Can Croatian Consumers Predict Inflation Dynamics?

RESEARCH PAPER

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Abstract

There exists a variety of papers dealing with the inflation generating process in Croatia. However, none of them touches upon the psychological factors driving inflation. Therefore this paper aims to fill in that niche. Applying the Carlson-Parkin method on consumer survey results, a direct measure of expected inflation is obtained. Its predictive characteristics regarding actual inflation dynamics are examined. It is found that Croatian consumers tend to produce biased expectations of actual inflation; hence they are proven not to be strictly rational in forming inflation expectations. Nevertheless, the consumers' expectation errors are not significantly influenced by the other observed macroeconomic variables. In that regard, the consumers' inflation expectations can be characterized as efficient in the *strong* sense.

Keywords: Carlson-Parkin method, expected inflation, rational expectations, Croatia
JEL classification: C32, E31, E21

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1 Introduction and Motivation

With no exceptions, each economic decision is determined (*inter alia*) by the uncertainty of its future real effects. Therefore, most macroeconomic models comprise economic agents' expectations about relevant variables from their environment. In that context, it is vital to discern the role of consumers' expectations in the inflation generating process. This necessity is even more accentuated in Croatia.

At the beginning of the 1990s, Croatia passed through the agony of hyperinflation in the conditions of severe economic crisis and war (Anušić, Rohatinski and Šonje, 1995). More precisely, in 1993 a historically high yearly inflation rate of as much as 1,616 percent was recorded (Vizek and Broz, 2009). Since the stabilization program of October 1993, through the HRK/EUR exchange rate, the Croatian National Bank (CNB) has been rather successful in fulfilling its main goal: maintaining price stability. However, the current economic conditions again shift the focus of public and scientific attention back to inflation. There are two main reasons for that. The primary reason is the global growth of oil, raw materials and food prices (CNB, 2011). An (in)direct consequence of such global tendencies is also the most recent domestic rise of gas prices (Vlada RH, 2012).

Secondly, Croatia is on the road of accession to the European Monetary Union (EMU). To achieve membership, it must meet the Maastricht convergence criteria. One of the imposed criteria explicitly states that the accession country must keep its inflation no more than 1.5 percent higher than the average of the three EMU countries with the lowest (but positive) inflation (Lewis, 2009). Hence, it is essential to adequately explore and clarify all significant factors driving inflation in Croatia, including the psychological ones such as consumers' inflation sentiment. Moreover, Botrić and Cota (2006) highlight that, as individual transition countries get closer to the EMU accession, the numerosity and intensity of their empirical inflation studies also tend to rise. In line with that, this paper represents an effort to stimulate the discussion about the psychological

driving forces of Croatian inflation, relying on a unique dataset obtained from consumer surveys (CSs).

Several important questions arise in that sense: In what way do the Croatian consumers form their inflation expectations? Are these expectations rational (unbiased)? Do they fully take into account the observable macroeconomic information set in the process of generating expectations? Are Croatian consumers able to predict future inflation values, i.e., is consumer behavior a relevant factor in explaining inflationary dynamics? Due to the proven data nonstationarity, the testing of expectations' unbiasedness is performed via cointegration analysis. Both Engle-Granger and Johansen procedures are examined, revealing that the actual and expected inflation are not cointegrated. This conclusion instantly rules out the possible validity of the rational expectations hypothesis. Short-run VAR analysis offers strong evidence that the consumers are indeed able to predict inflation movements. Finally, simple OLS analysis shows that the consumers' expectations are efficient in the strong sense: their forecasting errors are not significantly influenced by any of the observed macroeconomic variables except past inflation realizations.

2 The Role of Expectations in the Inflation Generating Process

Expected inflation plays a crucial role in many areas of economic decision making. From the aspect of consumer behavior, if consumers expect a price hike in the following year, they will raise their current expenditure. On the other hand, an anticipation of aggregate price reduction will probably postpone consumption. This interaction of expectations and real economic activity also has significant repercussions on the monetary sphere of the national economy. Namely, if a critical mass of consumers share the opinion that the prices will, e.g., rise in the following year, they will boost the aggregate demand, which will in the end indeed induce inflationary pressures.

In order to elucidate the relationship between expected and actual inflation, it is perhaps best to start from the model of the so-called *expectations trap* (Christiano and Gust, 2000). The authors use that model to explain the inflationary episode in the USA during the 1970s. Due to rising public inflation expectations, the labor force and the unions demand higher nominal wages. Thus the central bank finds itself in a dilemma. If it raises the amount of money in circulation in order to adjust the actual inflation path with the expected one, it will induce inflation. On the other hand, if it does not react, the probable final result will be a recession.

It is also often postulated that the level of expected inflation has an impact on the unemployment rate. For example, if agents' inflation expectations are higher than the actual inflation rate, wages offered to them are lower than their reservation wages. Ultimately, they postpone employment and in fact increase unemployment. That is why the New Keynesian Phillips curve (NKPC) incorporates expected inflation as a variable that is crucially needed to explain the phenomenon of *forward-looking inflation*. Namely, if firms anticipate a future aggregate price growth, they will also increase the prices of their products and services (Galí and Gertler, 1999).

2.1 Literature Review on the Inflation Dynamics in Croatia

There exist a number of studies of Croatian inflation, whose main characteristics are briefly synthesized in Table 1.

Several important conclusions arise on the basis of these papers. Payne (2002) and Malešević Perović (2009) both emphasize the influence of nominal exchange rate and wages on inflation. Vizek and Broz (2009) also highlight the kuna exchange rate as the crucial driving force of inflation.

However, only Basarac (2009) and Krznar (2011) consider inflation expectations as independent variables in the inflation model. In doing so, they both impose *ad hoc* restrictions on the expectation formation model in line with the existing theoretical frameworks, which have not

been adequately empirically tested in Croatia. Basarac (2009) presumes adaptive expectations, expressing expected inflation as the average of two most recent inflation realizations. Krznar (2011), in line with its underlying assumptions, incorporates rational expectations into the GMM estimation of the NKPC model. To be more specific, Krznar uses lagged values of PPI and CPI inflation, wage growth, and GDP gap as instrumental variables to estimate the inflation expectations. Although Basarac (2009) and Krznar (2011) approximate expected inflation in different manners, they both conclude that it plays a pivotal role in the Croatian inflation generating process.

Table 1 **Most Relevant Studies of the Inflation Generating Process in Croatia**

Article	Methodology	Inflation determinants
Payne (2002)	VAR	• monetary aggregate M4 • net nominal wage per employee • nominal effective exchange rate
Botrić and Cota (2006)	SVAR	• balance of payments • terms of trade • industrial production • real effective exchange rate • net nominal effective wage per employee
Vizek and Broz (2009)	Johansen cointegration	*Mark-up* model: • unit labor cost • import prices
	OLS regression	Purchasing power parity: • nominal effective exchange rate
	Johansen cointegration	*Excess money* model: • M1 aggregate • real GDP • real price of real estate • ZIBOR interest rate • interest rate on foreign deposits
	OLS regression	*Excess demand* model: • output gap
Malešević Perović (2009)	Johansen cointegration	• M1 aggregate • productivity (ratio of the industrial production and the number of employees in the industry) • nominal effective exchange rate
Basarac (2009)	Johansen cointegration	NKPC: • output gap (unit labor cost) • inflation expectations
Krznar (2011)	GMM method	Hybrid NKPC: • past inflation • inflation expectations • real marginal cost

Opposed to Basarac (2009) and Krznar (2011), the road taken in this paper is to directly assess consumers' inflation expectations from CS results.

That way it is possible to formally econometrically test whether inflation expectations follow a certain theoretical learning model.

2.2 Theoretical Expectations Models: Econometric Framework

The formation process of inflation expectations depends primarily on the information set available to the economic agent in the period of forming the expectation. However, there exist several cognitive concepts (mathematical functions or statistical models) that agents can use to transform the accessible information set into expected values.

One of the first theoretical attempts to model economic expectations in an econometrical fashion was the *adaptive expectations model*. It defines the expectation as a function of merely past realizations of the variable of interest (Cagan, 1956).

$$\pi^{e}_{t+1} = \sum_{i=0}^{\infty} (1-\lambda)\lambda^{i}\pi_{t-i} \ , \qquad (1)$$

where $0<\lambda<1$.

In the context of expected inflation, this means that the econometric testing of the adaptive expectations model comes down to testing the impact of past values of the information set (past inflation and other relevant macroeconomic variables such as the exchange rate, monetary aggregates, wages, etc.) (Curtin, 2006).

The *rational expectations hypothesis* (*REH*) was pioneered by Muth (1961), relying on the assumption that agents form economic expectations on the basis of all relevant economic information, available at the period of forming the expectations. In the mathematical sense this means that, under the rational expectations hypothesis, consumers do not make systematic prediction errors (they do not underestimate or overestimate inflation dynamics). Gramlich (1983) proposes the following OLS equation as an empirical test of the rational expectations hypothesis:

$$\pi_t = \alpha_0 + \alpha_1 \pi_t^e + u_t \ , \tag{2}$$

where π_t is actual and π_t^e is the expected inflation, and u_t is a white-noise term. In that framework, consumers' inflation expectations can be characterized as rational (in the sense of unbiasedness) if the following joint hypothesis cannot be rejected:

$$H_0 : (\alpha_0, \alpha_1) = (0, 1) \ . \tag{3}$$

Bakhshi and Yates (1998) consider the case of non-stationary π_t and π_t^e. They conclude that estimating Equation (2) would lead to a spurious regression problem in that situation. Therefore, the authors recommend employing cointegration analysis. If the long-run forecasting error is stationary and the cointegration relation does not comprise a constant, then it can be said that the inflation expectations are rational.

Forsells and Kenny (2004) go even further in the analysis of expectations' rationality. After estimating relations (2)-(3), they bring forward the concept of *macroeconomic efficiency*. This concept defines expectations as efficient if the past values of inflation and other relevant macroeconomic variables (information set, Ω) do not significantly feed into the consumers' expectation error (*weak* and *strong* form of efficiency).[1]

3 Methodological Issues

The main idea of this paper is to examine whether Croatian CSs can be utilized in modeling inflation. Therefore, it is vital to briefly explain the main concepts of CSs, their methodological foundations and the nature of data obtained through these surveys.

[1] *It should be noted here that the concept of rational expectations in the sense of Muth (1961) implies both weak and strong forms of macroeconomic efficiency, i.e., it presumes that agents are acquainted with the economic cause-and-effect relationships underlying the process of generating inflation.*

3.1 Consumer Surveys

CSs are based on empirical research concerning consumers' attitudes, judgments and prospects vis-à-vis variables from their economic surroundings. For example, consumers are asked to voice their opinion on general macroeconomic trends in the country, their individual financial situation or their propensity towards large purchases or savings.

CSs were first introduced by George Katona at the University of Michigan (Katona, 1946), in an effort to elucidate consumers' savings and expenditure patterns. CSs have quickly become an indispensable tool in both micro- and macroeconomic research all over the world. Moreover, within the process of euro integration, the methodology of conducting CSs has also been harmonized in all EU member and candidate countries through *The Joint Harmonised EU Programme of Business and Consumer Surveys* (Čižmešija, 2008). In Croatia, CSs have continually been carried out since 1999, first on a quarterly basis, and as of May 2005 on a monthly basis. In operational terms, CSs are fully administered by the CNB. The surveys are conducted on a stratified sample of 1,000 respondents, in full accordance with the EU methodology (European Commission, 2007).

As far as this study is concerned, it is of prior interest to scrutinize the inflation perceptions and expectations of Croatian consumers. Therefore the two most pertinent questions in the Croatian CSs are given as follows:

Q5 How do you think that consumer prices have developed over the last 12 months?

They have…
+ + 1 risen a lot
+ 2 risen moderately
= 3 risen slightly
– 4 stayed about the same
– – 5 fallen
N 9 don't know.

Q6 By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months?

They will…
+ + 1 increase more rapidly
+ 2 increase at the same rate
= 3 increase at a slower rate
– 4 stay about the same
– – 5 fall
N 9 don't know.

When using CS results in macroeconomic research, it is customary to put them in relation to specific referent variables such as consumer spending, investments, savings, or in the case of this paper, the aggregate price level. As CS questions are intended to record consumers' judgments on the economic climate in the last/following year, the referent variables are expressed as year-on-year (yoy) percentage changes (European Commission, 2007). In the context of this paper, the national price level will be analyzed in the form of yoy inflation rates.

3.2 Quantifying CS Results

Since all questions in the CS are of purely qualitative nature, it is essential to transform consumers' responses into exact numerical indicators of inflation sentiment. In order to do so, three possibilities arise.

Firstly, the distribution of responses is usually presented in the form of a weighted balance statistics (B):

$$B = (PP + 0{,}5P) - (0{,}5M + MM)\ , \tag{4}$$

where PP, P, M and MM are (respectively) the percentages of examinees declaring a strong growth trend in the observed variable (++), declaring a positive effect (+), negative effect (–) and a strong downward trend (– –).

However, the balance statistics and actual yoy inflation are measured in different scales, so it is not possible to compare them directly.[2] With that in mind, two further possibilities remain: the *nonlinear regression approach* and the *probability method*.

Nonlinear regression method was pioneered by Anderson (1952), and was further developed by Pesaran (1987) and Smith and McAleer (1995). Its basic feature is that inflation expectations are defined as a function of a specific regression model, through which the consumers are assumed to

[2] *It is not possible to derive the expectation error between consumers' inflation expectations represented with a balance (e.g.,* B = *56.3) and actual yearly inflation (e.g.,* π = *3.5 percent).*

perceive past inflation in the exact same manner (same regression model) as they anticipate its future values. Since this assumption has never been empirically corroborated (Nardo, 2003), the regression method will not be considered here due to its over-restricting properties.

On the other hand, the probability method was first introduced by Theil (1952), and further expanded by Carlson and Parkin (1975). In honor of its popularisers, the probability method is often referred to as the *Carlson-Parkin* (*CP*) *approach*. In the methodological sense, the CP approach is based on three important assumptions (Nielsen, 2003):

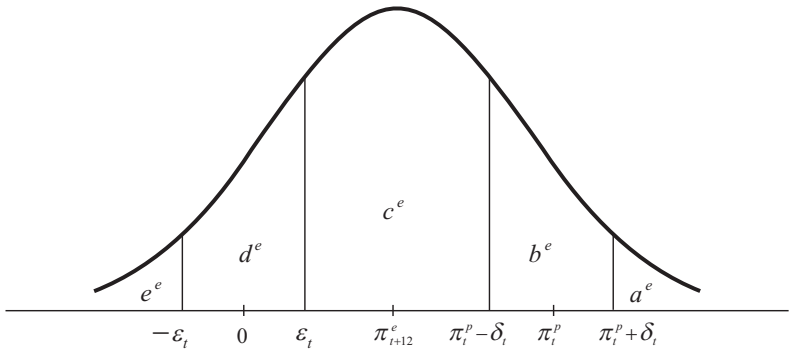
- **Consumers form inflation expectations according to their individual subjective probability density function (pdf)**
- **Respondents' individual pdfs can be aggregated into a joint distribution** $f(\pi_{t+12} \mid \Omega_t)$,
  where π_{t+12} is the future inflation rate (12 months ahead), and Ω_t is the information set available to the respondent at time *t*.
- **The cognitive formation process of consumer sentiment is characterized by two distinct sensitivity intervals:**

  Respondents declare that they expect a price growth/decline in the following year only if π^e_{t+12} (consumers' expected yoy inflation rate, formed in period *t*, referring to the period *t*+12) is at least ε_t units above/below zero. In other words, consumers are insensitive to expected changes in the price level smaller than ε_t.

  Likewise, respondents' price expectations are conditioned by their price perceptions, meaning that they would expect the prices to increase *more rapidly/at a slower rate* only if π^e_{t+12} is larger/smaller than their perceived inflation π^p_t (formed in month *t* for the last 12 months) by at least δ_t units.

Integrating the stated three assumptions leads to the following graphical presentation of $f(\pi_{t+12} \mid \Omega_t)$.

Figure 1 **Aggregate Probability Distribution of Inflation Expectations**



According to Figure 1, if the aggregate distribution has finite first and second order central moments, then it is evident that $E[\pi_{t+12} \mid \Omega_t] = \pi^e_{t+12}$. Also, this graphical presentation enables the researcher to interpret consumers' survey responses as areas under the joint probability distribution. Hence let a^e , b^e , c^e , d^e and e^e be the shares of consumers declaring that prices in the following year will *increase more rapidly*, *increase at the same rate*, *increase at a slower rate*, *stay about the same* or *fall* (respectively).

The final puzzle of the CP method is the issue of choosing the appropriate theoretical distribution to approximate Figure 1. The original CP approach (Carlson and Parkin, 1975) employs normal distribution, finding theoretical background in the central limit theorem (CLT): let inflation expectations of N respondents in time *t* be random $i.i.d.$ variables whose distributions have finite first and second order moments. Then, no matter what the shape of these distributions, the CLT argues that the distribution of the sum of these variables is asymptotically normal (Dias, Duarte and Rua, 2009). In addition, a number of recent papers dealing with the CP approach (on harmonised European Union CS data) consider several asymmetric distributions as possible alternatives to the Gaussian distribution (uniform distribution, noncentral *t* distribution, χ^2 distribution). Their unanimous conclusion is that approximating inflation expectations by asymmetric distributions does not significantly change the research results nor

contributes to the rationality of consumers' expectations (Berk, 1999; Löffler, 1999; Łyziak, 2003; Nielsen, 2003). Finally, recent empirical studies (Forsells and Kenny, 2004; Łyziak and Stanisławska, 2006; Dias, Duarte and Rua, 2009) also employ normal distribution in quantifying consumers' inflation expectations.

Bearing all that in mind, the CP method is applied here in order to quantify CS results, implying a *normal* aggregate probability distribution of inflation expectations.

In essence, the problem of estimating π^e_{t+12} comes down to calculating the four critical values of the sensitivity intervals. Therefore, it is necessary to calculate the appropriate inverses of the cumulative standardized normal distribution:

$$A^e = Nz^{-1}(1 - a^e) = \frac{\pi_t^p + \delta_t - \pi^e_{t+12}}{\sigma^e} \quad , \tag{5}$$

$$B^e = Nz^{-1}(1 - a^e - b^e) = \frac{\pi_t^p - \delta_t - \pi^e_{t+12}}{\sigma^e} \quad , \tag{6}$$

$$C^e = Nz^{-1}(1 - a^e - b^e - c^e) = \frac{\varepsilon_t - \pi^e_{t+12}}{\sigma^e} \quad , \tag{7}$$

$$D^e = Nz^{-1}(e^e) = \frac{-\varepsilon_t - \pi^e_{t+12}}{\sigma^e} \quad , \tag{8}$$

where Nz is the cumulative of the standardized normal distribution and σ^e is the standard deviation of inflation expectations. By applying simple linear algebra on these four relations, it is possible to obtain the expression for aggregate expected inflation (see Sabrowski, 2008 or Łyziak and Stanisławska, 2006 for a complete mathematical derivation of the CP method).

$$\pi^e_{t+12} = \pi_t^p \frac{C^e + D^e}{C^e + D^e - (A^e + B^e)} \tag{9}$$

It is also necessary to derive the analytical expressions for the parameters ε_t and δ_t, which would enable the researcher to locate the thresholds at which consumers become perceptively sensitive to inflation changes. Expressing

the relations (7) and (8) as functions of σ^e, the following equations are obtained.

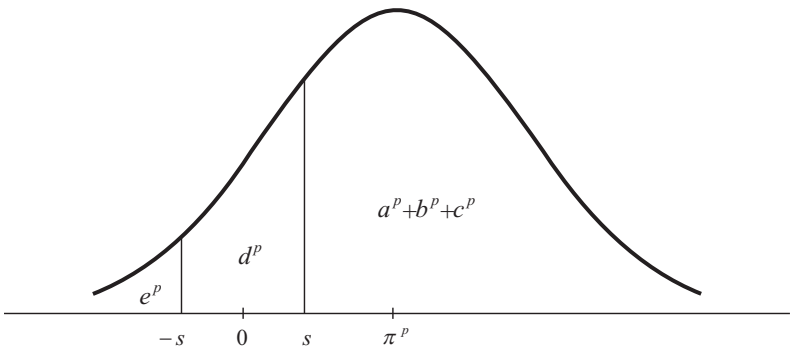
$$\varepsilon_t = \pi_t^p \frac{D^e - C^e}{C^e + D^e - (A^e + B^e)} \tag{10}$$

$$\delta_t = \pi_t^p \frac{(B^e - A^e)}{(C^e + D^e) - (A^e + B^e)} \tag{11}$$

Inspecting the relations (9)-(11), it is evident that they all incorporate the last unknown term: aggregate perceived inflation. Therefore, π_t^p is also estimated via CP method.

Let a^p, b^p, c^p, d^p and e^p be the shares of respondents declaring that prices in the previous 12 months have *risen a lot*, *risen moderately*, *risen slightly*, *stayed about the same* or *fallen* (respectively). The aggregate probability distribution of perceived inflation can be represented by Figure 2.

Figure 2 **Aggregate Probability Distribution of Perceived Inflation**



In a similar fashion as for the expected inflation, areas under the density curve can be interpreted as fractions of respondents giving particular answers to CS question 5:

$$A^p = Nz^{-1}\left[1 - (a^p + b^p + c^p)\right] = \frac{s - \pi^p}{\sigma^p} \quad , \tag{12}$$

$$B^p = Nz^{-1}(e^p) = \frac{-s - \pi^p}{\sigma^p} \quad , \tag{13}$$

where σ^p is the standard deviation of perceived inflation. Again, the CP method is based on the assumption about the existence of a sensitivity interval: consumers perceive aggregate price changes only outside the interval (*-s, s*).

Again, presenting Equations (9)-(10) as functions of σ^p leads to the final analytical expression for perceived inflation:

$$\pi^p = -s\frac{A^p + B^p}{A^p - B^p} \quad , \tag{14}$$

where s is the scaling factor (Forsells and Kenny, 2004):

$$s_t = \frac{-\sum_{i=1}^{T}\pi_t}{\sum_{i=1}^{T}\left(\frac{A_t^p + B_t^p}{A_t^p - B_t^p}\right)} \quad . \tag{15}$$

4 Empirical Results

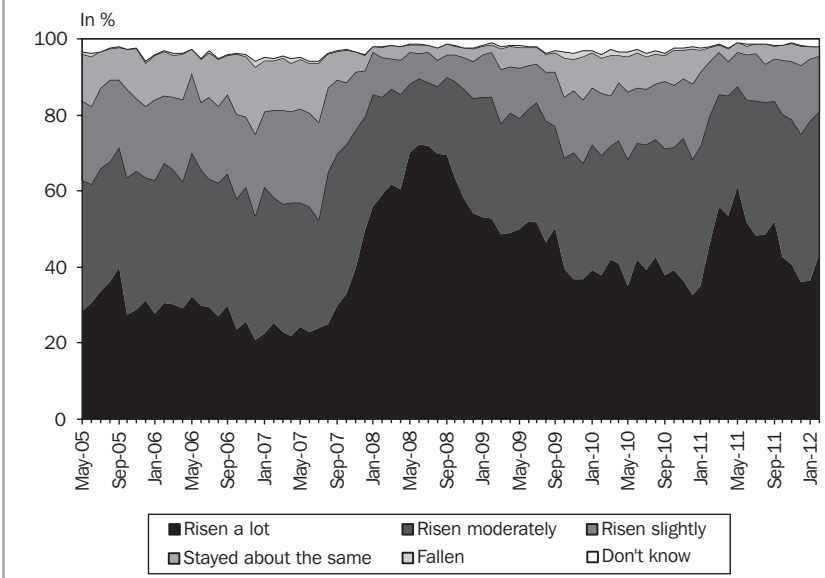
A mere glance at the distribution of responses to CS questions concerning perceived and expected inflation reveals the general time path of consumers' inflation sentiment.

Since the CNB was fairly successful in maintaining price stability throughout the whole observed period, the share of respondents indicating a strong inflationary pressure is also rather low. The only exception is the pre-crisis period (mid-2007 to mid-2008), when actual inflation rose to record-high values (as far as the observed sample is concerned).[3] There were two main reasons for such tendencies. First of all, the inflationary pressure was conditioned by supply-side factors: drought and the rise of food prices at the national and the global level, and the oil price shock (CNB, 2008;

[3] *The yoy inflation rate in July 2008 was 8.37 percent.*

2009). On the demand side, the prices were primarily pushed up by the growth of real personal consumption (6.2 percent in 2007) (CNB, 2008).

Figure 3 **The Distribution of Responses to Question 5**



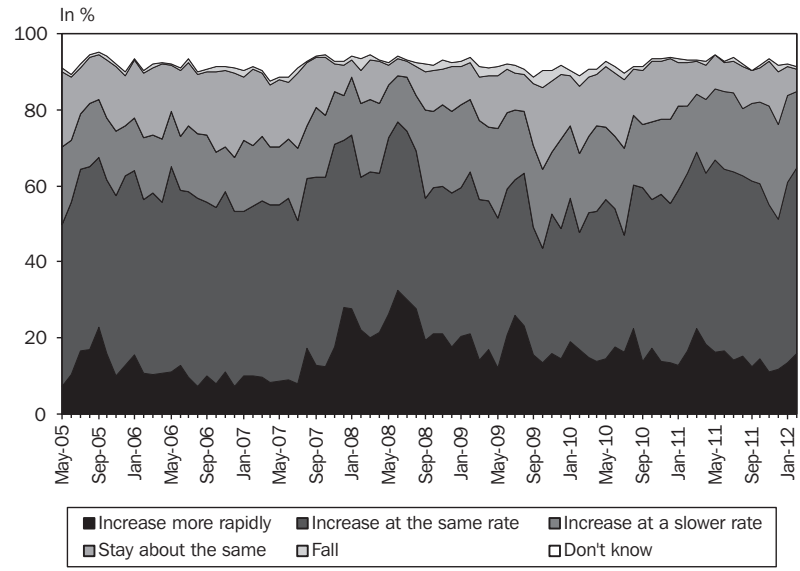
Sources: European Commission (2012) and author's calculations.

As far as the responses to question 6 are concerned, they manifest a similar trend, although with a less intensive rise of inflation sentiment during 2007 and 2008.

Let *inf* be the yoy inflation rate, and *exp_cp* be the expected inflation (obtained by the CP method on CS results). Prior to any statistical modeling, all variables were seasonally adjusted using the ARIMA X12 method.

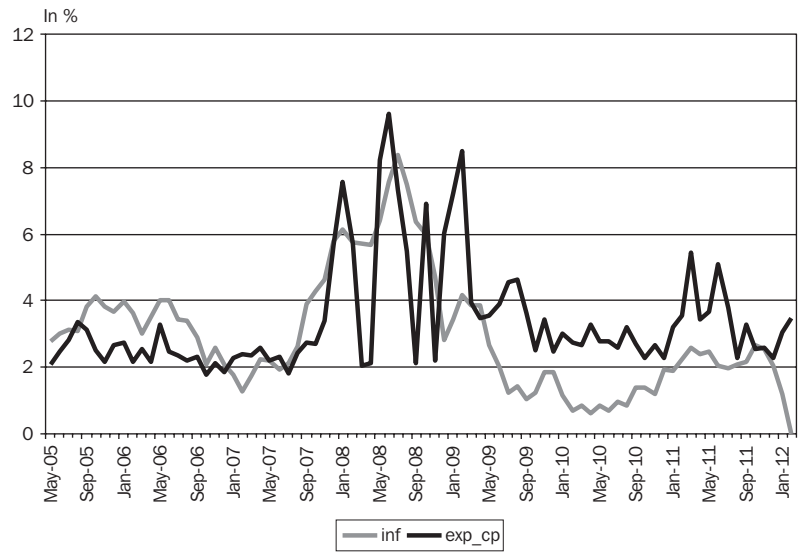
A first indication of the (potential) unbiasedness of consumers' inflation expectations can vividly be given by the graphical presentation of *inf* and *exp_cp* (Figure 5).

Figure 4 **The Distribution of Responses to Question 6**



Sources: European Commission (2012) and author's calculations.

Figure 5 **Actual and Expected Inflation in Croatia (2005:m05-2012:m02)**



Sources: Croatian Bureau of Statistics, European Commission (2012) and author's calculations.

It is clearly evident that consumers tend to overestimate actual inflation in the larger part of the observed time span.[4] On average, the actual inflation was at the 3.0 percent level, while the consumers expected an average inflation of 3.4 percent. Such tendencies are not in any sense unusual. On the contrary, it is a commonly drawn conclusion in many related studies. For example, Bryan and Venkatu (2001) find that US consumers on average severely overestimate future inflation (5.4 percent vs. actual 2.7 percent). Similar findings are also obtained for Sweden (Palmqvist and Strömberg, 2004) and Poland (Lyziak, 2003). Searching for plausible explanations of this discrepancy, it is impossible to circumvent *the availability heuristic*. That cornerstone of modern behavioral economics presumes that the probability of some future event heavily depends on the likelihood that economic agents recollect a similar event from their memory (Kahneman and Tversky, 1974). In the context of inflation sentiment, this means that consumers are more likely to expect high inflation if they have substantial experience with high inflation during their life. This is clearly the case in Croatia, where the memory of hyperinflation in the 1990s is deeply rooted in the public consciousness.[5]

Another plausible interpretation also arises. It is evident from Figure 5 that, in the pre-crisis period, the consumers often produce expectations lower than the actual inflation rates. In that context it is perhaps possible to argue that the consumers are not able to distinguish between transitory and permanent shocks to inflation. That way, in the period of economic over-heating, they frequently expect the inflation to be lower than it actually is (based on the relatively low and stable historical inflation rates). Likewise, in the cooling phase of the economic cycle, they again slowly adjust to the

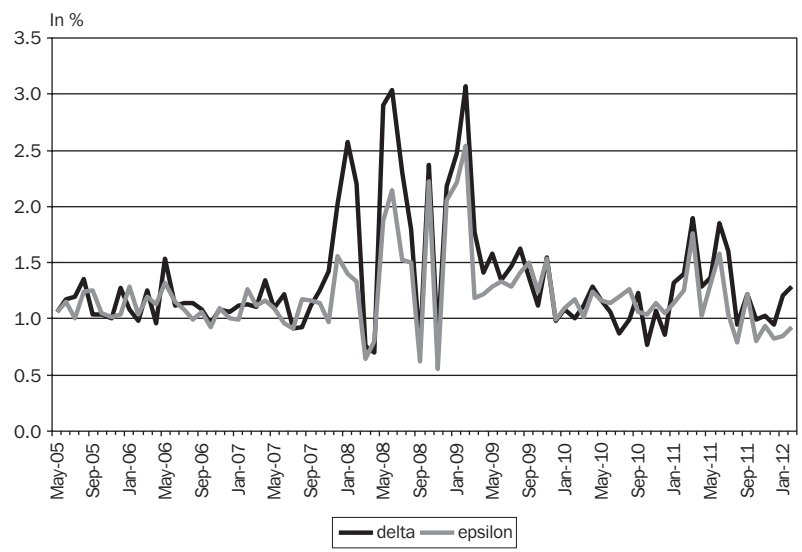
[4] One significant shortcoming of the CP method is that it is quite sensitive to extreme replies. For example, if none of the respondents declare that the prices will fall/have fallen, the method will result in untypically high values of expected inflation. This is precisely what happened in the pre-crisis period during the over-heating phase of the economic cycle.

[5] Although the empirical literature on testing the availability heuristic for inflation is rather scarce, this concept has been proven valid in countries with similar hyperinflation experiences (Łyziak, 2003 confirms it for Poland, while Lombardelli and Saleheen, 2003 do the same for the UK). In general, a fresh strand of literature has emerged dealing with the psychological factors influencing inflation developments. It is mainly based on behavioral concepts (heuristics) dealing with agents' experience with inflation during their life, the way they perceive price changes and the influence of social surroundings (media, overall state of the economy, etc.) on their inflation sentiment (Gnan, Langthaler and Valderrama, 2010 provide a fairly good introduction to the topic).

newly created conditions and again (wrongly) expect the price increases to continue for a longer period of time. This exact argument is also put forward by Dias, Duarte and Rua (2011). Behavioral literature calls this phenomenon *the anchoring and adjustment heuristic* (Gnan, Langthaler and Valderrama, 2010).

Since Figure 5 clearly shows that the two observed series diverge to some extent, it should be informative to test whether there are significant differences between them. Therefore a simple t-test for the equality of means is performed, resulting in the empirical test statistic $t = 1.423$ ($p = 0.157$). Thus, although the consumers' expectations are (on average) higher than the actual inflation figures, the differences between the observed series are not statistically significant (even at the 10 percent level). It will be interesting to see whether this result will be corroborated by the econometric tests of consumers' rationality. It is also of interest to examine the time-varying threshold parameters ε_t and δ_t.

Figure 6 **Response Threshold Parameters**



Source: Author's calculations.

Both response thresholds share a similar pattern, revealing that consumers are insensitive to changes of inflation lower than, on average, 1.2 percent (in the case of expected changes) and 1.3 percent (for perceived changes). In general, the threshold levels are quite comparable to the ones obtained by Forsells and Kenny (2004) for euro-area consumers.

The analysis is continued by questioning the rationality (unbiasedness) of consumers' inflation expectations.[6] A reasonable starting point for the rationality analysis is the estimation of Equation (2). Its results are given as follows:

$$\underset{(0.000)\ \ (0.003)}{inf_t = 4.227 - 0.382\, exp\_cp_t}, \tag{16}$$

$$LM = 29.06\ \ (0.000);\ \ JB = 12.353\ \ (0.002);\ \ \chi^2 = 6.048\ \ (0.048)\ ,$$

where *LM* is the *LM* autocorrelation test statistic, *JB* is the Jarque-Bera test statistic, χ^2 is the White test statistic and the *p*-values are given in the parentheses. It is evident that all diagnostic tests lead to unsatisfactory results, which easily may be a result of the data nonstationarity (see Appendix for ADF results). Moreover, the null hypothesis of rationality is questioned by the Wald test. Since the obtained test statistic χ^2=128.983, the null is firmly rejected ($p = 0.000$).

Bearing in mind that the observed variables are $I(1)$, the estimated parameters from Equation (16) are not consistent unless inf_t and exp_cp_t are cointegrated. Hence, their sign and value is not interpreted here, because it is compulsory to continue the analysis by testing cointegration.

In that sense, both Bakhshi and Yates (1998) and Forsells and Kenny (2004) put in practice the following procedure. The necessary condition for the expectations to be rational is the existence of a unique cointegrating vector between inf_t and exp_cp_t. Secondly, it should be tested whether the constraints α_0=0 and α_1=1 hold jointly. Afterwards, dynamic properties

[6] *The empirical testing of the adaptive expectations algorithm (such as in Curtin, 2006) was not possible due to data nonstationarity (see Appendix).*

of the observed relationship should be examined. Namely, if the above constraints hold, then the error correction mechanism offers evidence of how rapid the agents adjust their expectations towards a purely rational (unbiased) outcome. Hence, the same three steps will be employed here.

Equation (16) itself is the foundation of the Engle-Granger cointegration approach, which will be examined first. The existence of a long-run relationship between inf_t and exp_cp_t implies that the residuals from Equation (16) are stationary. Hence, the ADF test is applied and the obtained ADF test statistic equals -1.64 ($p = 0.655$). Therefore, the observed variables are not cointegrated at any reasonable significance level, and the Croatian consumers' inflation expectations are not rational. To see whether this result is robust with respect to different econometric methods, the Johansen cointegration procedure is also applied.

Table 2 **Johansen Cointegration Analysis Results**

Number of cointegration relations	Eigenvalue	λ_{trace}	$\lambda_{trace\ (0.05)}$	λ_{max}	$\lambda_{max\ (0.05)}$
0	0.115852	10.73853	12.32090	9.481093	11.22480

Notes: λ_{trace} *- trace statistics,* $\lambda_{trace\ (0.05)}$ *- trace statistics critical value (5 percent significance),* λ_{max} *- maximum eigenvalue,* $\lambda_{max\ (0.05)}$ *- maximum eigenvalue critical value (5 percent significance). Source: Author's calculations.*

Again, the results from Table 2 clearly suggest that there is no cointegrating vector at the 5 percent significance level, which immediately rules out the validity of REH.[7] Also, since the necessary condition for REH is not met, it is impossible to test the unbiasedness constraints. Obviously, the divergence of inflation movements (as seen in Figure 5) is of a scale sufficient to result in biased (non-rational) expectations.[8]

[7] *In accordance with Bakhshi and Yates (1998), the Johansen analysis was based on a model with no constant term in the cointegrating relation, since a significant intercept would imply a systematic expectation error.*

[8] *A plausible explanation of the mentioned divergence is the economic crisis (specifically during 2008), when the consumers were particularly incapable of recognizing real inflationary trends.*

This once more partially corroborates previous findings from related papers. Gramlich (1983), in one of the first empirical studies of inflation expectations' rationality, finds out that neither US households, neither business forecasters, nor professional economists are able to produce unbiased predictions of future inflation developments. Kokoszczyński, Łyziak and Stanisławska (2006), based on estimating relations (2)-(3), again confirm these inferences for Czech and Polish consumers. Sabrowski (2008) employs an even more in-depth analysis of German consumer expectations, with respect to different socio-demographic variables: age, gender, income and education. The author segregates the consumers into subgroups vis-à-vis their socio-demographic status. Nevertheless, for none of the observed subgroups was Sabrowski (2008) able to verify the REH.[9]

To the best of the author's knowledge, the only study that firmly confirms the REH is Forsells and Kenny (2004), who used cointegration analysis for euro-area consumers. Since it was not possible to prove cointegration between the observed variables, there is also no possibility of estimating an error-correction model. However, in order to inspect the short-run dynamics between inf_t and exp_cp_t a VAR model with variables in first differences is estimated. The lag length is set to 4, as chosen by the Akaike information criterion.

First of all, it is evident from the following table that Δexp_cp Granger causes Δinf (at the 5 percent significance level), while the causality in the opposite direction does not exist.

Table 3 **Granger Causality Test Results**

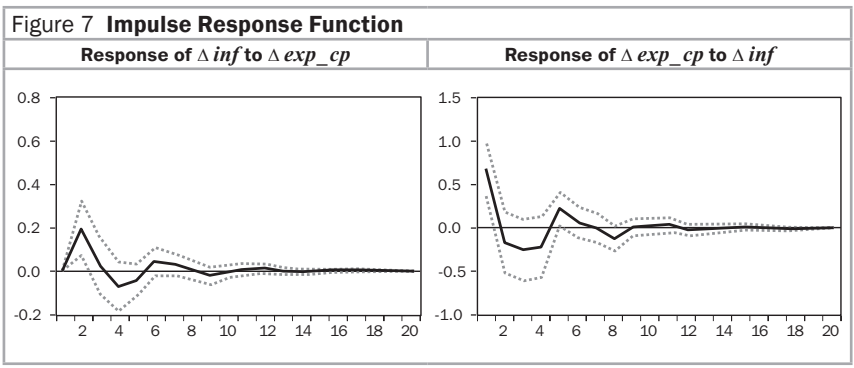
Dependent variable: Δinf			
Excluded variable	χ^2 test statistics	df	p-value
Δexp _ cp	10.927	3	0.012
Dependent variable: Δexp_cp			
Excluded variable	χ^2 test statistics	df	p-value
Δinf	1.114	3	0.774

Note: Δ is the first difference operator.
Source: Author's calculations.

[9] *See also Bakhshi and Yates (1998) for a detailed review of papers obtaining the same conclusion.*

Obviously, the consumers are indeed able to predict the inflation dynamics in the short run. A certain economic mechanism can be observed here: when consumers expect the prices to rise in the near future, they instantly generate additional demand pressure (to counteract the expected future price growth). The final consequence of such behavior is an actual aggregate price boom. The impulse response analysis offers an additional insight into the time dynamics of the observed interrelations.

Figure 7 **Impulse Response Function**



Source: Author's calculations.

Figure 7 again clearly shows that the responses of both observed variables fade away extremely quickly, characterizing their relationship as a purely short-run phenomenon.[10]

In line with the approach suggested by Forsells and Kenny (2004), the next step of the analysis is to examine consumers' efficiency. The expectation error (*error*) is regressed on lagged macroeconomic information available to the consumer at the time of forming the expectations. Lagged inflation (π_{t-12}) is used to test the *weak-form efficiency*. *Strong-form efficiency* is questioned using industrial production (ind_{t-12}) as a *demand-pull* variable, monetary aggregate M1 ($M1_{t-12}$) and the nominal HRK/EUR exchange rate (hrk_eur_{t-12}) as monetary variables, and finally net nominal wage per employee ($wage_{t-12}$) and Brent crude oil price ($brent_{t-12}$) are considered as indicators of *cost-push*

[10] *The impulse response function is based on the Choleski decomposition, where the variable ordering is the following:* Δinf, Δexp_cp. *In order to save space, the decomposition of the forecasting error variance is left out here, but can be obtained from the author upon request.*

inflation.[11] All variables are expressed as yoy percentage changes, according to the econometric practice of CS analysis.

The efficiency test is slightly modified in order to circumvent the spurious regression problem. Since both the expectation error ($error_t = \pi_t - \pi_t^e$) and most observed macroeconomic variables are nonstationary (see ADF results in the Appendix), the test is conceptualized as follows:[12]

$$\Delta error_t = c + \phi\ \Delta\Omega_{t\text{-}12} + u_t\ . \tag{17}$$

First of all, it is essential to examine whether the variables from the known information set are statistically significant at all. Namely, a significant positive/negative value of ϕ would imply that consumers underestimate/overestimate the effect of that particular information variable on inflation developments. In order to avoid multicollinearity problems, the efficiency test is not conducted in a multivariate framework (examining the whole $\Omega_{t\text{-}12}$ in a single equation). Alternatively, Equation (17) is estimated six times, for each individual variable from the macroeconomic information set.

The test results are given in the following table.

Table 4 **Efficiency Test Results**

Variable	ϕ	***p*-value**
$\Delta\pi_{t\text{-}12}$	-1.4729	0.0001
$\Delta ind_{t\text{-}12}$	0.0595	0.1891
$\Delta M1_{t\text{-}12}$	0.0115	0.8684
$\Delta hrk\_eur_{t\text{-}12}$	-0.3047	0.2106
$\Delta wage_{t\text{-}12}$	0.0651	0.7293
$\Delta brent_{t\text{-}12}$	0.0093	0.1142

[11] *All monetary variables,* π *and* wage *are obtained from the CNB website (www.hnb.hr),* brent *is obtained from the US Energy Information Administration (http://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm), and* ind *is obtained from Eurostat. All variables are seasonally adjusted using the ARIMA X12 method.*

[12] *The only exception is* brent*, which is proven to be stationary. Therefore, the 12th lag of* brent *enters Equation (17) in levels.*

Perhaps a bit illogical (at least at first glance), Croatian consumers are proven to be strong-form efficient, but the hypothesis of weak-form efficiency is firmly rejected. Looking at the ϕ value for $\Delta \pi_{t-12}$, it becomes evident that consumers strongly overestimate inflation persistence. This once again strongly corroborates the availability heuristic, proving that the painful hyperinflation episodes in recent Croatian history do not allow the consumers to rationally perceive aggregate price changes. On the other hand, with respect to all other macroeconomic variables, the consumers fully take into account the whole macroeconomic information set and seem to possess full knowledge about the underlying economic processes.

Relating this to international literature, it should be noted that there is no strong empirical consensus about the validity of inflation expectations' macroeconomic efficiency. Namely, Forsells and Kenny (2004) use the exact same methodology to prove that euro-area consumers are efficient vis-à-vis all information variables except the monetary aggregates and some market interest rates. Łyziak (2003) replicates the same model on Polish data and obtains rather miscellaneous results, depending on the observed information variable and the time period examined. Dias, Duarte and Rua (2011) employ the common factor approach on 50 macroeconomic variables for the euro area and nine individual member countries. They conclude that both weak and strong form of efficiency is valid for the euro area, while the results for individual countries are quite diverse. In that context, these results for Croatia can also be considered as a contribution to the international research on the properties of consumers' inflation expectations.

5 Concluding Remarks

This paper offers an initial attempt to directly quantify consumers' inflation expectations in Croatia. Namely, the economic science still mainly views agents' *expectations* as a non-measurable, purely psychological concept. In contrast with such standings, this research resulted in an exact numerical

indicator of expected inflation, obtained by the CP method. This enabled a detailed analysis of the properties of consumers' inflation sentiment.

Neoclassical economics views the economic agent as a strictly rational *homo economicus*. Moreover, the concept of rational expectations is embodied in most modern macroeconomic models. However, should that concept be exposed to empirical verification, the evidence often points to the rejection of REH. This was also the case for the inflation expectations of Croatian consumers. In more detail, it was proven that Croatian consumers produce biased expectations of future price developments. In the context of macroeconomic efficiency, the inflation expectation errors were proven to be orthogonal to the whole observed information set apart from the past inflation itself.

This inference draws two major issues to attention. Firstly, some authors put the inability of consumers to produce rational and efficient inflation perceptions in relation to the level of their macroeconomic literacy (Blanchflower and Kelly, 2008). Here, however, it is quite evident that consumers are familiar with the underlying economic processes that, ultimately, impact general price developments. Secondly (and lastly), it is shown that the consumers tend to misinterpret the transitory and permanent shocks in inflation. Therefore, consumers overestimate inflation persistence.

Appendix

Table A1 **ADF Test Results**

Variable	ADF value (constant and trend included)	ADF value (constant included)	ADF value (no constant or trend included)
inf	-2.4980 (11)	-1.9528 (1)	-1.2353 (1)
Δinf	-3.1205 (11)	-3.1182 (11)**	-3.1115 (11)***
exp _ cp	-2.1723 (10)	-2.3330 (10)	-0.4176 (6)
Δexp _ cp	-6.2580 (5)***	-6.2538 (5)***	-6.3005 (5)***
error	-1.6813 (3)	-1.6006 (3)	-1.5375 (3)
Δerror	-7.1854 (2)***	-7.2467 (2)***	-7.2997 (2)***
brent	-4.0305 (4)**	-4.0571 (1)***	-3.4342 (4)***
Δbrent	-4.5235 (11)***	-4.5501 (11)***	-4.5882 (11)***
M1	1.6763 (0)	-1.3377 (0)	-1.3154 (0)
ΔM1	-8.3435 (0)***	-8.4017 (0)***	-8.4499 (0)***
hrk _ eur	-3.0644 (0)	-2.3862 (0)	-2.4143 (0)**
Δhrk _ eur	-9.7303 (0)***	-9.7896 (0)***	-9.8288 (0)***
Ind	-1.5850 (4)	-1.5656 (4)	-1.6087 (4)
Δind	-6.6731 (3)***	-6.6873 (3)***	-6.6875 (3)***
wage	-3.3742 (8)*	-1.0883 (3)	-1.0107 (3)
Δwage	-4.9967 (2)***	-5.0017 (2)***	-5.0007 (2)***

*Notes: *, **, *** denotes rejecting the null hypothesis at the 10, 5 and 1 percent significance level, respectively. The optimal lag length is chosen using Akaike information criteria (AIC), and given in the parentheses. Δ is the difference operator.*
Source: Author's calculations.

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