INFLATIONARY EXPECTATIONS: THEIR ROLE IN INFLATION FORMATION IN UKRAINE

by

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Abstract

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Despite their intangible nature inflationary expectations do have real impact on macroeconomic variables and are considered to be one of the main factors in inflation formation in many developed countries. The present paper intends to study the characteristics of inflationary expectations in Ukraine employing the programmed composite Maximum Likelihood function and data set consisting of both survey data and aggregated macroeconomic variables. It turned out that inflationary expectations were not even weakly rational in Ukraine, which was also proved for some periods in the USA's and UK's economies. Moreover, in most of cases inflationary expectations used to overestimate the future inflation rate. The real impact of inflationary expectations on the future inflation was found to be rather ambiguous. This provides a space for further investigations in the sphere of macroeconomic dependence on economic factors of intangible nature.

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GLOSSARY

ACF- autocorrelation function

AIC- Akaike information criterion

AICC- bias-corrected version of AIC

AR- autoregressive process

ARIMA- autoregressive, integrated, moving average process

BIC- Bayesian information criterion

CPI- Consumer Price Index

EUR- official currency of countries-members of European Union

FPE- Final Prediction Error Criterion

GDP- Gross Domestic Product

IE- inflationary expectations

IMF- International Monetary Fund

IT- inflation targeting

LR- Likelihood Ratio

MA- moving average process

ML- maximum likelihood

MS- money supply

NBU- National Bank of Ukraine

PACF- partial autocorrelation function

PPI- Producer Price Index

VAR- vector autoregression

C h a p t e r 1

INTRODUCTION

Inflationary expectations (IE) may be defined as inner feeling of economic agents concerning the future rate of inflation. IE determine current economic behavior of agents, which is directed to maximize their utility in the future. IE usually arise on the base of agent's experience of previous rates of inflation or changes in government policy, energy sources prices, natural disasters and other unexpected shocks (Pesaran, 1982, p.962).

Despite their intangible nature, IE were considered to be inevitable factor in determination of inflation and, thus, to affect real economic variables, such as real interest rate, investment, real output, unemployment and others. As inflation issue became of great importance in Ukraine recently, the investigation of IE may provide the better understanding of its nature. This is related to the fact that in high inflation economies IE became one of the strongest inflation factors, stimulating the price growth. If the effect of IE in inflation formation is significant then control of IE will enable to restrict so rapidly developing inflation in Ukraine.

However, the main part in discovering any phenomenon, be it money velocity or atmosphere pressure, is to measure this phenomenon, thus making it applicable in the real estimations. Therefore, the first thing in IE investigation is to find the numerical measure of IE, which will enable to state the relationships between IE and inflation explicitly.

The other aspect of the issue is that IE become of great importance when a country switches its monetary regime to inflation targeting (IT). Proceding from the experience of such countries with IT as the United Kingdom, the New Zealand, Chile, Poland, Turkey, European Union Countries (implicitly) and others, IE constitutes one of the most important channels in the transmission mechanisms of their monetary policies. Thus, perfect knowledge of IE is required in such a monetary regime as IT.

According to IMF's report (Allen et al, 2006) Ukraine is close to switching to IT regime, as it has all preliminary conditions, which had the countries chosen IT regime. Namely, the domestic level of inflation was high in the last years, the exchange rate was pegged to the fixed level and the inflow of foreign capital expanded significantly, increasing the gross external debt. Moreover, inflation was constantly increasing in the last few years and the NBU's had not great success in its restricting. In addition, as pegged (de facto) exchange rate regime makes it impossible to use interest rate as a monetary policy tool, the increase in discount rate in November and December led to slow down of economic activity (Monetary Review by the NBU, 2008). In contrast, the IT regime makes the interest rate tool to be more effective.

So, one of the reasonable steps in the NBU's policy will be to shift to IT regime, which is recommended by the International Monetary Fund, the World Bank, the European Bank of Reconstruction and Development and other representatives of the world community. Moreover, the countries chosen the IT regime have successfully restricted inflation. So, if Ukraine follows the experience of the mentioned countries, the analysis of IE will be one of the main issues of the country.

Besides, the inflationary expectations were not quantitatively estimated till this time in Ukraine. Therefore the present paper attempts to quantify the inflationary expectations in two ways, using regression approach and the maximum likelihood approach, with the main accent put on the latter way.

The first part of the paper describes the previous findings in the field. Then two types of data employed in the estimation are described. Third and fourth parts contain the methodology and the estimation results obtained in the paper. The fifth part finishes the research with conclusions and possible policy implications.

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LITERATURE REVIEW

The literature review consists of main findings in the United States concerning the rationality of inflationary expectations (IE), which took their start after the rational expectations revolution. Then ways of dedicating the quantity measures of IE in developed countries are discussed. The closing part of the literature review describes main contributions to IE exploration in Ukraine.

In International Encyclopedia of the Social and Behavioral Sciences (Smelser, Baltes, 2001), the mechanism of IE's impact on core inflation[1] is called "self fulfillment" of IE and is described next. Basing on the previous hike in inflation and inertial nature of human psychology, consumers may expect that prices will rise in the future. Consequently, consumers try to buy more goods today, with a belief that with same income they will afford fewer goods in the future. In such a way, the demand on consumer market increases. With the demand pressure, producers will raise their production prices, causing a spill-over price increase effect in the economy.

[1] –core inflation –a measure of inflation that eliminates products that can have temporary price shocks, because these shocks can diverge from the overall trend of inflation and give false measure of inflation.

Besides, similar to consumers, producers will expect overall prices to increase in the future, including the prices of raw materials. In order to maintain previous output level they may increase goods' prices even above the demand pressure in order to afford enough raw materials for planned output. As a result, the core price level will really increase in the economy. This is how IE are defined in the modern market. However, investigation of IE takes its start from the mid of the XX century.

Interest to expectations arose after the rational expectations revolutions initiated by Lucas in 1972. He built his theoretical approach on the Muth's (1961) assumption about the possible influence of expectations on the real economy. Lucas stated that expectations heavily affected the results of the monetary policy implication in the real economy. In particular, if the expectations were rational, then increase in the money supply had zero effect on the economic growth and only inflation increased resulting from these actions. However, the rational expectations formulated by Lucas seemed to be rather theoretical. In particular, he assumed that all economic agents have perfect knowledge of all the macroeconomic changes and immediately adjust their behavior to these changes. Some other, rather unrealistic, assumptions were made, including the identical expectations formation of all economic agents. Therefore, the majority of the early empirical models rejected the hypothesis of the rationality. The book of Sheffrin (1994), for instance, describes rationality tests conducted on the IE database, built on the Livingston Survey in the USA[2]. The most frequently used consistency test stated that forecasts of inflation from different period IE's data should be consistent with one another. The efficiency test was equally popular. It stated that IE, if rational, should use information about the past history of the variable in the same way as inflation evolves through the time. Thus, Pesando (1975) and Carlson (1977) proved that Livingston data violated the consistency and efficiency tests of rationality. However, Mullineaux (1978) and some other economists could not reject the hypothesis of rationality of these expectations for the period 1959-1969. Most of later works on the USA's IE used improved methodology, which was obtained through such techniques as Kalman filter, univariate time series of inflation, or the random walk model of inflation. The results showed non-rationality of IE. As different techniques of the tests showed different results, the investigation of IE was continued. Some researches stated that it was the data imprecision which caused arguable tests results. From the rationality tests it was seen that the data derived from the real indicators (like CPI, PPI) seemed to describe IE better than data taken from survey in the USA..

Katona (1985) and Pesaran (1987) explained this fact in the way that "point data" surveys, i.e. which ask for particular expected level of inflation (Livingston survey in particular), are more susceptible to sampling and measurement errors (Dahl, Xia, 2003).

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[2] Livingston IE- data taken from the Livingston Survey of the economist's IE, conducted by Joseph Livingston since 1946 in the USA. From 1990 the Survey was conducted by the Federal Reserve Bank of the Philadelphia.

They also stated that simple "directional" surveys, i.e. which ask "yes/no" questions about the possible directions of the indicator, are better in this sense than "point data" surveys.

Therefore, the main task of many IE researches became to find the adequate measures, which would truly reflect the total population's expectations.

All methods, seeking to derive the appropriate measure of IE, may be divided into two big groups:

1) The first group describes the methods, which use "point data" surveys and try to remove all possible drawbacks of the estimates. Kalman filtering is one of the known methods from this category. Kalman filtering is used to dedicate the real value of the variable from its noised value, i.e. which contain the time and measurement errors. Struth (1984) was first who applied Kalman filtering to IE. When analyzing the previous works on Livingston data Struth noted that all researchers were mainly concentrated on whether IE given in the survey are rational, rather than to model the process of formation of the IE. From the author's point of view, it was far more important to learn how the expectations are formed basing on the survey data, or filter them, and than check for the rationality. On the pattern of the Livingston CPI forecast data Struth estimated the actual CPI forecasts via the Kalman Filter method. In particular, his model assumed that agents based their forecasts on a simple extrapolative rule of the form: $y_t = \begin{pmatrix} 1 & a & b \\ 0 & a & b \\ 0 & 0 & b \end{pmatrix} * y_{t-1} + \begin{pmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{pmatrix} * u_t$, where $\begin{matrix} y_t = (y_{1,t} & y_{2,t} & y_{3,t})' \\ u_t = (u_{1,t} & u_{2,t} & u_{3,t})' \end{matrix}$ (*)

where y_t was the logs of the agents estimates of the future inflation level (Livingston CPI forecast data), u_t was disturbance terms assumed to be serially uncorrelated and normally distributed. Also the equation of actual and unobservable variable was included into the model:

$$z_t = (1 \quad 0 \quad 0) * y_t + v_t, \qquad (**)$$

where z_t was actual inflation data, while v_t was the error existing in the agents' estimation of the future inflation. The system meant that agents' expectations were based on their previous experience (up to the third period in the past) and affected the level of the actual inflation.

The results of the Struth paper, noise-free IE, were much closer to the actual CPI values and have better forecasting properties. The paper concluded that economic agents formed their expectations solely on the past data and mostly underestimated the long run inflation, which cannot be considered as rational expectations. Also it was mentioned in the paper that it was possible to include other independent variables into the (*) model if they affected the expectations estimates.

The Kalman Filtering cannot be applied directly to the case of Ukraine as only qualitative data on the IE survey is available. Instead, there is a need to estimate the numerical estimates of IE in Ukraine.

Baghestani (1992) checked for rationality the inflation forecasts from the ISR survey conducted quarterly among the households in the United States since 1948. Survey was based on the point data. The author stated that IE are weakly rational if they perform as well as the ARIMA model in inflation forecasting. Meanwhile, the IE were considered to be strongly rational, if they performed as well as the VAR model in inflation predictions. Baghestani considered the

ARIMA(0,1,1) process, such that described the USA inflation. At the same time, the VAR model included such variables, as the CPI, manufacturing capacity utilization index and the exchange rate. The main criterion of the model's goodness in inflation forecasting was the mean squared error (MSE). It was found in the paper that IE in the USA were weakly rational in 1979-1983, i.e. they outperformed the ARIMA forecasts, while underperform the VAR model. In the rest of the periods IE failed to be both weakly and strongly rational.

The present paper will also take the ARIMA model in the check for rationality of IE in Ukraine. The preference to ARIMA model over the VAR one in the process of inflation forecasting may be explained by the fact that ARIMA model is more efficient in forecasting the variables in the short run, whereas the VAR performs better in the long rung forecasting. The period of 1999-2007 is considered to be rather short run. Therefore, the ARIMA model was used.

2) The second group contains the methods, seeking to quantify the qualitative data, on which the present paper is based. This method transforms the categorical ("yes/no" type) answers and indexes built on their base into actual levels of expected inflation aggregated over the sample. As mentioned in Dahl and Xia (2003) pioneers in quantifying the qualitative data were Theil (1952), Carlson and Parkin (1975), who used subjective probability approach in converting qualitative data into quantitative. They assumed that the respondents of the survey had common subjective probability functions, which determined their answers of the future level of inflation. It was also assumed that respondents

would change their previous expectations only if inflation rate exceeded some particular threshold value. Thus, the quantity estimates of IE were received purely from the survey data and assumptions of expectations formation model.

In 1984 Pesaran found new way of IE quantification using regression model approach. Apart from the subjective probability model, the regression approach did not assumed any behavioral function common for all agents. Instead, it investigated the relationship between actual rate of inflation, received from official macro statistics, and survey data. The use of two independent sources, according to the author, enabled to avoid casual explanation of the price changes, as no data set was derived from the other. The required data also included the variable of perception of the inflation rate by the respondents, available from the survey. The model consisted of two basic equations. The first considered IE obtained from the survey response as a function of actual inflation rate:

$$ {}_{t}\Pi^{*}_{t+1} = \alpha + \sum_{i=0}^{\infty} w_i * \Pi_{t-i} + v_{t+1}, \text{ where} $$

${}_{t}\Pi^{*}_{t+1}$ is the expected rate of inflation in period t+1 formed in period t, Π_{t-i} is actual inflation rate in period t-i, and w_i is the weight of inflation in period t-i. v_{t+1} is the disturbance term, which captures the effect of unobservable shocks on expectations.

The second model related actual IE in numerical terms with the survey response:

$$\Pi_{ti}^{e} = \delta_{1i} + \delta_{2i} * \Pi_{t}^{*} + \varepsilon_{ti}, \text{ where}$$

Π_{ti}^{e} is numerical value of IE in period t.

The combination of these two equations provided the possibility for numerical estimate of IE. Also, according to Pesaran, the first equation could be augmented with other exogenous variables, such as changes of raw materials and fuel prices, weekly wage rate, effective exchange rate and change of the manufacturing output. Pesaran applied such estimation models as Linear Probability and Logit to data of British Manufacturing Industries survey and made the following conclusions:

1) The main factor affecting inflation in United Kingdom was one-period lagged value of inflation. Also fuel and raw material prices and current growth of manufacturing output showed significant relations with inflation in the subsequent periods;

2) IE in British Manufacturing Industries were not rational.

Dahl and Xia (2003) improved existing quantifying models by combining both behavioral models of the respondents with the actual processes of inflation formation. The main advantage of the new model, due to the authors, was that it showed explicitly the underlying process driving the variable of interest relying on statistically accommodated model of inflationary processes. The idea of the approach is to assume that individuals' IE is the function of the population's IE,

$$y_{it+1|t}^{*} = \delta_0 + \delta_1 * E(y_{t+1} \mid \Gamma_t) + \sigma_\eta * \eta_{it+1}, \text{ where}$$

$y^*_{it+1|t}$ is the numerical value of inflation in period t+1, $E(y_{t+1} | \Gamma_t)$ is population's expectation function conditional on the information set Γ_t, η_{it+1} residuals from the model.

At the same time $y^*_{it+1|t}$ may be defined from latent function

$$IIE_i = \sum_j^J j(\beta_{j-1} \leq y^*_{it+1|t} < \beta_j) \text{, where}$$

IIE_i is categorical survey response, j(.) is the indicator function which takes value of j or zero and j is the categorical value of possible response, β_j is threshold value of inflation defining the respondent's answer. The term $E(y_{t+1} | \Gamma_t)$ may be computed from

$$y^*_{it+1|t} = E(y_{t+1} | \Gamma_{it}) = \int y_{t+1} dG(y_{t+1} | \Gamma_{it}) \text{, where}$$

$dG(y_{t+1} | \Gamma_{it})$ is a probability density function, derived from the model of actual inflation:

$$y_t = g(\Gamma_{t-1}; \theta) + \sigma_{ut} * u_t \text{, where}$$

$g(\Gamma_{t-1}; \theta)$ is a function of macroeconomic variables determining inflation (Γ_t), which may take a non-linear form. Also, the authors noted, that if there is no theory behind the variable driving process, it is better to use simple ARIMA models, when describing these processes. It was advised to use such criteria when choosing AR, MA orders, as AICC (the bias corrected version of the AI suggested by Hurvich and Tsai (1989), BIC and FPE (Final Prediction Error criterion) developed by Akaike (1969). The most appropriate process defining inflation in the paper was the AR(1) or ARIMA (1,0,0).

In estimations the authors used the Maximum Likelihood method in derivation of the model's coefficients, denoted as $\psi = (\theta^{'}, \sigma_{ut}, \delta_1, \delta_2, \sigma_n, \beta_1)$. The real values of expected inflation were calculated using the coefficients found. Dahl and Xia's model also provided the opportunity to check IE for rationality via applying the likelihood ratio (LR) test to estimated coefficients. LR test was used to check the hypothesis of $\delta_1, \delta_2 = 0,1$. If hypothesis was true then IE was considered to be rational, as such that approach the individual's expectations with the population's expectations. (This model is described in details in the methodology.)

Main finding of the authors were following:

1) The estimated threshold parameters revealed asymmetry in the respondents' decision making. The respondents believed that inflation would go up after it reached 4.5% rate in the previous period. While the larger drop (5.5%) was needed in the previous period for respondents to believe that prices would go down in the subsequent period.
2) Likelihood ratio test showed that on average IE of the population were rational in UK's Manufacturing Industries.

Most of the authors had only aggregated data from the surveys, rather than responses of each individual. Therefore, it was suggested to use proportions of each type of categorical responses to conduct the estimations. However, the use of aggregated data restricted the number of observations, which could lead to impreciseness in the results. Therefore, Dahl and Xia (2003) used Monte Carlo simulations to check the appropriation of their results. Dahl (2003) improved given results by application of the bootstrap estimations to the model.

Concerning the IE in the European countries such as Great Britain, France, Germany and Italy, Döpke et al (2005) found that in all these countries economic agents tend to renew their expectations just once a year. The rest of time they based their behavior on the past inflationary forecasts.

Despite the statement of zero-effect of the money supply on the real economy Bordo and Filadro (2006) claimed that monetary policy did affect real economic growth in all the countries, which were divided into inflation zones. According to the authors in high inflation countries, like transition ones, the monetary actions may combat the inflation through restraining the IE. However, these actions may not be words alone. They should be supported by the fiscal policy measures.

The discovery of IE in Ukraine can hardly be found in the economic literature. Only some general descriptions of inflationary expectations are available. Also hints about the effect of the monetary policy on the real economy and some channels through which inflation is related to real variables may be found.

The recent paper of Ukrainian scientists, Mishchenko and Somyk (2007), states that expectations of the economic agents contribute to one of the main channels in the monetary policy of Ukraine. Authors stressed on two kinds of expectations. In particular, future price and overall macroeconomic state expectations defined investment and consumption of the economic agents, thus affecting future inflation and output. It was also stated that long pessimistic expectations may destabilize the loans market, disturb the investment process and cause deviation from the initial monetary targets. The main indicators of the pessimistic expectation presence are the increase in money velocity, increase in both deposits and credits amount in the foreign currency, increase of the cash share in the money supply and others indicators.

The following papers discuss the channel from which IE as well related variables may be derived in Ukraine.

In their paper the scientists Tyrkalo and Adamyk (1999) showed that in 1992-1998 the change of the money supply hardly affected the level of inflation. They also mentioned that the vulnerability of inflation and money supply differed under either expansionary or contraction monetary policies. In particular, under the expansionary monetary policy the vulnerability of money supply was higher than that of the money supply. And vice versa, under contraction monetary policy the vulnerability of inflation was lower than money supply vulnerability. They related this fact to existence of IE, which were higher in expansionary monetary policy and lower under contraction policy.

In the paper of Shevchuk (2001) it is stated that in 1994-3M2000 there was a weak relation between the money supply and the GDP growths. Whereas, the growth rates of the money supply explained the dynamics of inflation. The scientist took three lags relationship between CPI and growth rates of MS. Additionally, the author mentioned that the three lags effect may be explained by the existence of the IE, those affect the reduction of the GDP after the money supply increase.

Money supply effect on IE was reflected in the present paper in the indicator of the real effective exchange rate, as such that affected the money supply creating process to the large extent. Moreover, from the papers mentioned above, it may be stated that IE do have a significant effect on the economy of Ukraine, and needs the deeper consideration.

Therefore, the present paper will employ the techniques used in developed countries in order to discover the process of inflationary expectations in Ukraine. In particular, the regression method of Pesaran and Baghestani as well as the most improved and up to date technique of Dahl and Xia will be used in the search of quantity measures of IE.

Chapter 3

DATA DESCRIPTION

Qualitative Data Description

As one kind of the source data the qualitative data of the joint survey of the International Center for Policy Study and company Gfk Ukraine was taken. The Survey contains the Index of Inflationary Expectations (IIE). IIE is calculated on the base of yes/no answers to the question: "Do you consider the inflation to rise or decrease in the next 1-2 months?" The index values fall in the range of 0-200 and are obtained from the next formula:

$$IIE = p_1 - p_2 + 100,$$

where p_1 is the share of answers, pointing out the increase of inflation, while p_2 is the share of opposite answers. The respondents sample consists of 1000 people 15-59 years old living all over Ukraine. The survey contains the IIE in the form of panel data, consisting of 32 periods and six regions results. Panel data of only 23 periods is publicly available, while 32 periods time series data of country aggregated IE is publicly available. The survey was conducted quarterly, starting from September 2000. However, the months of the Survey may have differed and in 2006 survey was conducted six times. Following regions were surveyed: Kyiv, North, West, East, Center and South. Kyiv was taken as separate city. North included: Zhytomyr, Sumy, Chernigiv and Kyiv regions. South included: Crimea, Mykolaiv, Odesa, Kherson regions. Center consisted of Vinnytsia, Kirovograd, Poltava, and Cherkasy regions. West included: Ivano-Frankivsk, Lviv, Rivne, Ternopil, Khmelnytsky, Volyn' and Zakarpattia regions. Finally, East consisted of Dnipropetrovsk, Donetsk, Zhaporizhia, Luhansk ans Kharkiv regions.

Summary statistics of the data may be found in the Table 1 and the illustration of the aggregated survey data is shown in the Figure 1.

Table 1. Summary Statistics for the quarterly Survey data in 2000-2006

Variable	Mean	SD	Min	Max
IE*	177.8	6.8	165.5	187.2
Kyiv	179.5	11.5	148.3	196.4
North	179.4	7.5	162.6	189.6
West	176.2	8.2	158.5	187.8
Center	176.2	15.6	125.2	196.6
South	178.3	7.3	160.9	191.7
East	180.6	7.7	160.9	191.7

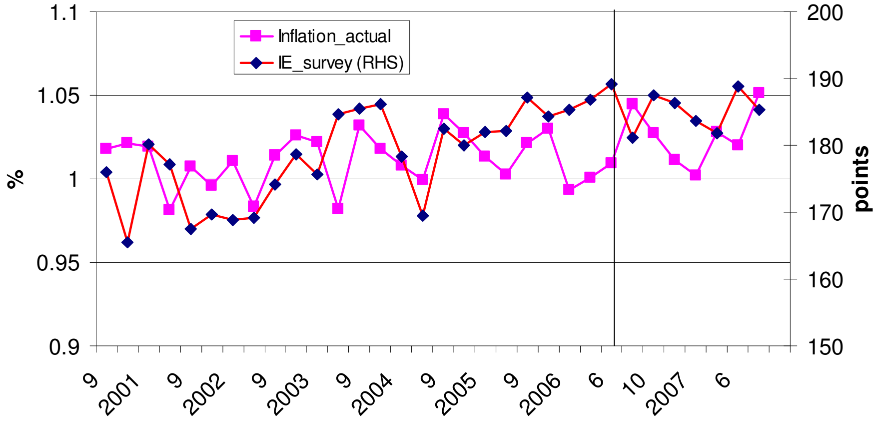
*-inflationary expectations index aggregated over all regions

Source: International center for policy studies

As can be seen from the Table 1, averages of IE are similar over the regions, while most volatile IE were in Kyiv and in the Central region. As volatilities over the regions differ a lot the panel data used, is likely to give reasonable results, in spite of the similar data set of the different regions.

As IE are based on two-month ahead inflation basis, the corresponding two-months growths of actual inflation were taken.

Figure 1. Dynamics of the expectations index and two month growth of inflation in 2000-2007



Source: International center for policy studies

As can be seen from the Figure 1 there is a positive relationship between actual inflation rate and inflationary expectations trends in Ukraine.

The quantification method also requires the data on individuals' perception of the actual inflation rate. As the Gfk Survey does not contain such information explicitly, present paper will employ the proxy obtained from the wealth change index (x1) from the survey. The x1 index was calculated the same way as IIE on the base of the question: "How did your wealth changed in the last 6 months". This index will be employed in the grouped data analysis, assuming that the response of the worsening in the wealth if likely to indicate that the prices rose. The drawbacks of this proxy is that it indicated the change in welfare over the last 6 months, whereas, the appropriate perception measure is needed for last 2 months. However, it may be assumed that the individual is likely to remember the most recent changes in wealth, thus giving higher weight to the last two month change in the wealth. Besides, the advantages of the given index are that it is more likely to be uncorrelated with the expectations of the future inflation rate, because the past improvement of wealth is considered to have zero effect on the expectation of external inflation factor. So, in the analysis it may be assumed that the probability of expecting a particular inflation rate is independent from the probability of the wealth change feeling.

<u>Data for the proxy method</u>

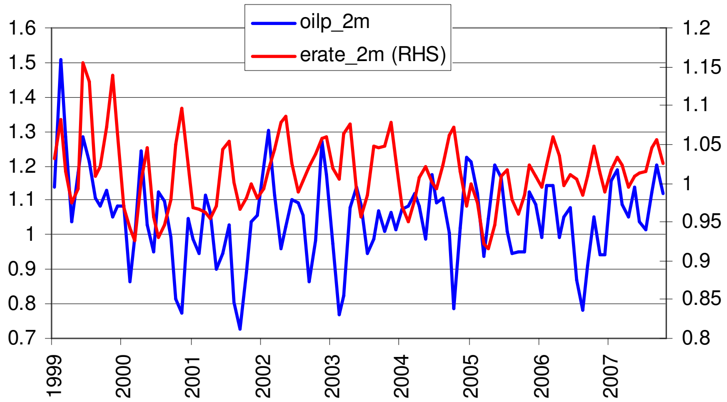
The proxy method will include such variables as inflation (cpi_2m), social payments (trans_2m), world oil prices (oilp_2m) and EUR/UAH exchange rate (e-rate_2m), which were taken in the form of two months relative change. The period under consideration is March 1999- December 2007 and consists of 105 observations. Description of the data may be found in Table 2 and Figures 2 and 3.

Table 2. Summary Statistics for the two-month macroeconomic data in 1999-2007

Variable	Obs	Mean	Std. Dev.	Min	Max
cpi_2m	106	1.02	0.02	0.97	1.09
trans_2m	106	1.05	0.13	0.76	1.57
erate_2m	106	1.01	0.05	0.92	1.15
oilp_2m	106	1.05	0.13	0.73	1.51

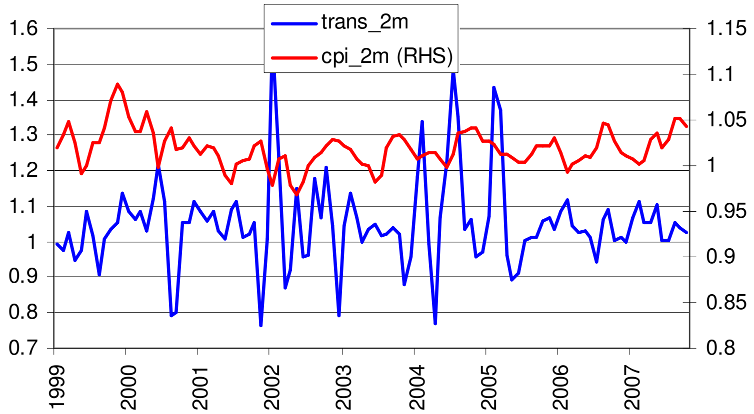
It can be seen from the table 2 that the data has similar mean, while differs in volatility. Similar means may be related to the normalization of the variables to the two month growth rate.

Figure 2. Two month relative changes in the Exchange Rate and World oil prices in 1999-2007



Source: The National Bank of Ukraine, International Energy Agency

Figure 3. Two month relative changes in Inflation Rate and Social Payments in 1999-2007



Source: The National Bank of Ukraine, the Finance Ministry of Ukraine

By the "eye-ball" test, the data seems to be stationary, however, it will be checked via statistical procedures in the estimation part.

Chapter 4

METHODOLOGY

The paper will employ two ways to quantify the IE data in Ukraine. The first one is proxy or regression method, which is quite simple and is based on the assumption of rational expectations, when aggregated over Ukraine. The second way is to use the more precise model of Dahl and Xia (2003), which is based on the Maximum Likelihood approach and uses qualitative data from the survey conducted in Ukraine. The last method is the most convenient for the paper as it employs two independent sources of information, official statistics and survey data, providing the possibility for inference on relations between actual inflation rate and IE. Moreover, the model seems to be the most improved comparing to the previous findings, as it includes both true model of actual inflation and explicit model for IE formation.

Regression approach

The first method of finding, a proxy for inflationary expectations, comes from the papers of Pesaran (1985) and Baghestani(1992), who tried to define the model of expectations formation through real macroeconomic data. The method assumes that the model of IE formation corresponds to actual inflation process. In other words, papers are based on rational IE hypothesis explicitly. It may be explained in the way that if there is no structural shocks or natural disasters in the economy, the IE, aggregated over whole population, will converge to reasonable (rational) prediction of the inflation. (The paper tries to check IE on rationality in the second part). Therefore, the most crucial issue in the model construction is to describe the inflation formation process in the country as precise as possible. In the paper of Dahl and Xia (2003) it is said that without concrete theory behind some economic process, the best way to describe this process is autoregression. Thus, the paper first tries to build appropriate ARIMA model for inflation in Ukraine and than to augment it with other relevant variables.

Following Jonston and DiNardo (1997), first inflation, measured by Consumer Price Index (CPI), should be checked for stationarity. With this aim the Augmented Dickey-Fuller test was used, accompanied by Durbin-Watson test for autocorellation in residuals. Then the ARIMA (j, k, l) process is defined, where j and l are the orders of AR and MA processes, k is the order of the integration of the variable if it is non-stationary. The first step in ARIMA estimation will be to define j, k and l. With this purpose the Autocorrelation Function (ACF) as well as Partial Autocorrelation Function (PACF) needs to be plotted. The process will be pure AR(j) if ACF infinitely damps out and PACF cuts off after lag j. The process will be pure MA(l), if ACF cuts off after lag l and PACF infinitely damps out. The process will be ARMA if both ACF and PACF infinitely damp out. In such a way the ARIMA (j, k, l) is defined. In order to check that the chosen model is most appropriate one two model selection criteria would be used. The first is AICC, the bias-corrected version of AIC suggested by

Hurvich and Tsai (1989), and the second is BIC criterion, developed by Akaike (1969) (Dahl and Xia, 2003). That model will describe the data in the best way, which shows the least AICC and BIC.

According to Pesaran (1985), the pure autoregressive model may be improved if there are some factors in the economy, which significantly influence the variable of interest. Following Pesaran (1985) and Baghestani (1992) such variables as world oil prices, transfers to the population and exchange rates were taken. As not all variables have moment effect on the others it is important to define the lag with which explanatory variable affects the inflation rate. The lags number was found via the command "varsoc" in the set of all the variables. Finally, the augmented ARIMA model was constructed:

$$y_t = \alpha_0 + \alpha_k * \sum_{k=1}^{K} y_{t-k} + \gamma_1 * trans\_2m_{t-l1} + \gamma_2 * erate\_2m_{t-l2} + \gamma_3 * oilp\_2m_{t-l3} + e_t$$

Applying the t- test to estimated coefficients, model, which better fits the data, will be chosen.

Values of IE will be fitted values of ARIMA model for inflation.

Maximum Likelihood approach

As an alternative way of quantifying the qualitative data, the paper will use the approach of Dahl and Xia (2003), based on qualitative IE data form the survey, which was conducted in Ukraine. This method assumes that yes/no answer of expected inflation increase of a respondent i (IIE_i) may be expressed as implicit function of the form:

$$IIE_i = \sum_{j}^{J} j(\beta_{j-1} \le y^*_{it+1|t} < \beta_j), \text{(1)}$$

where j(.) is the indicator function which takes value of j or zero and j=increase/decrease in Gfk Survey, $y^*_{it+1|t}$ is the numerical value of inflation in period t+1 expected by the individual in period t. β_j is numerical value of inflation, used to define the borders of qualitative answer. In Gfk survey case, β_0= -infinity, $\beta_1 = y_{t,}$ (y_t is actual inflation level in period t, which the respondents believes in), β_2=+infinity. Since the question of the current inflation rate was not stated in the survey, the coefficient β_1 is assumed to be unknown and will be estimated via the Maximum Likelihood method.

At the same time $y^*_{it+1|t}$ may be written as

$$y^*_{it+1|t} = E(y_{t+1} | \Gamma_{it}) = \int y_{t+1} dG(y_{t+1} | \Gamma_{it}) \text{(2)}$$

where Γ_{it} is the information set of the individual affecting the choice of a particular IE value. $G(y_{t+1} | \Gamma_{it})$ is conditional probability function, which shows the distribution of the IE given the effect of other factors.

If to assume that respondents in all regions on average use the information available all over the country (they are not isolated and are informed of the economic situation via mass media), then individual expectations may be written as:

$$y^*_{it+1|t} = \delta_0 + \delta_1 * E(y_{t+1} | \Gamma_t) + \sigma_\eta * \eta_{it+1}, \text{(3)}$$

where Γ_t is the union of all regions' sets of information. $E(y_{t+1} | \Gamma_t)$ are aggregated country's expectations given Γ_t. η_{it+1} is zero mean idiosyncratic error term (as panel data is used) with probability function $\Phi(x) = \Pr(\eta_{it+1} \le x)$.

In order to find $E(y_{t+1} | \Gamma_t)$ it is needed to define $G(y_{t+1} | \Gamma_t)$, proceeding from the equation

$$E(y_{t+1} | \Gamma_t) = \int y_{t+1} dG(y_{t+1} | \Gamma_t) \quad (4)$$

$G(y_{t+1} | \Gamma_t)$ may be defined assuming that y_{t+1} is generated according to the rule:

$$y_t = g(\Gamma_{t-1}; \theta) + \sigma_{ut} * u_t \qquad (5)$$

which means that actual inflation is a function of macroeconomic factors in the previous period. u_t is assumed to be stationary with probability function $U(x) = \Pr(u_t \le x)$.

As suggested by Dahl and Xia (2003) the equation (5) will be defined via ARIMA(j, k, l) process, described above and $E(y_{t+1} | \Gamma_t)$ will be taken in the form of one-period ahead inflation from the ARIMA model, estimated in the first part, assuming that it describes population's expectations the best.

Hence, the system of equations describing the process of expectations formation is as follows:

$$y^*_{it+1|t} = \delta_0 + \delta_1 * E(y_{t+1} | \Gamma_t) + \sigma_\eta * \eta_{it+1} \qquad (6)$$

$$y_t = g(\Gamma_{t-1}; \theta) + \sigma_{ut} * u_t \qquad (7)$$

$$IIE = \sum_{j}^{J} j(\beta_{j-1} \le y^*_{it+1|t} < \beta_j) \qquad (8)$$

In order to define the numerical values of IE it is needed to find the vector of coefficients $\psi = (\theta', \sigma_{ut}, \delta_1, \delta_2, \sigma_n, \beta_1)$, then plug coefficients into the equations and find estimated $y^*_{it+1|t}$. In order to uniquely identify the unknown parameters it was suggested by Dahl and Xia to augment the system with equations of inflation perception of the form:

$$y^*_{it|t} = \mu_0 + \mu_1 * E(y_t \mid \Gamma_t) + \sigma_w * w_{it} \quad (9)$$

$$y_{it|t} = \sum_{j}^{J} j(\alpha_{j-1} \le y^*_{it|t} < \alpha_j) \quad (10), \text{ where}$$

$E(y_t \mid \Gamma_t) = y_t$, expected level of inflation in period t, is known. $y^*_{it|t}$ is individual's perception of the actual inflation rate, $y_{it|t}$ is the response of perception in the survey, α_j is the threshold for perceptions. In the paper of Dahl and Xia (2003) it is assumed that $\alpha_j = \beta_j$, i.e. the same factors affect the inflation perception and expectations in the same periods. It also may indicate that individual decides on future inflation basing on the current inflation perception, rather than the officially reported inflation rates.

The coefficients may be found via the method of Maximum Likelihood (ML).

Joint conditional probability density function of the observed sequence (inflation and survey data) of the individual i is given by

$$\prod_{t=1}^{T} f(y_t, y_{it+1|t} \mid \Gamma_t; \psi) \text{ (11).}$$

Following, the likelihood function is $l(\psi) = \sum_{i=1}^{N} \sum_{t=1}^{T} \log(f(y_t, y_{it+1|t} \mid \Gamma_t; \psi)$.
Using the Bayes rule next can be written:

$$\begin{aligned} l(\psi) &= \sum_{i=1}^{N} \sum_{t=1}^{T} \log f_1(y_{it+1|t} \mid \Gamma_t; \psi_1) + \log f_2(y_t \mid \Gamma_{t-1}; \psi_2) \\ &= \sum_{i=1}^{6} \sum_{t=1}^{32} \log f_1(y_{it+1|t} \mid \Gamma_t; \psi_1) + \log f_2(y_t \mid \Gamma_{t-1}; \psi_2) \end{aligned} \quad (12)$$

where $\psi = (\psi_1 \;; \psi_2)$. $f_1(y_{it+1|t} \mid \Gamma_t)$ is conditional density function of $y_{it+1|t}$ given Γ_t and $f_2(y_t \mid \Gamma_{t-1})$ is conditional density function of y_t given Γ_{t-1}.

From the system of equations (1)-(3) we may define the probability function of idiosyncratic error η_{it+1}: $\Phi_{jt+1} = \Pr(\eta_{it+1} < \dfrac{\beta_j - \delta_1 - \delta_2 * E(y_{t+1} \mid \Gamma_t)}{\sigma_\eta}$.

Then $f_1(y_{it+1|t} \mid \Gamma_t)$ may be written as

$$\log f_1(y_{it+1|t} \mid \Gamma_t; \psi_1) = \sum_{j=1}^{J} 1(_{y_{it+1|t}=1}) * \log(\Phi_{jt+1} - \Phi_{j-1t+1}).$$

Assuming that u_t from equation (2) is normally distributed, $f_2(y_t \mid \Gamma_{t-1})$ may be written as:

$$\log f_2(y_t \mid \Gamma_{t-1}; \psi_2) = -\frac{1}{2}\log(2\pi) - \frac{1}{2}\sigma_{ut} - \frac{1}{2}\frac{(y_t - g(\Gamma_{t-1}; \theta))^2}{\sigma_{ut}^2} \text{ (13).}$$

Log likelihood function for perceptions will look like:

$$\log f_3(y_{it|t} \mid \Gamma_t; \psi_3) = \sum_{j=1}^{J} 1(_{y_{it+1|t}=1}) * \log(\Psi_{jt} - \Psi_{j-1t}) \text{ (14)}$$

According to Dahl and Xia if only proportions of the respondents giving a particular type of the answer are known (p^e_{jt} and p^p_{jt}), then the likelihood function should be improved as follows:

$$l_I(\psi)=\sum_{t=1}^{T}\sum_{j=1}^{J}\{p^e_{jt}*\log(\Pr(\eta_{it+1}<\frac{\beta_j-\delta_1-\delta_2*E(y_{t+1}\mid\Gamma_t}{\sigma_\eta})-\Pr(\eta_{it+1}<\frac{\beta_{j-1}-\delta_1-\delta_2*E(y_{t+1}\mid\Gamma_t}{\sigma_\eta}))$$

$$+p^p_{jt}*\log(\Pr(\omega_{it}<\frac{\beta_j-y_t}{\sigma_\omega})-\Pr(\omega_{it}<\frac{\beta_{j-1}-y_t}{\sigma_\omega})\} \quad (15)$$

$$-\frac{1}{2}\log(2\pi)-\frac{1}{2}\log(\sigma_{ut})-\frac{1}{2}\sum_{t=1}^{32}\frac{(y_t-g(\Gamma_{t-1};\theta))^2}{\sigma_{ut}^2}$$

Maximizing (15) with respect to parameters $(\theta',\sigma_{ut},\delta_1,\delta_2,\sigma_n,\beta_1)$ will provide the optimal parameter values, which after plugging to (3) will give the numerical estimated of inflationary expectations in Ukraine.

However, the Ukrainian data set needs that some modifications were implemented to the model. The first of all, as Ukrainian data set contains grouped data not only on the entire population, but also separate data sets on each of the six regions. Therefore, the likelihood function will consist of the sums of the log-likelihood functions of each region. This comes from the product of the independent joint probabilities of both perceptions and expectations over the six regions. Logarithm of such a probability will give a sum of log probabilities over the regions.

The second modification concerns the inclusion of the model of the actual inflation process (AR(7)) to the general log-likelihood function. The AR(7) model will be run on the limited number of observations, corresponding to the periods in which the Survey was conducted. Therefore, the AR(7) coefficients from the ML model are possible to be of low significance. The initial values of original AR(7) coefficients will be taken in the "restricted" AR(7) included to the ML model.

Therefore, the final model will look like

$$l_l(\psi)=\sum_{l=1}^{K}\sum_{t=1}^{T}\sum_{j=1}^{J}\{p_{jt}^{e}*\log(\Pr(\eta_{lt+1}<\frac{\beta_j-\delta_1-\delta_2*E(y_{t+1}|\Gamma_t)}{\sigma_\eta})-\Pr(\eta_{lt+1}<\frac{\beta_{j-1}-\delta_1-\delta_2*E(y_{t+1}|\Gamma_t)}{\sigma_\eta}))$$

$$+p_{jt}^{p}*\log(\Pr(\omega_{lt}<\frac{\beta_j-y_t}{\sigma_\omega})-\Pr(\omega_{lt}<\frac{\beta_{j-1}-y_t}{\sigma_\omega})\}(16)$$

$$-\frac{1}{2}\log(2\pi)-\frac{1}{2}\log(\sigma_{ut})-\frac{1}{2}\sum_{t=1}^{32}\frac{(y_t-g(\Gamma_{t-1};\theta))^2}{\sigma_{ut}^2}$$

where, K=6 is the regions' number.

The next important point is to find the form of the distribution of both expectations and perception residuals. It was suggested by Johnston and DiNardo (1997) that in the grouped data the appropriate distribution may be chosen via the Likelihood ratio test, which, when accommodated to the paper, has the following form:

$$LR=2*(\sum_{j=1}^{J}l_l(\psi)-\sum_{t=1}^{T}N*[p_{jt}^{e}*\log(1-p_{jt}^{e})+(1-p_{jt}^{e})*\log(p_{jt}^{e})$$
$$+p_{jt}^{p}*\log(1-p_{jt}^{p})+(1-p_{jt}^{p})*\log(p_{jt}^{p})])(17)$$

The null hypothesis of the significance of the restricted model will not be rejected if LR~Chi^2 (#of restrictions).

Found coefficients enable to estimate IE via the following formula:

$$y^{*}_{it+1|t} = \delta_0 + \delta_1 * E(y_{t+1} | \Gamma_t) + \sigma_\eta * \eta_{it+1} \quad (18)$$

In particular, in order to have white noise residuals the formula should be modified as follows:

$$y^{*'}_{it+1|t} = \delta_0 / \sigma_\eta + \delta_1 / \sigma_\eta * E(y_{t+1} | \Gamma_t) + \eta_{it+1} \quad (19)$$

The method of Dahl and Xia also enables to check IE found on rationality. With this aim the Likelihood ratio test is applied to model: $y^{*}_{it+1|t} = \delta_0 + \delta_1 * E(y_{t+1} | \Gamma_t) + \sigma_\eta * \eta_{it+1}$, stating that expectations would be rational if $\delta_0 = 0$ and $\delta_1 = 1$.

Chapter 5

ESTIMATION RESULTS

Results from the regression approach

The augmented Dickey-Fuller test showed stationarity of the CPI data, suggesting j-the integration order of the variable- to be zero. ACF was infinitely damping out, whereas, PACF cut off after 7^{th} lag, thus suggesting pure AR(7) process or ARIMA(7,0,0) (see appendix 1).

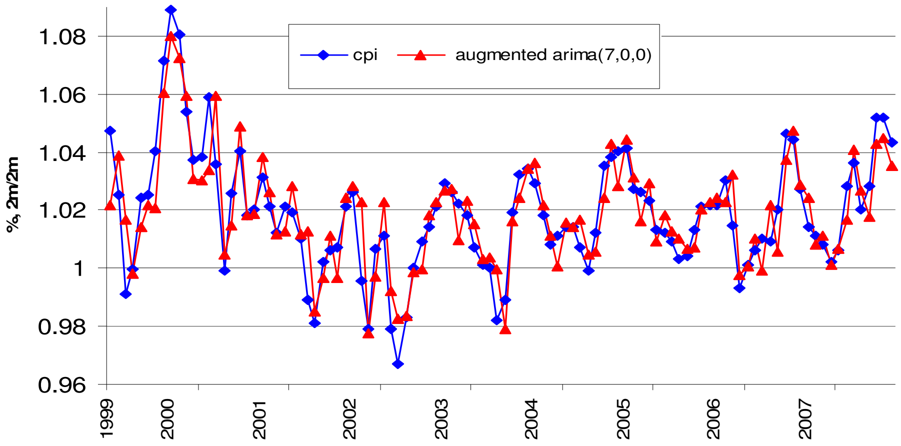
In order to verify that it was the best fitting model, AR(i), i=[1,9], as well as ARMA processes were run. AICC and BIC criteria showed that ARIMA (7,0,0) or AR(7) fitted inflation variable the best (appendix 2).

The next step was to augment the AR(7) forecast model with exogenous variables, having the greatest impact on inflation. Such variables as change of transfers (trans_2m), change of the exchange rate (erate_2m) and change in the world oil prices (oilp_2m) were included into the model. The "varsoc" command of these four variables was run in order to know the appropriate lags number of this variables in the forecast model. The LR, FPE and AIC statistics, received after the "varsoc" command, suggested inclusion of the 4^{th} lag of all 3 variables. However, the variables with such lag numbers, when included into augmented ARIMA model, failed t-test. It seemed that chosen lags of the variables did not explain the inflation. Moreover, coefficient before oil price had the wrong sign, as the depreciation of the national currency is positively related to inflation rate in the country. At the same time, best p-values and right signs were received from 2-lagged change in transfer's amount, current value of the exchange rate change and the first lag of the change in oil prices. Including that lagged exogenous variables into ARIMA model provided the final functional form of inflation:

$$y_t = 0.94 + 1.50 * y_{t-1} - 1.43 * y_{t-2} + 1.46 * y_{t-3} - 1.19 * y_{t-4} + 0.69 * y_{t-5} - 1.52 * y_{t-6} + 0.32 * y_{t-7} + 0.01 * trans\_2m_{t-2} + 0.06 * erate\_2m_t + 0.002 * oilp\_2m_{t-1} + e_t \quad (20)$$

By performing z-test on coefficients of the model, the hypothesis of insignificant transfers and oil price coefficients cannot be rejected (see z-statistics table, appendix 3). This may be explained by not precise data of transfers taken and low influence of the world prices for oil on domestic inflation. The data on per capita transfers, rather than on aggregate transfers, will be advisable to include to the model, as increase in the aggregate transfers might not increase the inflation, because of the increase in the number of people receiving transfers. Meanwhile, the domestic oil prices would better fit the model as Ukraine's consumes react on world prices after their change by the domestic distributors. Both actual and fitted inflation may be seen from the Figure (4):

Figure4. Actual and fitted inflation in 1999-2007



The Figure 4 shows that augmented AR (7) model is successful in describing the actual rate of inflation. Therefore, if to assume that, on average, population forms its expectations rationally, then AR(7) model may be taken as one describing total population expectations. From the methodology, described above, AR(7) will serve as $E(y_t \mid \Gamma_t)$ in the second part of the quantification method.

<u>Maximum Likelihood quantity results</u>

In the search of quantity measures of inflationary expectations the Matlab programming software was used. The Maximum Likelihood function was programmed by hand and consisted of three parts. The first and the second parts described IE and perception functions, while the third one described the AR(7) function of inflation dynamics. As ML function is fully parametric, the first step of the estimation was to define the functional forms of both coefficients and residuals distributions the Likelihood function. As it was suggested by Dahl and Xia, the coefficients of IE and perception functions were non-linear. Also the authors suggested that the residuals of the third part (i.e. the AR(7)) were distributed normally and the model was linear in coefficients.

According to the assumptions of the present paper the residuals of the perception model were distributed normally with zero mean and a finite variance. While the residuals of the IE model were distributed normally with a finite mean and variance. The mean of IE residuals was not assigned zero at once, as the Survey data set suggests that in most of cases respondents expected increase in inflation in the next period. Therefore, the mean value of expected inflation is assumed to be non-zero. Moreover, the mean is expected to be negative, which will seem about overestimation of the inflation increase by individuals. The choice of normality in the present paper was proved by the LR test of the distribution check for the grouped data suggested by Johnston and DiNardo. The LR test did not reject the hypothesis about the normal distribution of the model.

In order to estimate the coefficients maximizing the likelihood function two-step procedure was applied. On the first step the optimization function "fminsearch" was used, which found the optimal coefficients, taking into account the initial values of the coefficients suggested by the programmer. Meanwhile, the initial values of the coefficients $(\beta_1, \delta_1, \delta_2, \sigma_\eta, \sigma_w, \mu_1, \sigma_1, \sigma_2) = (0,0,1,1,1,-1,1,1)$ were taken suggested from the theory and are described next. β_1, as a single threshold value dividing the range between positive and negative answers, was assumed to be zero, as respondents are supposed to think that inflation will go down after its decrease (and not increase) in the past, and to increase after the rise in inflation. The assumption of $\delta_1, \delta_2 = 0{,}1$ comes from the rationality hypothesis, which says that the majority of individual forms their expectations very close to the population expectation. The coefficients before residuals and standard deviations of the distributions are assumed to be around unities, while mean coefficient choice was described above.

On the second step of the estimating procedure the "fminunc" optimization technique was employed. It took the values of the coefficients found in "fminsearch" as initial values and derived the final optimal coefficient values. In addition, the "fminunc" technique allowed finding the Hessian matrix, inversed values of which were standard deviations of the coefficients. Therefore, the statistical significance of the coefficients was found via the "fminunc" technique.

The drawback of the model in context of Ukraine's data is that the number of variables included is quite high comparing to the number of observations (17 vs. 138) leaving degrees of freedom equal to 121. However, as it was described in the methodology, the model is considered to be most improved among the previous findings as it included the components describing both explicitly expressed subjective expectations model and the actual dynamics of inflation.

The estimated coefficients, giving the maximum values of the likelihood function are provided in the table 3 (for the full set of the coefficient see appendix 4):

Table 3. **Estimates of the likelihood function's coefficients from the normal distribution**.

coefficient	Normal value	st.dev.
β	101.83	14.22
δ_0	231.87	31.38
δ_1	-7.15	0.94
μ_1	-4.33	0.07
σ_n	43.65	5.31
σ_w	192.64	31.79
σ_1	2.94	0.08
σ_2	0.43	0.04

The obtained coefficients values should be transformed according to the next function in order to have the meaningful value:

$$y^{*'}_{it+1|t} = \delta_0 / \sigma_\eta + \delta_1 / \sigma_\eta * E(y_{t+1} | \Gamma_t) + \eta_{it+1} \quad (21) \longrightarrow$$

$$y^{*'}_{it+1|t} = 5.31 - 0.16 * E(y_{t+1} | \Gamma_t) + \eta_{it+1} \quad (22)$$

The transformed threshold coefficient $\beta_1 = 2.33$ denoted the average respondents' perception of inflation, in other words, by how much on average the prices grew in the previous two months in the respondent's opinion. If the respondent thought the prices increase by the lower size than 2.3%, then she reported about the price decrease in the next two months; if the respondent thought the price rise was higher than 2.3%, then she replied about the increase in prices growth.

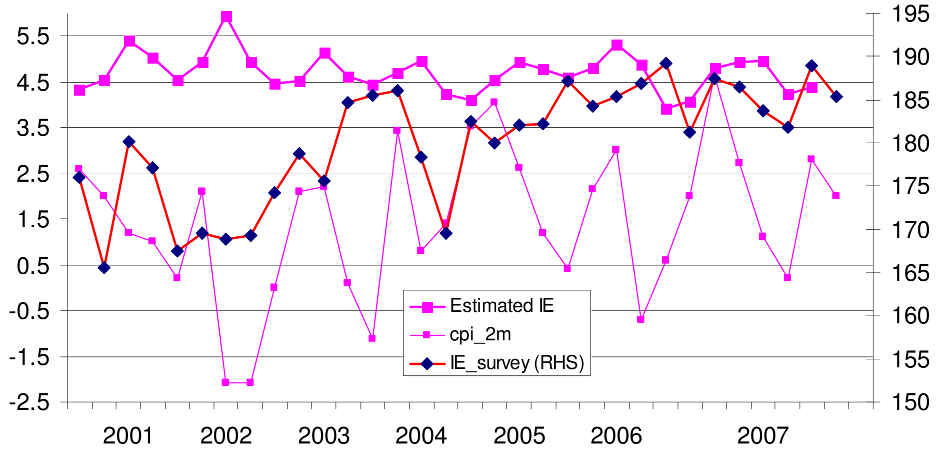
The rationale behind the threshold coefficient β_1 slightly differs from that of Dahl and Xia's. This may be explained by the difference in the Survey question types. In Dahl and Xia three types of responses about the future inflation were possible: ”increase”, “decrease” and “remain the same”. That is why the two threshold values were obtained, which denoted the thresholds for the expectations neutral respondent to change her mind on the inflation dynamics. As it was stated above, the -5.5% change in prices was needed for a respondent to reply about the future price decrease and +4.5% was needed to reply about the future price increase. However, the Gfk Survey considered only two types of responses: the inflation will be “higher” or “lower” than the actual inflation rate. Therefore, it may be concluded that the Ukraine’s threshold value points on the respondent’s perception of the current price rise. Therefore, in the case of Ukraine the respondent should think that prices increased by less than 2.3% in the previous two months (or roughly 1.2% per month) in order to expect the prices to decrease in the next two months. Likewise, if the respondent considers the price rise of higher than 2.3%, then she will expect prices to increase in the next two months.

The coefficients obtained from the Maximum Likelihood estimation are $\delta_1 = 5.31$ and $\delta_2 = -0.16$. Proceeding, the numerical values of inflationary expectations may be found as follows:

$$y^*_{it+1|t} = 5.31 - 0.16 * y^A_{t+1}, \quad (23)$$

where y^A_{t+1} are values of the two-months ahead ARIMA inflation forecast. The negative correlation sign between inflationary expectations, which is significant, may seem about the slight ARIMA’s overestimation of the inflation (as can be seen from the figure 4). The quantity measures of the inflationary expectations may be seen on the figure 5:

Figure 5: **The quantity vs. quality measures of inflationary expectations.**



As it can be seen from the figure 5, inflationary expectations in Ukraine used to overestimate the actual inflation rate and vary in the range between 3.5-5.6% per two months. The estimations of IE are quite approximate, which arises from the slight discrepancy in all three trends in the figure 5. This may be explained by the relatively low number of survey conductions, which were irregular in some periods. Moreover, the Survey questions concerned the two-month's dynamics of inflation. This approximates the estimations, as actual inflation might decrease in one month and than increase in the next month.

After the estimation of the δ_1, δ_2 coefficients it is possible to conduct the likelihood ratio test in order to check the expectations for rationality, i.e. to check the hypothesis of $\delta_1, \delta_2 = 0, \sigma_\eta$ ($\delta_2 = \sigma_\eta$ in order to $\delta_2^* = 1$ in quantification equation (18). The likelihood ratio test was also programmed in Matlab. The value of unrestricted likelihood function was obtained via plugging the estimated coefficients into it. Restricted likelihood, in its turn, was calculated with $\delta_1, \delta_2 = 0, \sigma_\eta$, remaining the rest of the coefficients same as in the unrestricted function. Resulting likelihood ratio value was equal to 17,539, which seems that at 99% confidence interval the hypothesis of $\delta_1, \delta_2 = 0, \sigma_\eta$ or rational expectations hypothesis can be rejected. So, it may be concluded from the LR test that inflationary expectations in Ukraine are not rational. The results may be explained by high inflation dominated in most of the years of the survey conduction. Therefore, while thinking of relatively adequate (to the real) current inflation rate the respondents expected on average the increase in inflation over this rate in the next period.

CONCLUSIONS AND POLICY IMPLICATIONS

The value of the present paper is that it tried to estimate the intangible item of inflationary expectations, which is supposed to play important role in the economy of Ukraine not only by the author, but also by recognized world community. Also the paper was one of the first IE investigations, which tried to find the numerical measures and provide some of the characteristics of the inflationary expectations in Ukraine.

It was found in the paper that IE in Ukraine are not rational and used to overestimate the current inflation rate. Namely, the threshold value from the survey, which is expected to be zero in rational expectations economy, turned out to be 2.3% in Ukraine. This suggests that on average the individuals think that prices increased in the previous two months by 2.3%. The conclusion is not similar to that of Dahl and Xia for United Kingdom, however, explains the high inflationary state of Ukraine's economy in 2000-2007.

It was also found out that quantity measures of the inflationary expectations were varying in the range of 3.5-5.6% per two months and roughly followed the trend of the quality measures of inflationary expectations. However, inflationary expectations failed to follow the actual inflation trend precisely. This may be concluded form the irrationality of IE, which was shown by the Likelihood Ratio test.

Also the innovation of the present paper was that it modified the whole estimation procedure to the panel data set in order to minimize the losses from the small time series set. While all the previous estimations were based on relatively rich time series survey data. In addition, unlike to the previous works, the testing on the appropriate distribution of the residuals was done in the paper.

The significance of the paper in the real world is that having the numerical measures of inflationary expectations it is possible to discover their impact on the actual inflation in the economy. In particular, having the richer data set, which is privately, but not publicly, available, the VAR IE-inflation model may be constructed. In such a way found contribution of the IE to inflation growth comparing to all other factors, will enable the following:

1) The first is that, IE-inflation relations will enable to regulate the inflation via the impact on the inflationary expectations, which is extremely important in the countries with inflation targeting. Moreover, the closer Ukraine is to inflation targeting, the greater weight will be thus devoted to inflationary expectations exploration;
2) The second point is that usually IE were considered to be in the residuals of any model describing inflation. After the exploration of IE-inflation relations, it may be possible to make such models more precise and to make more effective forecasts of inflation. This especially concerns the inflation forecasts made by the government in the Budget estimation.

As the main drawback of the present model is relatively small available data set, the further improvements may be done using the IE data based on the individual responses.

Additionally, in the case of the richer data set the VAR IE-CPI model may be run in order to see the mutual impact of IE on inflation and of inflation on IE. While the impact of inflation on the IE may be calculated by hands using transformation of CPI into estimated ARIMA process and then find CPI impact on IE via the IE regression coefficients, the VAR model will enable to find the inverse relations between IE and inflation. Moreover, the VAR model, if applied, may separate the mutual impact of both variables in different periods and is supposed to be done by the author.

Also in the case when individual data on the Large Purchase index is available from the Survey, it may be possible to discover the impact of inflationary expectations on the decision to convert someone's monetary assets into the real commodities. Hence, knowing the impact of inflation on the IE (from the VAR model) and the impact of IE on the large purchase making the inflation impact on the future consumer demand may be estimated. The latter relations will approximately describe the 'inflation spiral" potential in Ukraine.

Finally, the present paper gives the start for the future inflationary expectations exploration, which will become of great importance in the nearest one-two years in Ukraine and will be continued by the author.

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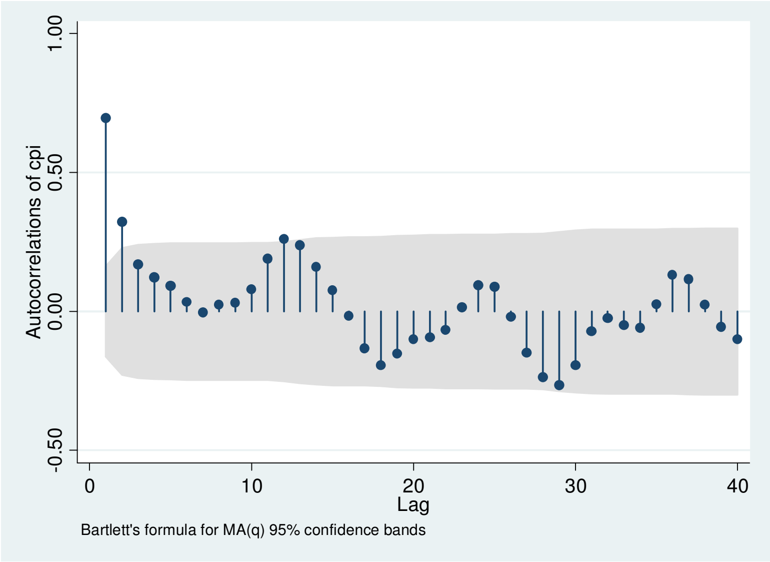
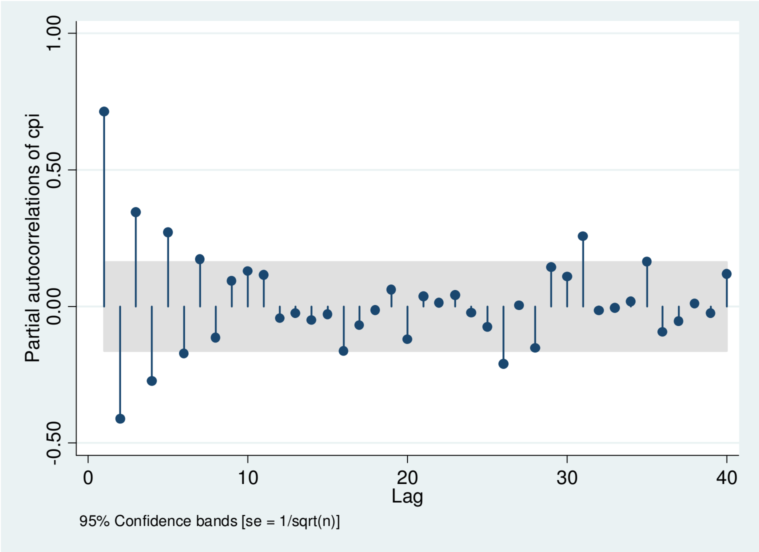
APPENDIX

1. ACF and PACF of CPI

ACF



PACF



2. Comparison of autoregressive functions of different orders

	Model Selection Criteria	
Model	AICC	BIC
ARIMA(1,0,0)	-780.98	-772.04
ARIMA(2,0,0)	-807.87	-795.95
ARIMA(3,0,0)	-826.06	-811.18
ARIMA(4,0,0)	-836.47	-818.61
ARIMA(5,0,0)	-846.72	-825.88
ARIMA(6,0,0)	-849.64	-825.82
ARIMA(7,0,0)	**-853.01**	**-856.22**
ARIMA(8,0,0)	-853.09	-823.32
ARIMA(9,0,0)	-852.8	-820.05
ARIMA(7,0,1)	-857.15	-827.38

3. Z-statistics and p-values of the variables from the AR(7), model

Variable	z-statistics	p-value
l2.trans-2m	1.27	0.206
e-rate_2m	1.97	0.048
l.oilp_2m	0.28	0.776
l.y	13.87	0.000
l2.y	-6.65	0.000
l3.y	5.57	0.000
l4.y	-4.27	0.000
l5.y	2.60	0.009
l6.y	-2.63	0.008
l7.y	3.08	0.002
const	27.89	0.000

4. Coefficients obtained from the Maximum likelihood estimation (full set)

Coefficient	value	st.dev.	Coefficient	value	st.dev.
β	101.83	14.22	Z1	1.03	1.17
δ_0	231.87	31.38	Z2	-0.10	0.51
δ_1	-7.15	0.94	Z3	-0.03	0.50
μ_1	-4.33	0.07	Z4	0.86	0.42
σ_n	43.65	5.31	Z5	0.12	0.41
σ_w	192.64	31.79	Z6	0.11	0.39
σ_1	2.94	0.08	Z7	-0.32	0.41
σ_2	0.43	0.04	Z8	0.49	0.39
σ_u	7.60	2.92			

** Z-coefficients of the AR(7) model estimated via Maximum likelihood. Most of them are not significant as data set was takes not on 2 months basis, but in periods, when survey was conducted (once a quarter).*