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Modelling Inflation in Croatia

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Modelling Inflation in Croatia

Abstract:

The aim of this paper is to construct a quarterly inflation model for Croatia. In order to model inflation dynamics we use the general-to-specific approach. The advantage of this approach is its ability to deliver results based on underlying economic theories of inflation, which are also consistent with the properties of the data. A two step procedure is followed. In the first step, the long-run sectoral analysis of inflation sources is conducted, yielding long-run determinants of inflation (mark-up, excess money, nominal effective exchange rate and the output gap). In the second step, we estimate an equilibrium error correction model of inflation deploying, among other variables of interest, long-run solutions derived in the first step. The derived model of inflation suggests that mark-up and excess money relationships are very important for explaining the short-run behaviour of inflation, as well as the output gap and nominal effective exchange rate, import prices, interest rates and narrow money. Comparing the results of the model suggests that short-run inflation is more responsive to supply side and exchange rate changes than to monetary conditions.

Keywords: inflation modelling, cointegration, general-to-specific, Croatia

JEL classification: C51, C53, E31, E37

Modeliranje inflacije u Hrvatskoj

Sažetak:

Cilj je ovoga rada izraditi tromjesečni model inflacije u Hrvatskoj. U tu će se svrhu koristiti pristup ekonometrijskom modeliranju "od općeg k specifičnom". Prednost se tog pristupa nalazi u činjenici da su njegovi rezultati istodobno utemeljeni na odgovarajućim teorijskim modelima inflacije i konzistentni sa statističkim karakteristikama korištenih vremenskih nizova. U radu se slijedi postupak koji se sastoji od dva koraka. U prvom se koraku provodi dugoročna sektorska analiza inflacijskih izvorišta, iz koje proizlaze dugoročne determinante inflacije: agregatna marža, višak ponude novca te jaz BDP-a i nominalni efektivni tečaj kune. U drugom se koraku ocjenjuje ravnotežni model korekcije odstupanja za inflaciju u kojem se, između ostalog, koriste i dugoročna rješenja izvedena u prvom koraku. Dobiveni model inflacije sugerira da su agregatna marža i višak ponude novca vrlo važni za objašnjavanje kratkoročnog ponašanja inflacije. Isto tako, jaz BDP-a, nominalni efektivni tečaj, uvozne cijene, kamatna stopa na depozite i monetarni agregat M1 također imaju kratkoročni utjecaj na inflaciju. Usporedbom se ocjena pojedinih članova modela dolazi do zaključka da je inflacija osjetljivija na kretanja na strani sektora ponude i tečaja nego na kretanja u monetarnom sektoru.

Ključne riječi: modeliranje inflacije, kointegracija, od općeg k specifičnom, Hrvatska

JEL klasifikacija: C51, C53, E31, E37

1 Introduction

The aim of this paper is to formulate a structural model of inflation in order to explain its short-run behaviour in Croatia. The paper uses quarterly data from the period of 1995-2006, relying on the general-to-specific approach and structural-based modelling.

Exploring the behaviour of inflation is necessary because it allows for a better understanding of the role that monetary policymakers play in controlling inflation behaviour. Moreover, in-depth knowledge of how inflation behaves is needed because monetary policy efficiency is challenged by the fact that its effects are often lagged. Given these time lags, a pre-emptive strike strategy seems like a reasonable choice for monetary authorities. However, the strategy requires a suite of inflation models in order to obtain reliable inflation forecasts. In the Croatian case, one more motive for modelling inflation emerges. In light of Croatian efforts to join the EU, knowing the determinants of inflation is of essential importance for fulfilment of the Maastricht convergence criteria, which is necessary for entering the euro area.

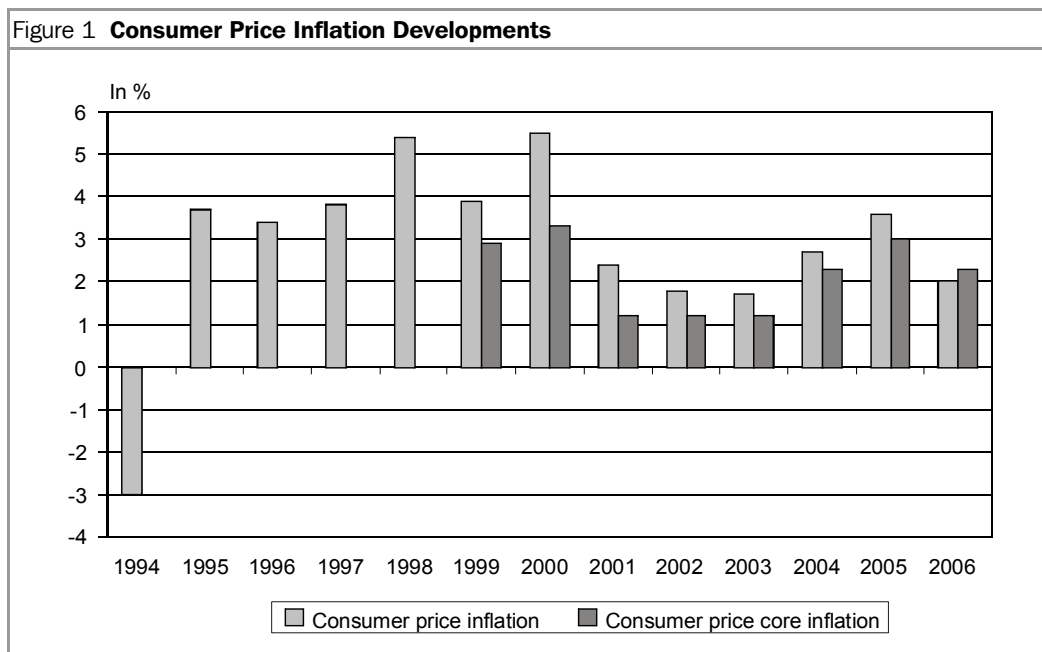
In order to investigate inflation in Croatia, this paper will attempt to explore inflation behaviour in Croatia in an integral and systematic way. Related research on the subject is very scarce, which is quite surprising knowing how important the inflation process is for monetary policy. On the other hand, since Croatian monetary policy has been quite passive, i.e. reduced to preserving exchange rate movements within an implicit band it does not surprise that more attention has been given to analysing the exchange rate. Besides two papers modelling specific aspects of inflation - exchange rate pass-through (Billmeier and Bonato, 2002; Kraft, 2003) - three remaining inflation-related papers focus exclusively on modelling inflation using VARs (Payne, 2002; Botrić and Cota, 2006,) or forecasting inflation with an ARIMA model (Pufnik and Kunovac, 2006).

In this paper we focus on inflation modelling, i.e. we construct a theoretically plausible structural model of inflation which includes the relevant sectors of the economy and theories of inflation. We use the general-to-specific modelling approach in order to obtain a single equation model for explaining short-run inflationary dynamics.

The paper starts with a short overview of past inflation behaviour, followed by a review of related work on modelling inflation in Croatia. In the fourth section, long-run determinants of inflation are derived in order to establish a structural inflation function in the form of an equilibrium error correction model. In the fifth section, using the general-to-specific approach we derive a structural inflation model and present its diagnostic tests. The last section concludes with the main findings of our research.

2 Historical Background

For Croatia, the early 1990s were quite dramatic. On the political front, Croatia gained independence from Yugoslavia, but also faced a situation of war. On the economic front, it experienced macroeconomic instability in terms of significant output loss and hyperinflation. War, the transition process, but also monetary instability inherited from Yugoslavia contributed to such developments; output fell 36 percent from 1990 to 1993 while the annual rate of inflation reached 1616 percent in 1993. In late 1993, the Stabilisation Programme based on a nominal exchange rate anchor was introduced. The Programme successfully achieved its main aim: in the last 13 years (from 1994 to 2006) Croatia has enjoyed a stable inflation rate, which can be observed in Figure 1. Controlling the exchange rate of national currency to the deutschmark/euro has become the key for maintaining price stability since pegging the nominal exchange rate meant anchoring domestic inflation expectations.



Note: Consumer price core inflation is available since 1999.

Source: Central Bureau of Statistics and Croatian National Bank.

However, stable inflation does not mean that one should not be interested in its main determinants. Quite the opposite, since stable inflation rates in line with those in the EU are one of the preconditions for joining the euro area, it is of the utmost importance to understand what drives inflation. Hence, it is not surprising that inflation-related research increased in other transition countries as the date of joining the EU approached (Botrić and Cota, 2006).

3 Literature Review

As we already mentioned, there are three papers investigating the inflation process in Croatia. Payne (2002) and Botrić and Cota (2006) focus on modelling inflation, while Pufnik and Kunovac (2006) are more interested in forecasting inflation.

Payne (2002) explores the inflationary dynamics in Croatia using vector autoregression (VAR) over the period January 1992 - December 1999. The VAR incorporated four variables: broad money supply, the retail price index¹, nominal net wage per employee and the nominal effective exchange rate. The model results suggest that wage increases and currency depreciation are positively correlated with inflation rates. Quite surprisingly, no evidence of inflation inertia was found, although the data sample covers the period of hyperinflation.

Building on Payne's model Botrić and Cota (2006) model Croatian inflation dynamics using the VAR. They find that the terms of trade and balance of payment shocks have the strongest impact on prices. The authors find justification for such a result in Croatia being a small open economy with high import dependency and uncompetitive economic structure. In order to contrast these findings, the authors also re-estimated Payne's model. While Payne's conclusion on the influence of wages and currency depreciation on prices still holds, in the newly estimated four-variable VAR, a positive correlation between broad money and prices and some inflation inertia also emerged.

Pufnik and Kunovac (2006) used a seasonal ARIMA model for forecasting inflation dynamics. Besides directly forecasting future inflation, this paper also establishes a framework for forecasting the main components of the CPI to better understand sources of inflation and calculate an aggregate inflation forecast. Their analysis shows that aggregating the CPI component forecasts outperforms both aggregate ARIMA and random walk inflation forecasts.

¹ At that time, the consumer price index was not calculated.

4 The Block Structure of the Inflation Model

The main objective of this section is to estimate a number of long-term relationships that govern or help explain inflation in Croatia. The variables in the long-run relationships will be specified and grouped in sector VARs in a way that is a priori based on economic theory. Also, additional restrictions will be imposed on the long-run models in order to maintain consistency with the underlying theory.

It is well known that inflation can be an outcome of various economic factors. On the demand side, factors like excess output cause demand-push inflation. Monetary factors like excess money supply can also induce inflationary pressures. Supply side factors come from cost-push or mark-up relationships. In addition, factors inherent to open economies, such as the deviation from the equilibrium exchange rate and the Balassa-Samuelson effect may also cause inflationary pressures.

In order to capture these various determinants of inflation, we will apply and combine the methodology developed in Juselius (1992) and Sekine (2001). Thus, section 4.1 of the paper measures the mark-up relationship, section 4.2 analyses the nominal effective exchange rate and Balassa-Samuelson effect, section 4.3 is devoted to monetary sources of inflation and section 4.4 examines excess output. After these relationships are determined, they will be imposed on an inflation function as equilibrium correction terms in the remainder of the paper.

4.1 Mark-up

Following de Brouwer and Ericsson (1998) and Sekine (2001), we examine a mark-up relationship for Croatian inflation. A simple mark-up model can be specified as²:

$$Lcpi = \delta * (Lulc)^\gamma * (Limport_prices)^{1-\gamma} \quad (1)$$

where $Lcpi$ is the logarithm of the consumer price index, $Lulc$ is the logarithm of the unit labour cost, $Limport_prices$ is the logarithm of the import deflator and $\delta-1$ corresponds to a mark-up.³ The equation assumes that linear homogeneity holds in the long-run. In order to estimate this relationship, a cointegration analysis is applied, using a trivariate VAR that consists of $(Lcpi, Lulc, Limport_prices)$. It must be noted that the unit labour costs and import prices series are not calculated by the national statistical office. Since these series are unavailable, they were calculated from those available. A more detailed description of the variables can be found in Appendix.

² See de Brouwer and Ericsson (1998) and Sekine (2001).

³ Where δ represents the share of labour and input cost in the CPI and 1 represents the CPI. For details on deriving the mark-up see de Brouwer and Ericsson (1998).

Table 1 and Table 2 summarise the main features of the cointegration analysis. The Johansen λ trace statistics support the existence of one cointegrating vector, while various tests on residuals imply a congruent VAR, as shown in Table 3.

Assuming one cointegrating vector and linear homogeneity, the derived long-run mark-up relationship becomes⁴:

$$Lmarkup = Lcpi - 0.54 * Lulc - 0.46 * Limport_prices \quad (2)$$

The linear homogeneity restriction is accepted ($\chi^2(1) = 0.166(0.69)$). The corresponding α vector is:

$$\begin{array}{lcl} Lcpi & \dots & -0.22 \\ Limport_price & \dots & -0.12 \\ Lulc & \dots & 0.48 \end{array} \quad (3)$$

The share of unit labour costs in the total unit cost (0.54) seems reasonable considering that the Croatian economy is highly dominated by the service sector. The share of unit labour costs in the total unit cost is higher than in Australia -0.43, but much lower than in Japan -0.90 (de Brouwer and Ericsson, 1998; Sekine, 2001). The relatively large share of import prices in the total unit cost is due to the high import dependency of the Croatian economy. If we replace import prices with the producer prices index, one cointegrating vector can also be found, but the size and sign of the long-run coefficients contradict the theory. Moreover, for $Lcpi$, $Lulc$ and $Lppi$ the long-run homogeneity condition does not hold.

Rank	eigenvalue	λ trace	p-value
0	-	30.8	0.037**
1	0.357	10.9	0.22
2	0.150	3.6	0.06
3	0.077	-	-

*Notes: All variables are seasonally adjusted; corresponding VAR included 1 lag of each variable, unrestricted constant and dummy variables for war, banking crises dummies and a dummy for the introduction of value added tax; VAR was estimated over the sample period 1995Q1 - 2006Q2; * - the null hypothesis of no cointegration rejected at 1%; ** - the null hypothesis of no cointegration rejected at 5%.*

Source: Authors' calculation.

As expected, the observed mark-up (upper left and lower right panel in Figure 2) highly correlates with the movement of the business cycle, i.e. it is pro-cyclical. It peaked in 1998 during the short-lived economic expansion and slumped during the recession in 1999. Since 2000, the mark-up has been on the rise reflecting favourable economic conditions in the past six years.

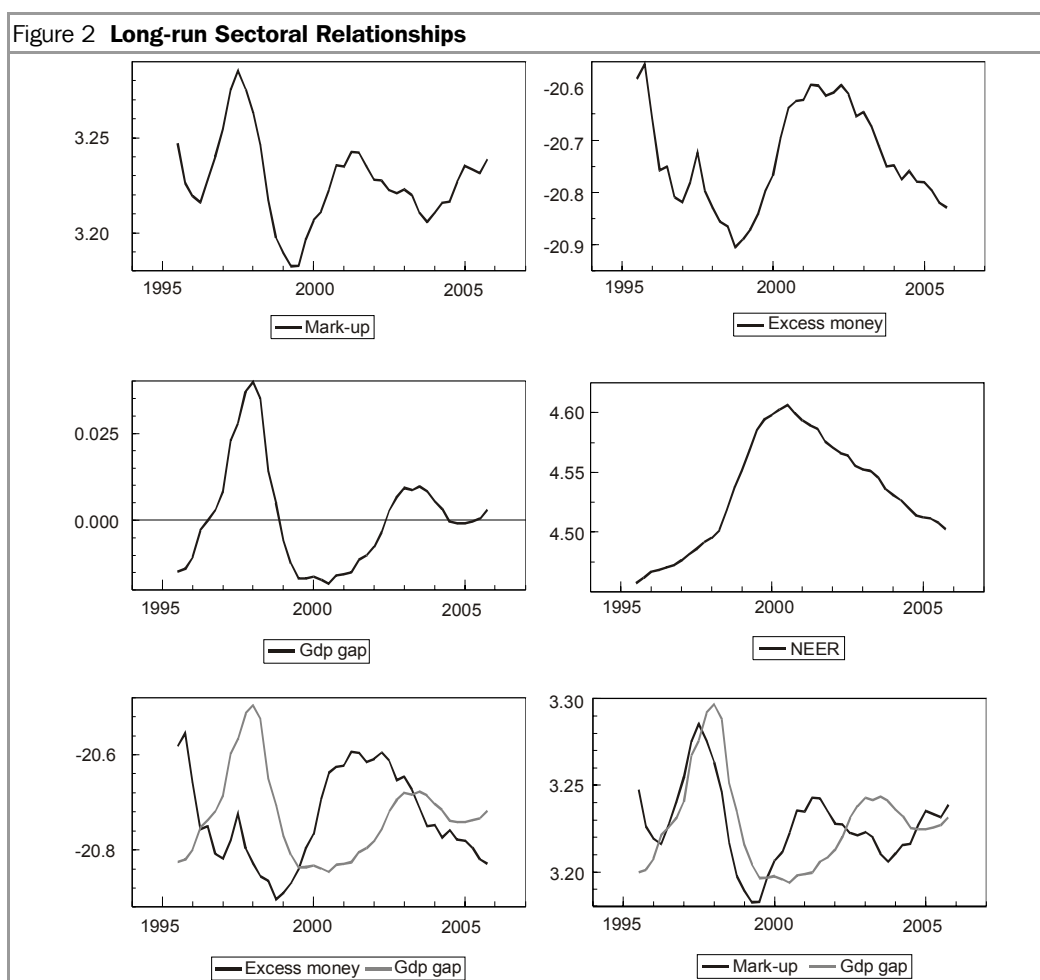
⁴ Coefficients in this equation represent a normalised and restricted cointegrating vector, while the coefficients in Table 2 come from a normalised cointegrating vector.

Variables	Standardised eigenvectors β'	Standardised adjustment coefficients α
Lcpi	1.000	-0.213
Limport_prices	-0.519	-0.104
Lulc	-0.538	0.491

Source: Authors' calculation.

Variables	AR 1-4 test F(4,34)	Normality test Chi ² (2)	ARCH 1-4 test F(4,30)	Hetero test F(9,28)
Lcpi	0.703 [0.59]	3.389 [0.18]	0.123 [0.97]	0.416 [0.92]
Limport_prices	1.729 [0.17]	0.689 [0.71]	1.295 [0.29]	0.490 [0.87]
Lulc	1.036 [0.41]	0.562 [0.75]	0.621 [0.65]	2.024 [0.07]

Source: Authors' calculation.

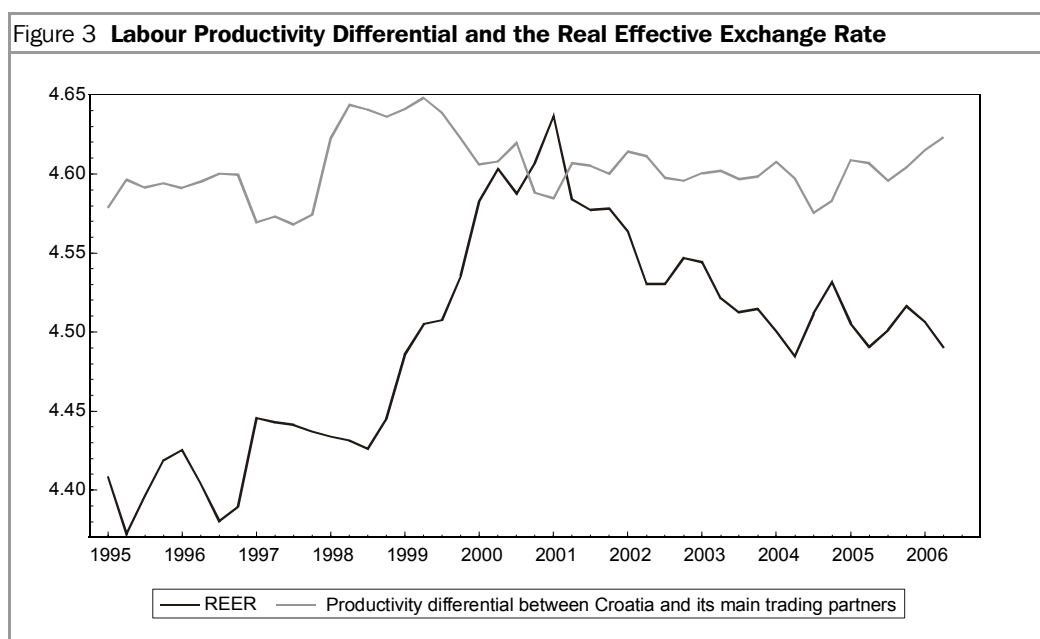


Note: All variables are represented by their moving averages; the series means and scales in the two lower panels are adjusted.

Source: Authors' calculation.

4.2 Purchasing Power Parity

Since Croatia is a small, open and highly euroised economy, exchange rate behaviour is very important to understand not just inflation, but the overall macroeconomic developments. As far as inflation is concerned, purchasing power parity (PPP) and deviations from it are found to be significant for inflation functions in Juselius (1992) and Hendry (2000). However, the PPP theory can be further expanded to encompass the Balassa-Samuelson effect (as in Golinelli and Orsi, 2001) because, on the one hand, in most CEE countries, real effective exchange rates have been appreciating and, on the other hand, the time span is too short to test the PPP hypothesis. However, if we were to judge on the presence of the Balassa-Samuelson effect in Croatia according to graphical analysis only (Figure 3), the Balassa-Samuelson effect may not have been present since Croatia did not achieve significant productivity gains in the tradable sector when compared to its main trading partners in the given time period. Since we were not convinced that the Balassa-Samuelson effect may be a long-run explanation of the inflation process in Croatia, we did not estimate its long-run relationship and consequently did not impose it on the inflation function as in Golinelli and Orsi (2001). Instead, for the short-run inflation function only the kuna nominal effective exchange rate (shown in Figure 2) will be used, since we assume that, due to high unofficial euroisation of the Croatian economy, economic agents in the country are more interested in nominal, rather than real exchange rate movements.⁵



Note: Scales are adjusted in order to fit two series on one graph.

Sources: Eurostat, Croatian National Bank, Central Bureau of Statistics and authors' calculation.

⁵ From a purely statistical point of view, using either the real effective exchange rate or nominal effective exchange rate would probably yield quite similar results since the correlation coefficient between the first differences in logarithms of the real and nominal effective exchange rate (used for estimating the short-run inflation model) is 0.82.

4.3 Excess Money

After defining the mark-up and nominal effective exchange rate, we turn to monetary determinants of inflation. In order to measure the excess money that eventually leads to inflationary pressures, we need to examine the long-run relationship between narrow money supply, CPI inflation, real GDP, the real price of real estate, the own rate of money and interest rate on rival assets. A more detailed description of the variables can be found in Appendix. The estimated VAR corresponds to Juselius (1992) and Sekine (2001).

Tables 4-6 summarise the residual properties and a system cointegrating analysis of the VAR. The Johansen test supports the existence of one cointegrating vector. There are indications of autocorrelation in the residuals (indicated by the AR test), but otherwise the VAR seems satisfactory. The occurrence of autocorrelation can be attributed to the spike in the GDP series in 1997. When the first three years of data are excluded from the sample, all diagnostic tests are satisfactory. The resulting excess money can be expressed as:

$$L_{excess_money} = Lm1 + 4.07^* L_{cpi} - 2.97^* L_{gdp} + 0.39^* L_{p_estate} + 2.67^* L_{zibor} - 8.55^* L_{r_forex} - 0.04^* Trend \quad (4)$$

The excess money represented by the above equation indicates a sharp spike at the beginning of the sample followed by a sharp decline in 1996 due to the economic expansion (Figure 2). The second spike can be observed just before the recession in 1999. From the lower left panel in Figure 2 one can conclude that, unlike the mark-up, excess money exhibits counter-cyclical behaviour, i.e. it contracts during periods when the economy is overheating, and it expands during economic recessions.

Rank	eigenvalue	λ trace	p-value
0	-	120.49	0.031**
1	0.582	82.1	0.137
2	0.541	47.8	0.519
3	0.400	25.3	0.775
4	0.245	12.9	0.746
5	0.151	5.7	0.507
6	0.122	-	-

Notes: All variables are seasonally adjusted; corresponding VAR includes 2 lags of each variable, unrestricted constant and restricted trend; the VAR was estimated over the sample period 1995Q1 - 2006Q2; * - the null hypothesis of no cointegration rejected at 1%; ** - the null hypothesis of no cointegration rejected at 5%.

Source: Authors' calculation.

Variables	Standardised eigenvectors β'	Standardised adjustment coefficients α
Lm1	1.000	0.087
Lcpi	4.069	-0.045
Lgdp	-2.971	0.057
Lp_estate	0.394	-0.061
Lzibor	2.673	0.007
Lr_forex	-8.549	0.045
trend	-0.035	-

Source: Authors' calculation.

Variables	AR 1-4 test F(4,34)	Normality test Chi ² (2)	ARCH 1-4 test F(4,30)	Hetero test F(9,28)
Lm1	0.184 [0.90]	1.166 [0.55]	1.486 [0.26]	28.55 [0.33]
Lcpi	0.662 [0.58]	0.101 [0.95]	0.163 [0.91]	28.89 [0.32]
Lgdp	5.49 [0.008]**	0.654 [0.72]	0.909 [0.46]	32.14 [0.18]
Lp_estate	1.854 [0.17]	0.0068 [0.99]	0.108 [0.95]	28.33 [0.34]
Lzibor	1.582 [0.23]	0.891 [0.64]	0.427 [0.73]	27.80 [0.36]
Lr_forex	1.835 [0.17]	0.679 [0.71]	0.334 [0.80]	27.86 [0.36]

Note: ** The null hypothesis of no autocorrelation in residuals is rejected at the 5 percent level.

Source: Authors' calculation.

4.4 Excess Demand

The final component that needs to be represented in the short-term inflation function is excess demand. It is expressed in terms of the output gap, where the output gap equals actual GDP minus potential GDP. In order to calculate the output gap we used the Hodrick - Prescott (HP) filter with $\lambda=1600$. Although the disadvantage of the HP filter is that it may create spurious cycles, in the Croatian case the validity of the HP filter can be verified by applying a production function approach to estimate the output gap (Vrbanc, 2006). Since both output gaps exhibit very similar cyclical movement, we proceed with our analysis using the output gap obtained by the HP filter. The behaviour of the output gap is presented in the middle left panel in Figure 2. One can observe the overheating of the economy during the economic expansion in 1997 and 1998, followed by the cooling that began in 1999 during the short-lived economic recession. The output gap turned positive again in 2002, with one more slowdown in late 2004 and early 2005 when more moderate rates of GDP growth were recorded.

5 Inflation Model

After detecting the long-run relationships, we developed a single equation inflation model described below. We followed a general-to-specific approach.

At the beginning, we estimated a general model in which we regressed $DLcpi$ (first difference in the logarithm of the consumer price index) on the above mentioned long-run structural relationships ($Lmarkup_{t,i}$ and $Lexcessmoney_{t,i}$), two other sectoral sources of inflation ($DLNeer_{t,i}$ and $DLgdp_{t,i}$) and the short-run dynamics ($DLppi_{t,i}$, $DLtrading_partners_cpi_{t,i}$, $DLm1_{t,i}$, $DLimport_prices_{t,i}$, $DLr_forex_{t,i}$), where i takes values 1, 2 and 3 for all variables. A more detailed description of the variables can be found in Appendix. Our sample covers the period 1995Q1 - 2006Q2 and for that sample period our unrestricted general model yields $\sigma = 1.1$ percent for 28 regressors and 42 observations (Schwarz criterion = -7.22). The next step was to eliminate statistically insignificant terms from the model which led to the derivation of the following model:

$$\begin{aligned}
 DLcpi = & -0.30^* Lmarkup_1 - 0.05^* Lexcess_money_2 + 0.07^* DLm1_2 - 0.41^* DLNeer_2 \\
 & (0.00) \qquad (0.00) \qquad (0.07) \qquad (0.001) \\
 & + 0.18^* DLimport_prices_2 + 0.33^* DLgdp_gap_1 - 0.25^* DLr_forex_3 \\
 & (0.04) \qquad (0.002) \qquad (0.06) \qquad (5)
 \end{aligned}$$

T=1995Q1-2006Q2, $R^2=0.60$, $\sigma=0.009$, Schwarz criterion=-8.89, AR=0.72(0.58), ARCH=0.79(0.54), Normality=0.26, (0.88) Chow=0.18(0.94), RESET=0.32(0.57); p-values in parenthesis.

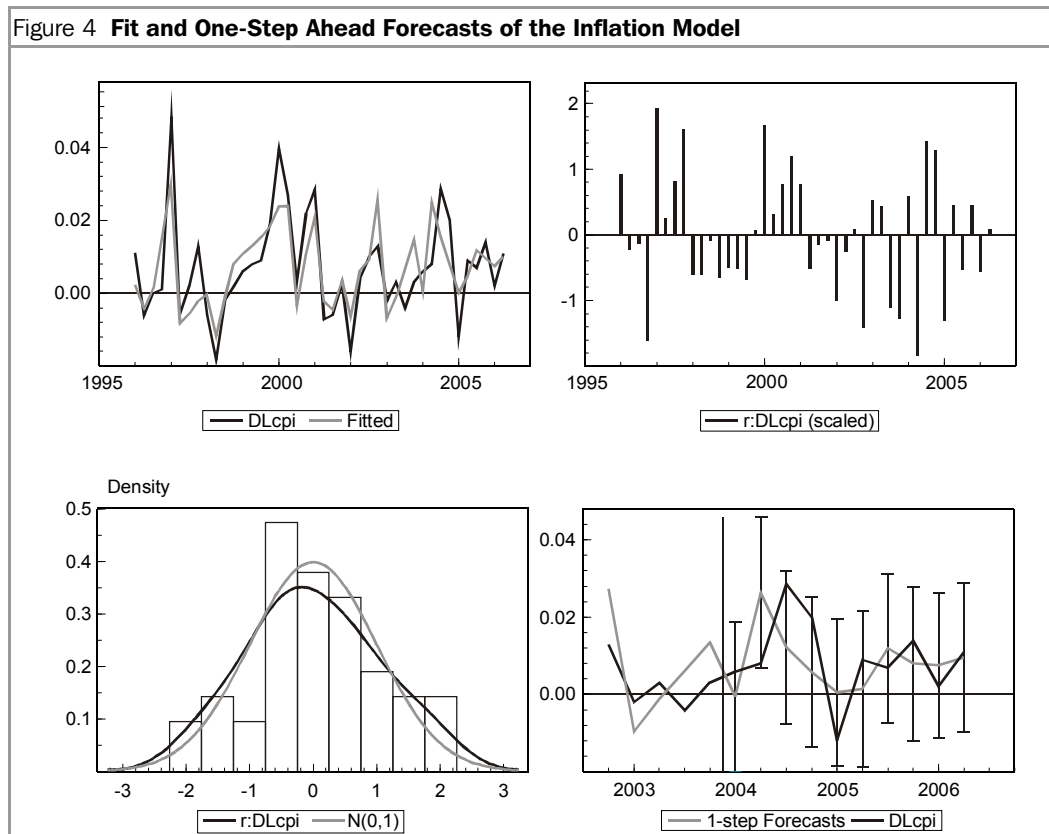
The model proved its adequacy in terms of various diagnostic tests and also encompasses the unrestricted general model ($F \sim [0.763]$, the null hypothesis of encompassing). All variables are statistically significant and have theoretically plausible signs except the nominal effective exchange rate.

As can be seen, both error correction terms are included in the short-run inflation model and have the expected (negative) sign. However, consumer price inflation reacts more strongly and quickly to deviations from the long-run mark-up relationship than to deviations from the long-run excess money relationship. The weaker and slower reaction of prices to monetary developments can also be observed from the coefficient and the lag of narrow money. The reaction of consumer prices to changes in the GDP gap and interest rates, on the other hand, is quite strong with one difference; it takes 1 quarter for the GDP gap to affect inflation, while changes in interest rates affect inflation after 3 quarters. Changes in import prices are also important for explaining the short-run inflation behaviour, as is the nominal effective exchange rate of the Croatian currency, although its sign contradicts theory. One could, of course, argue that although it is not usual for a nominal effective exchange rate depreciation to cause lower consumer price inflation, in the Croatian "fear of floating" context it may mean that monetary policy reacts excessively to depreciation pressures thus causing price contractions.

Figures 4, 5 and 6 present the basic diagnostic features of the model. The model fits the data very well, residuals are normally distributed and do not appear correlated, as shown by panels in Figure 4. Moreover, besides the fact that the model fits the Croatian inflation generating process quite well, it could be used for forecasting inflation since, as can be seen from the lower right panel in Figure 4, it successfully forecasts the last 10 inflation observations, with actual outcomes being within approximately 2 standard errors of the forecasts.

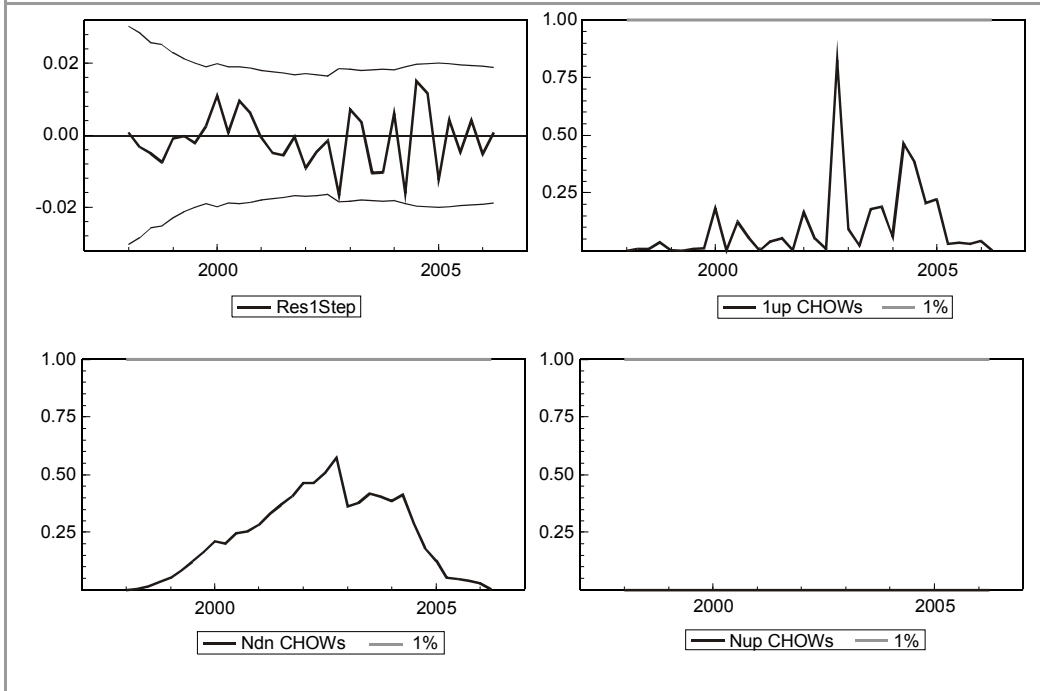
Figure 5 displays recursive statistics, more precisely one-step ahead forecasted residuals and one-step, breakpoint and forecast Chow tests. Both one-step forecasted residuals, which are within 2 standard error confidence bands, and Chow tests confirm the stability of the model. In other words, the model's parameters are constant and there are no structural breaks inherent to the model.

Finally, Figure 6 presents the recursively estimated coefficients of the model. It is clear that the coefficient estimates are stable and almost always significantly different from zero. This conclusion, however, does not apply for narrow money, the nominal effective exchange rate and import prices, whose coefficients are not significantly different from zero before the year 2000.



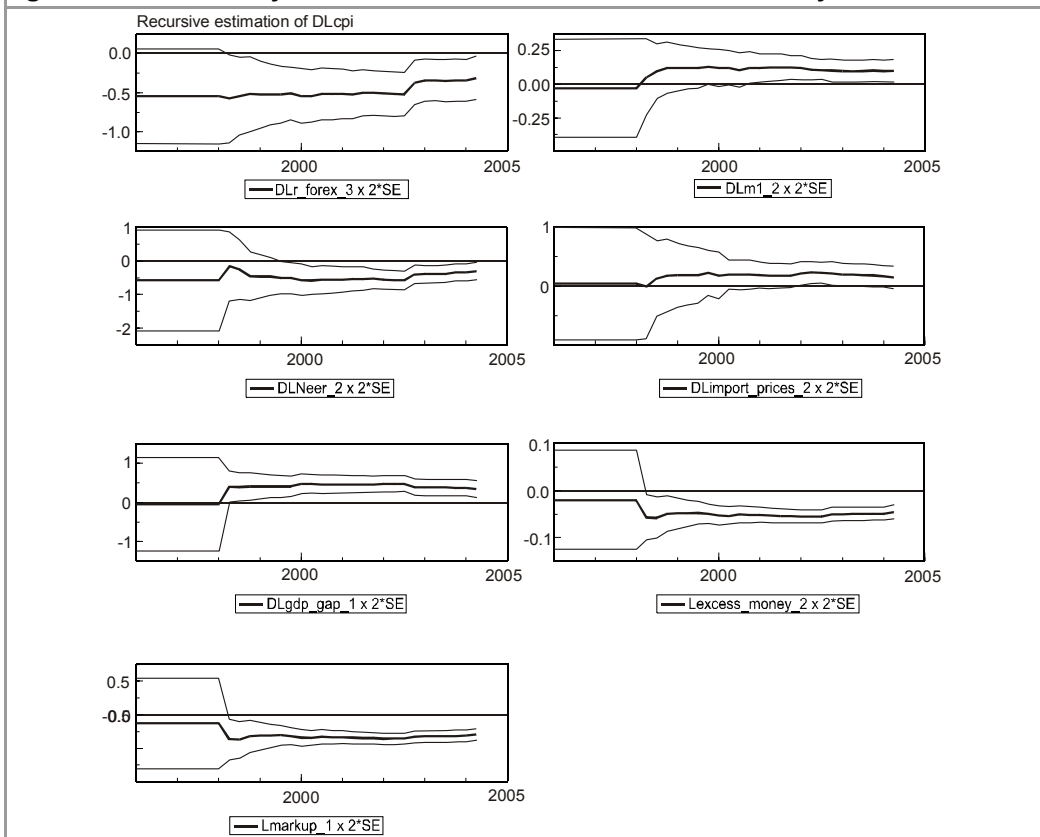
Source: Authors' calculation.

Figure 5 Recursive Analysis of the Inflation Model – Model Stability



Source: Authors' calculation.

Figure 6 Recursive Analysis of the Inflation Model – Parameter Constancy



Source: Authors' calculation.

Given the diagnostic features of the model, we can conclude that the short-run inflation model could be used for forecasting inflation. However, assessing its forecasting performance and comparing it to the other, preferably purely statistical models, is beyond the scope of this paper.

6 Conclusion

In this paper we wanted to analyse the driving forces of the inflation process in a transition economy, such as Croatian. First we derived, according to the theory, the long-run sectoral relationship affecting inflation (mark-up, excess money, nominal effective exchange rate and GDP gap). Then we estimated the short-run structural inflation function by imposing the above-mentioned long-run relationships together with various short-run variables which contribute to explaining the inflation process in general and in Croatia. The derived model of inflation suggests that mark-up and excess money relationships, imposed as error correction terms, are the most significant variables for explaining the short-run behaviour of inflation. Two other sectoral variables, i.e. the GDP gap and nominal effective exchange rate are also significant for explaining the short-run inflation dynamics. However, according to the results of the model, it turns out that Croatian inflation is much more responsive to deviations from the equilibrium on the supply side and to changes in the nominal effective exchange rate than to deviations from equilibrium in the monetary sector. We also find Croatian consumer price inflation to be affected by changes in interest rates and import prices. Presented diagnostic tests suggest that the model could be used for forecasting purposes.

Appendix

<i>cpi</i>	Consumer price index – the CPI data can be obtained only from 1998, so for the previous period we used the retail price index. Source: Central Bureau of Statistics.
<i>excess_money</i>	Excess money supply Source: Authors' calculation.
<i>gdp</i>	Gross domestic product, constant prices Source: Central Bureau of Statistics.
<i>gdp_gap</i>	GDP gap Source: Central Bureau of Statistics and authors' calculation.
<i>import_prices</i>	Import prices – a deflator of the nominal volume of total goods and services imports from the national accounts. Source: Central Bureau of Statistics and authors' calculation.
<i>m1</i>	Narrow money. Source: Croatian National Bank.
<i>mark-up</i>	Aggregate mark-up Source: Authors' calculation.
<i>neer</i>	Nominal effective exchange rate – calculated as a weighted geometric mean using the weights for main trading partners and the nominal exchange rate at the end of the month. Source: Central Bureau of Statistics, Croatian National Bank and authors' calculation.
<i>p_estate</i>	Real price of real estate, deflated by the CPI. Source: Central Bureau of Statistics and authors' calculation.
<i>ppi</i>	Producer price index Source: Central Bureau of Statistics.
<i>reer</i>	Real effective exchange rate Source: International Financial Statistics, Central Bureau of Statistics, Croatian National Bank and authors' calculation.
<i>r_forex</i>	Interest rate on foreign deposits Source: Croatian National Bank
<i>trading_partners_cpi</i>	CPI of Croatia's main trading partners – This includes Germany, Italy, Slovenia, USA, Austria, UK, Switzerland and France. The weights are determined on the basis of the average foreign trade structure in the period from 1999 to 2004. Source: International Financial Statistics, Central Bureau of Statistics and authors' calculation.
<i>ulc</i>	Unit labour cost – separate series on the number of persons employed in legal entities, agriculture and crafts had to be estimated and corrected. Total labour cost for legal entities was obtained by multiplying the average net wage and the number of persons employed in legal entities. Total labour cost in agriculture was obtained by multiplying the average net wage in agriculture with the number of persons employed in agriculture, while total labour cost for crafts was obtained by multiplying the number of persons employed in crafts in each category of activity by the respective average net wage. Cumulative labour cost was then divided by real GDP. Source: Central Bureau of Statistics and authors' calculation.
<i>zibor</i>	Zagreb inter-bank offer rate – ZIBOR is available from 2000, so for the previous period we used interest rates from the Zagreb Money and Short Term Securities Market. Source: Croatian National Bank
<i>dummies</i>	In deriving mark-up, we used 3 dummies (for banking crises in 1995 and 1997 and the first half of 1998; VAT – after introduction in 1998; war – until 1996).

Quarterly data are used in the analysis. For data with higher frequencies, we used quarter averages. L implies data in logarithms and D implies differenced data.

References

- Billmeier, Andreas and Leo Bonato, 2002, "Exchange Rate Pass-Through and Monetary Policy in Croatia", IMF Working Paper, No. 109, Washington D.C.: International Monetary Fund, <http://www.imf.org>.
- Botrić, Valerija and Boris Cota, 2006, "Sources of Inflation in Transition Economy: The Case of Croatia", *Ekonomski pregled*, 57(12), pp. 835-855.
- de Brouwer, Gordon and Neil R. Ericsson, 1998, "Modeling Inflation in Australia", *Journal of Business and Economic Statistics*, 16(4), pp. 433-449.
- Golinelli, Roberto and Renzo Orsi, 2001, "Modeling Inflation in EU Accession Countries: the Case of the Czech Republic, Hungary and Poland", presented at the seminar "East European Transition and EU Enlargement: A Quantitative Approach", organised by the Macroeconomic and Financial Data Centre of the University of Gdansk (Poland) on June, 15-21, <http://amsacta.cib.unibo.it/archive/00000661/>.
- Hendry, David, 2000, "Does Money Determine UK Inflation over the Long-run?", in Roger Backhouse and Andrea Salanti, eds., *Macroeconomics and the Real World*, Oxford: Oxford University Press, pp. 85-114.
- Juselius, Katarina, 1992, "Domestic and Foreign Effects on Prices in an Open Economy: The Case of Denmark", *Journal of Policy Modeling*, 14(4), pp. 401-428.
- Kraft, Evan, 2003, "Monetary Policy under Dollarization: The Case of Croatia", *Comparative Economic Studies*, 45(3), pp. 256-277.
- Payne, James E., 2002, "Inflationary Dynamics of a Transition Economy: the Croatian Experience", *Journal of Policy Modeling*, 24(3), pp. 219-30.
- Pufnik, Andreja and Davor Kunovac, 2006, "Kratkoročno prognoziranje inflacije u Hrvatskoj korištenjem sezonskih ARIMA procesa", Istraživanja, I-18, Zagreb, Croatian National Bank, <http://www.hnb.hr>.
- Sekine, Toshitaka, 2001, "Modeling and Forecasting Inflation in Japan", IMF Working Paper, No. 82, Washington D.C.: International Monetary Fund, <http://www.imf.org>.
- Vrbanc, Igeta, 2006, "Estimate of Potential Gross Domestic Product Using Production Function Method", presented at "12th Dubrovnik Economic Conference", organised by Croatian National Bank on June 26-July 1, <http://www.hnb.hr>.

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