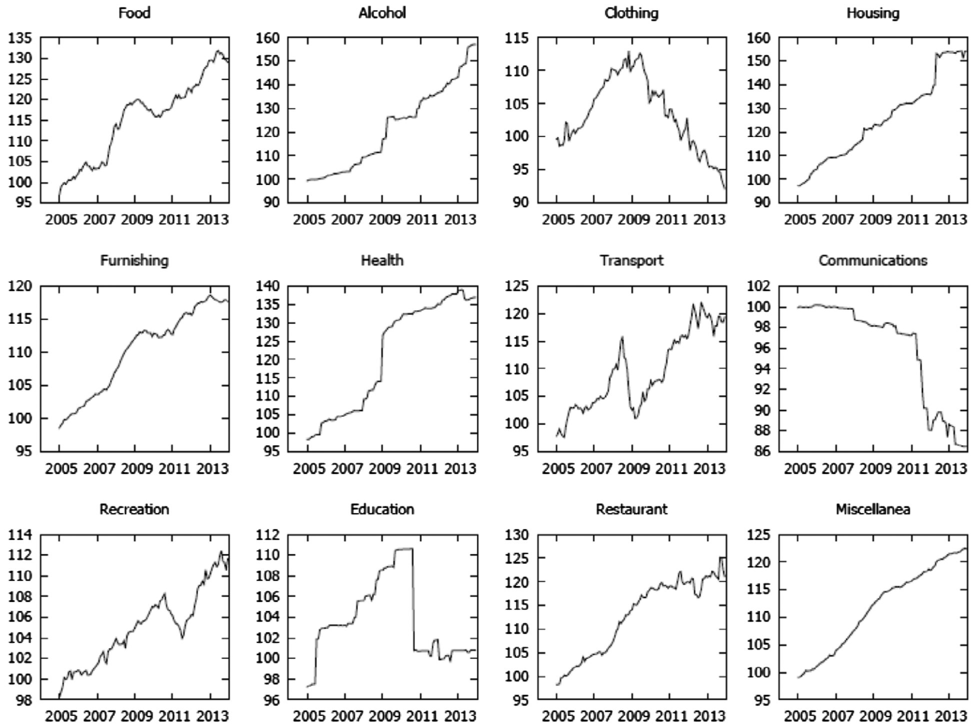

Figure 4. Inflation rates for particular groups of commodities and services in Croatia in the period of 2005–2013 (2005 year = 100, seasonally adjusted). Source: Own calculations.

Table 2. Inflation persistence coefficients in Croatia for different groups of goods and services in the period of 2005–2013.

Goods and services	Inflation persistence coefficients (ρ)	The number of months necessary to absorb 50% of the inflation shock (h)
Food and non-alcoholic beverages	0.91	10.1
Alcoholic beverages, tobacco	0.82	4.6
Clothing and footwear	0.89	8.1
Housing, water, electricity, gas and other fuels	0.82	4.6
Furnishings, household equipment	0.91	10.1
Health	0.91	10.1
Transport	0.90	9.0
Communication	0.91	10.1
Recreation and culture	0.91	10.1
Education	0.87	6.7
Restaurants and hotels	0.90	9.0
Miscellaneous goods and services	0.91	10.1
Average	0.88	7.3
Weighted average	0.90	9.0

Source: Author's calculations.

was found for 'alcoholic beverages, tobacco' and 'housing, water, electricity, gas and other fuels'. The coefficient of inflation persistence was lower than the average inflation persistence in Croatia and stood at 0.82. Diversified coefficients of inflation persistence determined also the length of time that inflation needed to absorb 50% of the price shock. The longest

Table 3. Inflation persistence coefficients in different countries in the period of 2005–2013.

Countries	Inflation persistence coefficients (*ρ*)	The number of months necessary to absorb 50% of the inflation shock (*h*)
Czech Republic	0.57	1.3
Serbia	0.81	4.3
Romania	0.73	2.7
Hungary	0.82	4.5
China	0.98	49.0
Japan	0.88	7.3
Malaysia	0.78	3.5
Singapore	0.89	8.1
Japan	0.92	11.5

Source: Mladenović and Nojković (2012); Gerlach and Tillmann (2010) and author's calculations.

absorption period took place in the case of goods which revealed the highest inflation persistence, whereas the shortest absorption time was noted for groups of goods revealing the lowest inflation persistence.

Diversified degrees of inflation persistence occurred also in other countries of diversified levels of economic development. In the examined period, the highest values of the inflation persistence coefficient were found in the countries which were economically better developed, whereas the lowest values – in relatively less developed economies (Table 3).

Similar trends were noted for the speed with which inflation absorbed 50% of the price shock before it returned to its baseline in the examined countries. Among the countries analysed, the Czech Republic was the country in which inflation absorbed half of the price shock most quickly, in China – this absorption was the slowest. At the same time, it must be mentioned that this period was much shorter in most of the analysed countries (except for China, Japan and Singapore) than in Croatian economy.

5. Conclusion

Many empirical analyses which have been conducted so far indicate clearly that inflation convergence achieved by the Euro area member countries prior to the adoption of the common currency was not maintained in all current member countries of the monetary union. The ability to uphold the Maastricht convergence criteria is determined, among others, by the degree of inflation persistence, which can be a crucial problem for the countries which are candidates for the eurozone, both before and after the adoption of common currency. The calculated inflation persistence coefficient in Croatia stood at 0.88 in the period 2005–2013, which apparently confirmed the occurrence of high inflation persistence in this economy. High inflation persistence means a slow return of inflation to its long-run value after a shock. A high degree of inflation persistence should be a signal for the economic authorities of a country to initiate indispensable institutional and labour market reforms which usually increase flexibility of domestic economy and lead to a reduced degree of inflation persistence (Franta et al., 2007).

What can be of utmost importance are reforms leading to more competition in the market of goods and services, both at the level of producers and salesmen, which in turn can cause a reduced degree of price rigidity and facilitate adjustment of prices to changing economic conditions. Furthermore, reforms in the labour market aiming at greater flexibility of wages and salaries and leading to abolishment of wage indexation can contribute to a decrease in the inflation persistence degree (Altissimo et al., 2006). In view of the above, one can expect that in future the inflation persistence degree and price rigidity degree in Croatia should decrease in response to the growing degree of foreign competition in the European Union and advancing process of globalisation of economies.

Disclosure statement

No potential conflict of interest was reported by the author.

References

Alogoskoufis, G., & Smith, R. (1991). The Phillips curve, the persistence of inflation and the Lucas critique: Evidence from exchange rate regimes. *American Economic Review*, *81*, 1254–1275.

Altissimo, F., Ehrmann, M., & Smets, F. (2006). *Inflation persistence and price-setting behavior in Euro area: A summary of IPN evidence* (European Central Bank Occasional Paper, No 46). Frankfurt am Main: European Central Bank.

Andrews D. W. K., & Chen H. (1994). Approximately median-unbiased estimation of autoregressive models, *Journal of Business & Economic Statistics*, *12*, 187–204.

Angeloni I., Aucremanne L., & Ciccarelli M. (2006). *Price setting and inflation persistence. Did EMU matter?* (European Central Bank Working Paper Series). Frankfurt am Main: European Central Bank.

Batini N. (2002). *Euro area inflation persistence* (European Central Bank Working Paper Series, December). Frankfurt am Main: European Central Bank.

Batini N., & Nelson E. (2001). The lag from monetary policy actions to inflation: Friedman revisited. *International Finance*, *4*(3), 1–25.

Benati L. (2004). *International evidence on the persistence of inflation*. London: Bank of England, mimeo.

Benati L. (2006). Investigating Inflation persistence across monetary regimes. Unpublished.

Bratsiotis, G. J., Madsen, J., & Martin, C. (2002). *Inflation targeting and inflation persistence* (Brunel University Public Policy Discussion Papers, No 02-12). Uxbridge: Brunel University.

Burdekin, R., & Siklos, P. (1999). Exchange rate regimes and shifts in inflation persistence: Does nothing else matter?, *Journal of Money Credit and Banking*, *31*, 235–247.

Cogley, T., & Sargent, T. (2006). Inflation-gap persistence in the U.S. Unpublished.

Darvas, Z., & Varga, B. (2007). *Inflation persistence in the Euro area, US, and New Members of the EU: Evidence from time-varying coefficient models*. Paper presented at the Money Macro and Finance Research Group Conference, Birmingham.

Davig, T., & Doh, T. (2009). *Monetary policy regime shifts and inflation persistence* (The Federal Reserve Bank of Kansas City, Research Working Paper, No. 08-16). Kansas City: Federal Reserve Bank of Kansas City.

De Oliveira, F. N., & Petrassi, M. (2010). *Is inflation persistence over?* (Banko Central do Brasil Working Paper Series, December). Brasília: Banco Central do Brasil.

Franta, M., Saxa, B., & Šmídková, K. (2007). *Inflation persistence in new EU member states: Is it different than in the euro area members?* (Czech National Bank Working Paper Series, No. 10). Praha: Czech National Bank, Economic Research Department.

Franta, M., Saxa, B., & Šmidkova, K. (2009). *The role of inflation persistence in the new EU member states, In what drives inflation in the new EU member states*. Brussels: European Commission.

Fuhrer, J. C. (2009). Inflation persistence (Federal Reserve Bank of Boston Working Papers, No. 09-14). Boston: Federal Reserve Bank of Boston, Economic Research.

Gali, J., & Gertler, M. (1999). Inflation dynamics: A structural econometric analysis, *Journal of Monetary Economics*, *44*, 195–222.

Gerlach, S., & Tillmann, P. (2010). *Inflation targeting and inflation persistence in Asia* (C.E.P.R. Discussion Papers, No. 8046). London: Centre for Economic Policy Research.

Gujarati, D. N. (2003). *Basic econometrics*. Boston, MA: London, McGraw-Hill.

Levin, A. T., & Piger, J. M. (2004). Is inflation persistence intrinsic in industrial economies? (European Central Bank Working Paper Series, No. 334). Frankfurt am Main: European Central Bank.
McCarthy, J. (1999). Pass-through of exchange rates and import prices to domestic inflation in some industrialized countries (Bank for International Settlement Working Papers, No. 79). New York, NY: Federal Reserve Bank of New York, Research Department.
Meller, B., & Nautz, D. (2009). *The impact of the European Monetary Union on inflation persistence in the Euro area* (SFB Discussion Paper, No. 649). Berlin: Humboldt-Universität zu Berlin.
Mishkin, S. F. (2007). Inflation dynamics (Working Paper Series National Bureau of Economic Research, NBER, No. 13147). Cambridge: National Bureau of Economic Research.
Mladenović, Z., & Nojković, A. (2012). *Inflation persistence in Central and Southeastern Europe: Evidence from univariate and structural time series approaches*, *Panoeconomicus, 2*, 235–266.
Sims, Ch. A. (1980). Macroeconomics and Reality, Econometrica, *1*, 1–48.
Stock, J., & Watson, M. (2007). Why has U.S. inflation become harder to forecast? *Journal of Money, Credit and Banking*, *39*(1), 1–33.
Willis, J. L. (2003). Implications of structural changes in The U.S. economy for pricing behavior and inflation dynamics (Federal Reserve Bank of Kansas City, Economic Review, First Quarter). Kansas City: Federal Reserve Bank of Kansas City.

Appendix 1. Augmented Dickey-Fuller test for CPI and PPI including 2 lags.

```
Augmented Dickey-Fuller test for CPI
including one lag of (1-L)CPI
(max was 2, criterion modified AIC)
sample size 106
unit-root null hypothesis: a = 1

   test without constant
   model: (1-L)y = (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: 0.01
   estimated value of (a - 1): 0.00
   test statistic: tau_nc(1) = 3.79
   asymptotic p-value 1

Augmented Dickey-Fuller regression
OLS, using observations 2005:03-2013:12 (T = 106)
Dependent variable: d_CPI

             coefficient   std. error    t-ratio   p-value
  --------------------------------------------------------
  CPI_1       0.00     9.25    3.79     1.00
  d_CPI_1     0.23     0.09    2.44     0.01  **


   test with constant
   model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: 0.02
   estimated value of (a - 1): -0.00
   test statistic: tau_c(1) = -1.37
   asymptotic p-value 0.59

Augmented Dickey-Fuller regression
OLS, using observations 2005:03-2013:12 (T = 106)
Dependent variable: d_CPI

             coefficient   std. error   t-ratio   p-value
  ------------------------------------------------------
  const        0.03      0.02      1.44     0.15
  CPI_1       -0.00      0.00     -1.37     0.59
  d_CPI_1      0.21      0.09      2.25     0.02   **


   with constant and trend
   model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: 0.01
   lagged differences: F(2, 100) = 3.25 [0.04]
   estimated value of (a - 1): -0.03
   test statistic: tau_ct(1) = -1.11
   asymptotic p-value 0.9255

Augmented Dickey-Fuller regression
OLS, using observations 2005:04-2013:12 (T = 105)
Dependent variable: d_CPI

             coefficient    std. error    t-ratio   p-value
  ---------------------------------------------------------
  const        0.15     0.13       1.13      0.25
  CPI_1       -0.03     0.03      -1.11      0.92
  d_CPI_1      0.24     0.09       2.49      0.01   **
  d_CPI_2     -0.09     0.10      -0.93      0.35
  time         6.55     7.35       0.89      0.37
```

```
Augmented Dickey-Fuller test for PPI
including 2 lags of (1-L)PPI
(max was 2, criterion modified AIC)
sample size 105
unit-root null hypothesis: a = 1

   test without constant
```

Appendix 1. (*Continued*)

```
   model: (1-L)y = (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: -0.01
   lagged differences: F(2, 102) = 7.57 [0.00]
   estimated value of (a - 1): 0.00
   test statistic: tau_nc(1) = 2.46
   asymptotic p-value 0.997

Augmented Dickey-Fuller regression
OLS, using observations 2005:04-2013:12 (T = 105)
Dependent variable: d_PPI

             coefficient   std. error    t-ratio   p-value
  --------------------------------------------------------
  PPI_1       0.00      0.00      2.46    0.99
  d_PPI_1     0.23      0.09      2.42    0.01  **
  d_PPI_2     0.21      0.09      2.18    0.03  **


   test with constant
   model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: -0.06
   estimated value of (a - 1): -0.00
   test statistic: tau_c(1) = -0.74
   asymptotic p-value 0.83

Augmented Dickey-Fuller regression
OLS, using observations 2005:03-2013:12 (T = 106)
Dependent variable: d_PPI

             coefficient   std. error   t-ratio   p-value
  -------------------- ----------------------------------
  const        0.02       0.02      0.82    0.41
  PPI_1       -0.00       0.00     -0.74    0.83
  d_PPI_1      0.296      0.09      3.15    0.00   ***

   with constant and trend
   model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: -0.08
   estimated value of (a - 1): -0.05
   test statistic: tau_ct(1) = -1.82
   asymptotic p-value 0.69

Augmented Dickey-Fuller regression
OLS, using observations 2005:03-2013:12 (T = 106)
Dependent variable: d_PPI

             coefficient    std. error    t-ratio   p-value
  ---------------------------------------------------------
  const        0.25      0.13      1.84    0.06  *
  PPI_1       -0.05      0.02     -1.82    0.69
  d_PPI_1      0.33      0.09      3.47    0.00  ***
  time         0.00      0.00      1.72    0.08  *
```

Source: Author's calculations.

Appendix 2. Johansen test.

```
Number of equations = 2
Lag order = 2
Estimation period: 2005:03 - 2013:12 (T = 106)
Case 3: Unrestricted constant

Log-likelihood = 1159.31 (including constant term: 858.494)

Rank Eigenvalue Trace test  p-value   Lmax test  p-value
   0    0.04     5.67 [0.73]      5.16 [0.72]
   1    0.00     0.50 [0.47]      0.50 [0.47]

Corrected for sample size (df = 101)
Rank Trace test p-value
   0     5.67 [0.74]
   1     0.50 [0.48]

eigenvalue    0.04    0.00

beta (cointegrating vectors)
CPI              60.28      -25.69
PPI             -36.81       25.82

alpha (adjustment vectors)
CPI         -0.00  -0.00
PPI         -1.35  -0.00

renormalized beta
CPI              1.00     -0.99
PPI             -0.61      1.00

renormalized alpha
CPI           -0.04   -0.00
PPI           -0.00   -0.01

long-run matrix (alpha * beta')
                CPI      PPI
CPI           -0.03    0.02
PPI            0.00   -0.00
```

Source: Author’s calculations.

Appendix 3. Var lag selection, maximum lag order 12.

VAR system, maximum lag order 12

The asterisks below indicate the best (that is, minimized) values of the respective information criteria, AIC = Akaike criterion, BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags	loglik	p(LR)	AIC	BIC	HQC
1	765.75		-15.86	-15.76*	-15.82
2	772.38	0.01	-15.92*	-15.71	-15.83*
3	776.27	0.09	-15.92	-15.60	-15.79
4	777.34	0.71	-15.86	-15.43	-15.68
5	779.83	0.28	-15.82	-15.29	-15.61
6	780.90	0.70	-15.76	-15.12	-15.50
7	785.88	0.04	-15.78	-15.04	-15.48
8	788.61	0.24	-15.76	-14.90	-15.41
9	796.70	0.00	-15.84	-14.88	-15.45
10	797.70	0.73	-15.78	-14.71	-15.35
11	798.17	0.91	-15.71	-14.53	-15.23
12	804.01	0.01	-15.75	-14.46	-15.23

Source: Author's calculations.