NBKR Working Paper

Inflation expectations and methods of their study: theoretical and empirical approaches

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Inflation expectations and methods of their study: theoretical and empirical approaches

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The views and conclusions in this Working Paper are those of the author(s) and do not necessarily represent those of the NBKR. The aim of this paper is to provide information to the public and further discuss the results of studies carried out by the National Bank of the Kyrgyz Republic.

Abstract

The paper presents theoretical materials and methods for measuring inflation expectations in the Kyrgyz Republic. The level of inflation expectations is calculated on the basis of preliminary survey carried out among the NBKR experts and staff. The empirical part of this paper is based on the studies carried out by the staff of the National Bank of Poland, as well as the experience of the staff of the National Bank of the Kyrgyz Republic.

Key words: adaptive inflation expectations, rational inflation expectations, survey.

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Introduction

In 2007-2008, rapid rise in prices in the Kyrgyz Republic due to external shocks attracted interest for further detailed study of expectations and forecasts for price behavior by economic agents in the domestic market. In the world practice, inflation expectations are assessed by the central banks and private companies. Study of inflation expectations will allow measuring the confidence level of economic agents in the monetary policy conducted by the central bank and adjusting the level for inflation forecasting.

Inflation expectations play significant role in formation of inflation climate in the economy, which should be taken into account in conducting monetary policy. Survey is among the most popular methods of inflation expectations monitoring.

I. Theoretical aspects and necessity to measure inflation expectations

Particular strategy, which comprises such term as “inflation expectations”, is currently used for forecasting the level of future inflation. Importance of inflation expectations consists in effect, which each economic agent has on the market. Such effect can be reflected both directly and indirectly. For example, monopoly – large company – can increase the value of its production by means of conducting its pricing policy, which has slight effect on the market.

The term “inflation expectations” can be considered as economic category, which reflects sustainable expectations of the consumers about further increase of overall price level in the economy. Sustainable expectations result from rise in prices for goods and services. Moreover, in case of price reduction, its primary level can not be achieved. If such cycles occur at certain intervals, the economic agents tend to think about upward dynamics in future prices. Rise in prices for goods and services make agents and trade unions demand increase in the nominal wage, which contributes to expansion of existing consumer demand. Manufacturers establish progressively high prices for their products, expecting that soon raw materials and accessory items will become more expensive.

There are two main theories of inflation expectations:

– the theory of adaptive inflation expectations;

– the theory of rational inflation expectations.

The first theory is based on forecasts of economic trends made by participants of commodity-money relations derived from the results of the previous period. Economic agent supposes that the price is strongly correlated with historical values. Such process can be observed based on the following example. The enterprise is developing the budget or determining the pricing policy for the year ahead. The indicators of the previous years are the

basic values, which the enterprise will rely upon. The enterprise supposes that the growth rate of economic indicators and indicators of economic activity remain at the same level; meanwhile, possible shocks are additionally taken into account. In other words, in case of rise in prices in the last year, the enterprises and their employees traditionally expect rise in prices in the current year. Therefore, the enterprises increase their prices beforehand in order not to be left behind in the inflation rush. Meanwhile, the employees demand to increase their wage, in order to avoid reduction in their actual incomes due to rise in prices. As a result, inflation expectations become a reality: the prices actually rise. Thus, adaptive inflation expectations is forecasting of the future price change based on the data of the previous periods.

Introduction of the term "adaptive inflation expectations" resulted in measuring this indicator in a quantitative way. One of the first theories belongs to Cagan.[2] Cagan developed the model, in which expectations (future value of the indicator) were calculated by means of lag, i.e. on the basis of the previous price level.

Thus, the theory of rational inflation expectations stipulates more complex process of expectations formation, as the economic agent should take into account all available data about measures taken by the financial and regulatory institutions, as well as measures to be taken, besides previous trends of the indicator.

Generally, the following approaches for determining inflation expectations are used:

– surveys;

– calculations according to the data of the previous periods.

II. Analysis of the theory and methods of measuring inflation expectations

During analysis of the data received in the course of conducted survey, it is necessary to single out more qualitative data. World practice indicates that the surveys of businessmen are characterized by significant forward-looking ability and less amount of biases as compared to the surveys of ordinary consumers and households. This statement is proved in the paper by Satish Ranchhod.[3] This occurs because businessmen deal with macroeconomic indicators more often due to the peculiarity of their activity; therefore they try to forecast these indicators, including the level of inflation. Ordinary consumers' expectations are close to everyday life, and in many cases inflation for a consumer is generally rise in prices for frequently purchased goods. The aforementioned facts result in unfair assessment of the future inflation.

[2] Cagan P. Inflation and Market Structure, Explorations in Economic Research, Vol. 2, 1956, p. 236.

[3] Ranchhod S. The relationship between inflation expectations survey data and inflation, Reserve Bank of New Zealand, 2003, p. 65.

Earlier working papers devoted to inflation expectations described *simple or static expectations,* which supposed that inflation in the future period *t* is equal to the previous value of inflation rate with the period (lag) *t-1*. Mathematically it can be presented by the following formula:[4]

$$\pi_t^e = \pi_{t-1}$$

where, π_t^e – expected inflation value, π_{t-1} – previous value of inflation with a lag, which is equal to 1 period.

The theory of *adaptive inflation expectations* was found in the paper written by I. Fisher in the 30s of the XX century. It was later modified by Cagan (1956), Fridman (1957) and based upon the following formula in determining the expected price level:

$$\pi_t^e = \pi_{t-1}^e + \lambda(\pi_{t-1} - \pi_{t-1}^e)$$

Adaptive inflation expectations can be expressed by the following formula:

$$\pi_t^e = \lambda \sum_{i=0}^{\infty} (1-\lambda)^i \, p_{t-1-i} \,,$$

Adaptive expectations plaid a dominant role in the macroeconomics in the 60-70s of the XX century in correlation with the Phillips curve. It was found out later that adaptive expectations does not reflect completely perfect forecast.

Therefore, development of the theory of rational inflation expectations was initiated. This theory stipulates more exact forecasting of the future inflation. According to the theory of rational inflation expectations, the economic agents are provided with all necessary information for assessment of future price change and use the following formula by adding endogenous and exogenous factors:

future inflation = current inflation + shocks (assessments of economic agents)

or

[4] George W. Evans & Seppo Honkapohja: Learning and Expectations in Microeconomics, Princeton University Press, 2001, p. 23.

$$\pi^{e}_{t+1} = E_t \pi_{t+1},$$

where $E_t \pi_{t+1}$ means expectations of future inflation conditioned by information provided to the consumers in period *t*.

The following formula is also used:

$$\pi^{e}_{t} = E_{t-1} \pi_{t},$$

where $E_{t-1} \pi_t$ means mathematical (statistical) expectation of current inflation π_t conditioned by the variables observed in the previous *t-1* (including previous data).

Sociological approach should be used in order to determine rational inflation expectations. It can be used both independently and with mathematical approaches. In the world practice, sociological approach was implemented by means of surveys. For example, assessment of inflation expectations in New Zealand is based on five surveys. The first three surveys are based on expectations of businessmen and professional economists:

- Surveys conducted in the Reserve Bank of New Zealand – quarterly interviews with the Chairmen and influential representatives of the bank. It includes approximately 200 respondents;
- Surveys of economists – quarterly interviews with 15 chief economists of the private companies and financial institutions;
- Surveys conducted in the National Bank of New Zealand – monthly interviews of approximately 1500 employees of the National Bank.

Moreover, two more surveys are based on the consumers' expectations:

- Surveys conducted in the markets – correspondents of the National Bank interview on a quarterly basis 1000 random chosen households;
- Survey conducted with separate persons is a telephone interviews with 1500 random chosen house-owners on quarterly basis.

All surveys are based on revealing expectations of annual inflation.

For this purpose 1 thousand of respondents are interviewed by means of special questionnaire on monthly or quarterly basis, i.e. respondents are not provided with exact quantitative variant of responses concerning the future inflation indicator. The respondents are asked general questions.

The questions about current inflation level should be involved in the questionnaires of our country in order to study the level of people awareness on this issue.

The Phillips curve and its modifications are also used in modern practice in order to obtain quantitative indicator of inflation expectations. The initial Phillips[5] theory reflected the ratio of cost-push inflation and the level of unemployment in Great Britain. Afterwards, a new Phillips[6] curve was built, which graphically reflected dependence of the unemployment level on the inflation rate. Herewith, inverse dependence of the level of unemployment on the inflation rate was presumed. In other words, according to this theory high inflation rate can condition low level of unemployment. However, in 1970, during stagflation, i.e. high level of unemployment and inflation rate, this theory became useless and was subjected to widespread criticism. Such situation resulted in statement that high inflation rate decreases the level of unemployment only in the short-term period. Afterwards, in the long-term period, this effect is neutralized by means of inflation expectations formed in the previous periods and the Phillips curve becomes vertical.

The following formula describes the Phillips curve:

$$\pi_t = \beta E_{t-1}\{\pi_t\} + \lambda Y_t^c$$

where, π_t – inflation rate, E – expectations operator and Y_t^c – economic cycle indicator (the cycle, in which economy is located).

This formula demonstrates the rate of current inflation on the traditional Phillips curve; business cycle and inflation expectations formed in the previous periods have their effect on this inflation. In the long-term period, economy returns to its potential level of development and shows that inflation expectations are not constantly biased (i.e. their variance is normally distributed), in the long-term period β =1 and the Phillips curve is vertical.

It should be noted that economic agents should be provided with information about change of the existing economic regime: whether these are economic shocks, ecological disasters or political regime change. And all aforementioned facts are sure to have effect on the expectations of consumers, producers of goods, works and services. In order to evaluate hypothesis with reference to the domestic economy it is necessary to assess quantitatively the effect of the regime change by means of model development.

[5] Phillips, Alban William. The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom. Economica, vol. 25, № 100, 1958, pp 230-263.
[6] Aleksejs Melihovs, Anna Zasova, Estimation of the Phillips Curve for Latvia, Latvijas Bank, 2007, pp 15-20.

The approach applying interval-coded data[7] should be emphasized. The questionnaire comprises samples of responses with exact figures. For example, the following samples of responses are given to the question about inflation expectations:

1. prices will fall by 5 percent and more;
2. prices will fall by 2 percent and more, but not more than by 5 percent;
3. prices will fall by not less than by 2 percent;
4. prices will stay at their present level (0 percent);
5. prices will rise by not more than by 2 percent;
6. prices will rise by 2 percent, but not more than by 5 percent;
7. prices will rise by 5 percent and more.

Measuring of inflation expectations occurs according to the similar procedure represented in Appendix, i.e. by means of using normal probability law $N(0; 1)$ and its functions:

$$F_N(x) = \frac{1}{2} + \frac{1}{2}\Phi\left(\frac{x-a}{\sigma}\right), \text{ where } \Phi(x) = \frac{2}{\sqrt{2\pi}}\int_0^x e^{-\frac{t^2}{2}}dt$$

– Rational or adaptive inflation expectations.

In order to determine rationality of inflation expectations, they should be unbiased and efficient for inflation forecasting. It is so called rational expectations hypothesis (REH). In other words, actual inflation rate should be equal to expected inflation rate plus errors of the periods. Formally, the following dependence should exist between actual and expected inflation:

$$\pi_{t-n}^{ad} \equiv \alpha + \beta\pi_t + u_t, \text{ where}$$

π_t – inflation rate in period *t*,

π_{t-n}^{ad} – inflation expectations in period *t*, formed in period *t-1*,

u_t – white noise errors,

α, β – parameters.

REH states that, on the one part, expectations are unbiased, i.e. α, β = (0.1), and, on the other part, they are efficient as well: i.e. u_t residuals are not autocorrelated (co-variation of residuals is not equal to zero), or correlates with other data of economic agents. Detailed description of determining unbiasedness of expectations is given in the paper by Engsted and

[7] Yasutomo Murasawa, Measuring Inflation Expectations Using, Interval-Coded Data, Economic and Social Research Institute, 2010, p 29.

Paquet [8], where expectations and actual inflation rate were tested, which differed stationary in the specified period. These authors came to the conclusion that in such circumstances the data on inflation expectations and actual inflation rate should be tested for co-integration: if expectations are rational, the result of testing should reflect sustainable difference among indicators of actual and expected inflation rates. Secondly, testing for unbiasedness stipulates that the data are co-integrated, i.e. co-integration vector has no constant value and this stationary (invariable) combination comprises equal and opposite coefficient of expected and actual inflation rate.

Method of rational expectations assessment on the basis of the data obtained during the survey stipulated development of the model involving significance of the percentage of respondents, who selected one variant of response out of offered ones.

$$\pi^{r}_{t+n} = \pi^{f}_{t} + \beta_1 A + \beta_2 B + \beta_3 C + \beta_4 D + \beta_5 E + \varepsilon_t, \text{ where}$$

A – percentage of respondents expecting prices to rise faster,

B – percentage of respondents expecting prices to rise at the same rate,

C – percentage of respondents expecting prices to rise more slowly,

D – percentage of respondents not expecting prices to stay at their present level,

E – percentage of respondents expecting prices to go down,

π^{r}_{t+n} – level of rational inflation expectations,

π^{f}_{t} – actual inflation rate,

β_n – coefficient preceding a variable,

ε_t – standard error.

In order to use this model it is necessary to form a set of data based on the data obtained during the survey.

III. Calculation of inflation expectations in the Kyrgyz Republic

Methods developed for measuring inflation expectations suggests using actual inflation rate as a basis for calculations. Moreover, the general level of inflation expectations should be determined by means of the following formula:

$$\pi^{ex}_{t+n} = \pi^{ad}_{t} + \pi^{r}_{t}, \text{ where}$$

π^{ex}_{t+n} – level of inflation expectations,

[8] Hasan Bakhshi, Anthony Yates, Are UK inflation expectations rational? Bank of England, 1998, p 39.

π_t^{ad} – adaptive inflation expectations,

π_t^r – rational inflation expectations.

Currently, the NBKR makes assessment of inflation expectations according to methods of adaptive inflation expectations, i.e. $\pi_t^e = \pi_{t-1}$.

Economic model for assessment of domestic inflation expectations was built by using theoretical and practical materials on inflation and inflation expectations. The results of modeling reflect impact made by the previous inflation values (adaptive inflation expectations) with lag of 4 months (Fig. 1.), which is conditioned by poor awareness of the population.

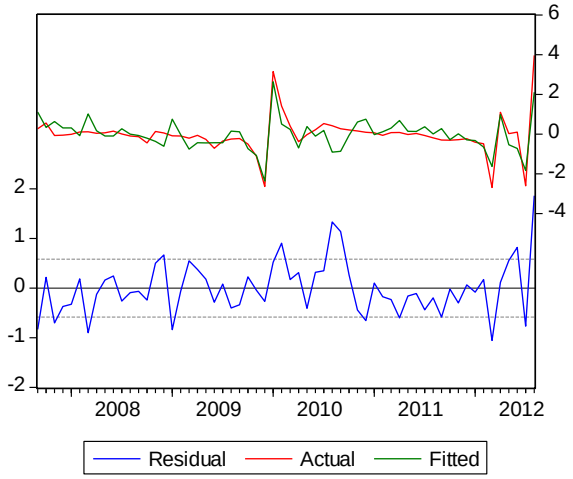
According to preliminary data, out of 1 percent of inflation 0.32 percentage points are attributed to adaptive inflation expectations. Therefore, more exact quantitative measure of expectations can diminish difference between forecasted and actual inflation rate.

Figure 1. Results of model specification.[9]

Dependent Variable: DLOG(ABS(CPI))
Method: Least Squares
Date: 12/10/12 Time: 08:57
Sample (adjusted): 2007M09 2012M08
Included observations: 60 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(ABS(DB(-4)))	0,69	0,24	2,84	0,01
DLOG(ABS(WHEAT_S(-7)))	0,22	0,06	3,72	0,00
DLOG(ABS(USD(-6)))	0,20	0,11	1,80	0,08
DLOG(ABS(URL_S(-2)))	0,51	0,10	5,32	0,00
DLOG(ABS(PIM(-2)))	0,37	0,22	1,70	0,10
DLOG(ABS(TRANS(-8)))	0,37	0,16	2,38	0,02
DLOG(ABS(CPI(-4)))	0,32	0,11	2,85	0,01
C	-0,04	0,08	-0,56	0,58

R-squared	0,68	Mean dependent var	-0,03
Adjusted R-squared	0,63	S.D. dependent var	0,96
S.E. of regression	0,58	Akaike info criterion	1,88
Sum squared resid	17,62	Schwarz criterion	2,16
Log likelihood	-48,38	F-statistic	15,59
Durbin-Watson stat	1,62	Prob(F-statistic)	0,00



Note: DB – monetary base, WHEAT_S – price for wheat in the world market in the national currency, USD – KGS/USD exchange rate, URL_S – price for oil in the world market in the national currency, PIM – consumer import, TRANS – remittances of migrant workers, CPI – inflationary inertia. Period (lag) of influence is given in brackets.

It is necessary to conduct surveys and form the base of the results of surveys carried out during several years in order to determine the level of rational inflation expectations. Therefore, due to lack of the data for analysis it will be difficult to determine the rational inflation expectations at the initial stage.

[9] Set of data for the period since January 2004 till August 2012 is used to build this model. If the reviewed period is changed, lag values are likely to alter correspondingly.

Herewith, preliminary calculations of the level of rational inflation expectations can be made on the basis of data received in the course of experimental interviews of the experts of the Scientific and Expert Council (SEC) and the employees of the Economic Department of the NBKR for the purposes of revealing the opinions about the further dynamics of inflation rate.

Generally, theoretical investigations and fulfilled calculations indicated that the level of inflation expectations based on the results of October, 2013 constituted 4.2 percent, thereof rational expectations of experts made 4.4 percentage point, general adaptive expectations – (-0.2) percentage points.

It is necessary to extent the range of selected respondents (simultaneously develop and adapt this methods for the domestic economy) in order to obtain more complete picture. Surveys can be conducted directly on the web-site of the NBKR or on the web-sites of the news agencies (AKI-press, 24.kg). International practice reflects obtaining efficient results after involvement of independent sociological agents for implementations of such works.

Conclusion

In fact, behavior and expectations of economic agents should be assessed in order to improve the quality of inflation processes analysis in the country and introduce generally acknowledged mechanisms of the monetary policy, such as inflation targeting. More deep analysis of consumer expectations is possible to carry out on the basis of responses given by the consumers in the course of survey. Thus, data collection on the basis of answers to the questions contained in the questionnaires is the key objective at the initial stage of measuring inflation expectations of consumers.

The nature and structure of inflation expectations will allow influencing consumer behavior in order to regulate inflation pressure.

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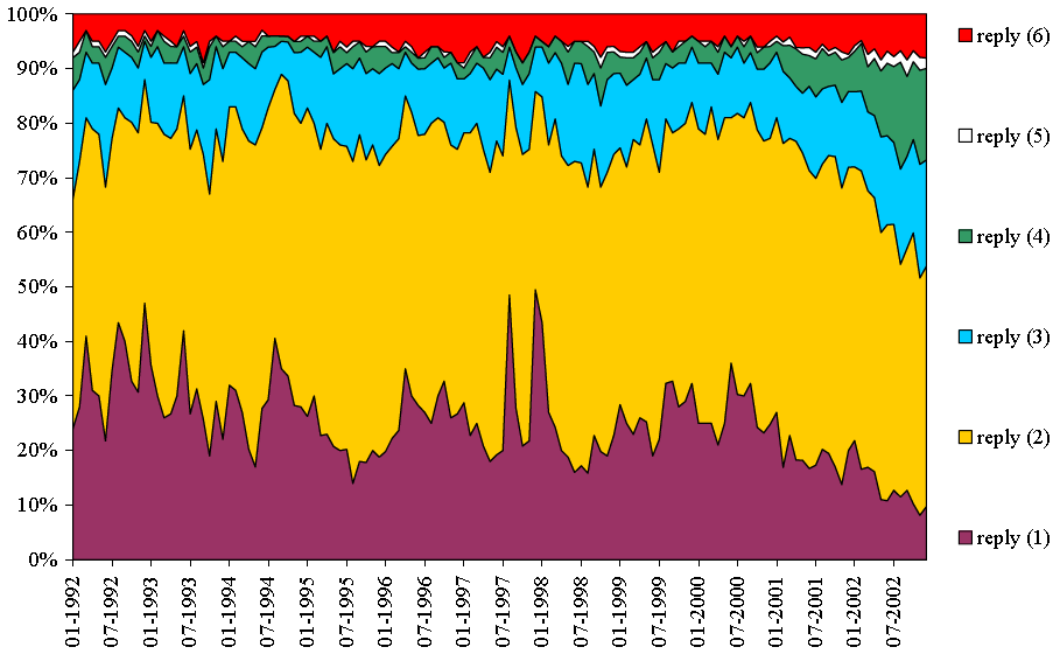
Appendix

Measuring consumer inflation expectations on the basis of work carried out by the specialists of the National Bank of Poland. [10]

1.1. Survey of the National Bank of Poland (NBP) and analysis of obtained data

Quantitative data of the NBP survey are used to derive quantitative measures of consumer expectations. Survey is conducted on monthly basis, when approximately 1000 respondents are interviewed. The survey question concerning inflation expectations is designed in a qualitative way, i.e. the respondents do not give precise quantitative answers regarding future inflation, but rather declare the expected direction and magnitude of change in prices, comparing their predictions against the price movements currently observed. They respond to the following question: *"Given what is currently happening, do you believe that over the next 12 months prices will: (1) rise faster that at present, (2) rise at the same level, (3) rise more slowly, (4) stay at their present level, (5) go down, (6) difficult to say."* The results of surveys for 1992-2002 are presented in Figure 1 below.

Figure 1. Response patterns of the NBP survey conducted for assessment of inflation expectations, 1992-2002



Source: Data obtained as a result of the survey conducted by the NBP

Analysis of the Figure presented above reveals the following two tendencies: firstly, a decrease in the proportion of respondents declaring that prices will rise faster (since 1992 till 2000, decrease constituted approximately 7 percentage points) and an increase in the proportion believing that prices will rise at the same rate (increase approximately by 9 percentage points). The percentage of other answers was rather steady, with the scale of changes observed making it difficult to distinguish any clear tendencies. In 2001 and 2002, overall change in consumer expectations was observed due to increase in the share of answers about preserving the same level of prices. Moreover, there was decrease in the number of respondents expecting prices to

[10] Lyziak, T., 2003, *Consumer Inflation Expectations in Poland*, Working Paper No. 287 (Frankfurt: European Central Bank).

rise faster. Thus, replacement of pessimistic views, which dominated in the previous years, by optimistic mood is clearly observed.

1.2. Probability approach to quantification of the future inflation expectations

The probability method was first employed by Theil in order to derive quantitative measures of inflation expectations which could represent an alternative to simple "balance statistics". "Balance statistics" was defined as the difference between the percentage of respondents reporting an increase in prices and the percentage of respondents reporting a decrease. Theil's method and also its further implementation by Knubl, Carlson and Parkin, and more recently by Taylor, refers to surveys in which respondent are questioned as to whether prices are expected to "go up", "stay the same" or "go down".

There are two central assumptions in probability methods. Firstly, each individual is supposed to have a probability function over the expected price change. This may vary by individual and over time, but it determines the responses to the survey question. Secondly, it is assumed that, if the expected price falls within a certain interval centered around zero (−s, +s), the respondent will report that prices are going to stay the same. This interval is termed the "sensibility interval" or "indifference interval."

If the data of the survey contain more response categories, it is necessary to adjust the quantitative procedure, as in Berk or Forsells and Kenny. Two probability methods, as proposed by Łyziak, are presented in this section. The first, i.e., the adjusted Carlson and Parkin method, assumes that, if the number of respondents is sufficiently large, the expected rate of price change is normally distributed, while the second treats this distribution as uniform.

1.2.1. Normal distribution – adjusted Carlson and Parkin method

In the following parts of this paper, the following notions are applied:
a – percentage of respondents expecting prices to rise faster;
b – percentage of respondents expecting prices to rise at the same rate;
c – percentage of respondents expecting prices to rise more slowly;
d – percentage of respondents expecting prices to stay at the same level;
e – percentage of respondents expecting prices to go down;
π^{e}_{+12} – expected rate of price change over the next 12 months in the population, assumed to be normally distributed with unknown parameters m, σ^2;
π_0 – perceived rate of price change over the previous 12 months;
f – density function of expected rate of inflation;
F – distribution function of expected rate of inflation;
Nz – cumulative standardized normal distribution function.

The number of qualitative responses makes use of the fact that, in replying to the survey question regarding inflation expectations, respondent compare their predictions with the rate of the current price change. Indeed, two replies – that price will rise at the same rate or stay at their present level – are in fact quantitative in nature.

A proxy for the perceived rate of price change used in this paper is the current rate of inflation, i.e. the most recent inflation rate available to respondents when answering the survey questions regarding future prices.[11] Alternatively the perceived rate of inflation might be derived on the basis of survey question pertaining to price development in the past 12 months (Berk, Forsells and Kenny), but the lack of such a question within the Ipsos-Demoskop consumer survey constrains the implementation of this approach.

[11] The survey in carried out at the beginning of each month, i.e. prior to the official release of the data on the previous month's inflation rate.

Probability methods presume that the respondents reporting that prices will rise at the same rate include agents whose expectations fall within a sensibility interval centered on the current rate on inflation: *(π_0 -s; π_0 +s)*. For example, if the current inflation rate is 2 percent, one might expect that the respondents who declare that the prices will rise at the same rate are composed of agents who predict that, over the next 12 moths, the rate of inflation will be 2 percent, but also individuals who think that future inflation will differ insignificantly from 2 percent (1.8 percent, 2.1 percent).

It may be expected that the length of the sensibility interval is contingent on the current rate of inflation. Batchelor argues that the theory of signal detection, suggesting that perceptual thresholds depend systematically on the level and noisiness of inflation. This theory finds support in the survey data from eight European countries.

Another sensibility interval applies to respondents reporting that prices will stay at their present level, i.e. the rate of price change over the next 12 months will amount to 0. It is assumed that this reply will be chosen by individuals expecting the inflation rate 12 months ahead to fall within an interval centered on zero: (-t; +t).

Contrary to the primary version of the Carlson and Parkin method where only one sensibility interval was considered and it was necessary to fix its length on an *ad hoc* basis, the adjusted quantification procedure makes the variables *s* and *t*, determining the length of indifference intervals, fully endogenous. Due to the broader scope of information contained in the Ipsos-Demoskop survey, the only assumption that must be made with regard to the adjusted Carlson and Parkin approach refers to the type of distribution of the expected rate of inflation.

Figure 2. Adjusted Carlson and Parkin method

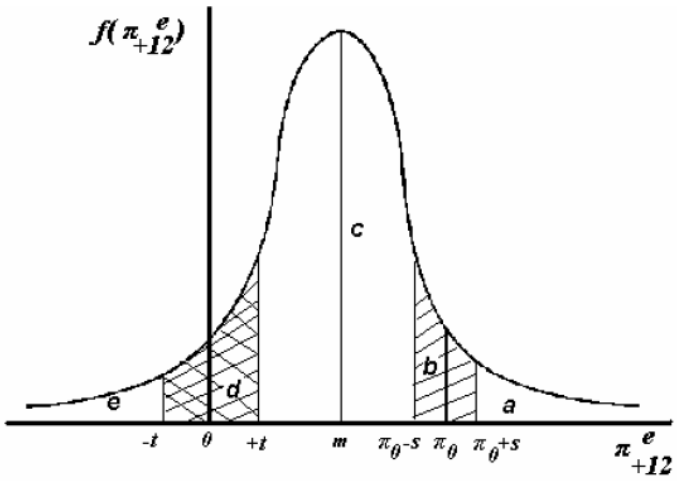


Figure 2 gives a graphical presentation of the adjusted Carlson and Parkin method, as tailored to the Ipsos-Demoskop survey. The quantitative method may be expressed algebraically in the following equations:

[1] $a = P(\pi^e_{+12} > \pi_0 + s) = 1 - F(\pi_0 + s)$

[2] $b = P(\pi_0 - s < \pi^e_{+12} < \pi_0 + s) = F(\pi_0 + s) - F(\pi_0 - s)$

[3] $c = P(t < \pi^e_{+12} < \pi_0 - s) = F(\pi_0 - s) - F(t)$

[4] $d = P(-t < \pi^e_{+12} < t) = F(t) - F(-t)$

[5] $e = P(\pi^e_{+12} < -t) = F(-t)$

The equations [1] – [5] may be rearranged using the formula [6] of the normal standardization:

[6] $F(k) = Nz\left(\frac{k-m}{\sigma}\right)$

where m is unknown mean of the expected inflation rate, and σ denotes its standard deviation. With this transformation, the system may be rewritten as follows:

[7] $a = 1 - Nz\left(\frac{\pi_0 + s - m}{\sigma}\right)$

[8] $b = Nz\left(\frac{\pi_0 + s - m}{\sigma}\right) - Nz\left(\frac{\pi_0 - s - m}{\sigma}\right)$

[9] $c = Nz\left(\frac{\pi_0 - s - m}{\sigma}\right) - Nz\left(\frac{t - m}{\sigma}\right)$

[10] $d = Nz\left(\frac{t - m}{\sigma}\right) - Nz\left(\frac{-t - m}{\sigma}\right)$

[11] $e = Nz\left(\frac{-t - m}{\sigma}\right)$

There are four dependant variables in the aforementioned equations, namely, m (mean of the expected rate of price change), σ (standard deviation), as well as s and t (parameters determining the length of sensibility interval). The explanatory variables comprise: *a, b, c, d, e* (fractions of respondents choosing different responses to the survey question) and π_0 (current rate of inflation). After resolving the equations [7] – [11], the following results are obtained:

[12] $m = \frac{\pi_0 \cdot (C + D)}{C + D - (A + B)}$

[13] $\sigma = \frac{-2 \cdot \pi_0}{C + D - (A + B)}$

[14] $s = \frac{\pi_0 \cdot (B - A)}{D + C - (A + B)}$

[15] $t = \frac{\pi_0 \cdot (D - C)}{C + D - (A + B)}$

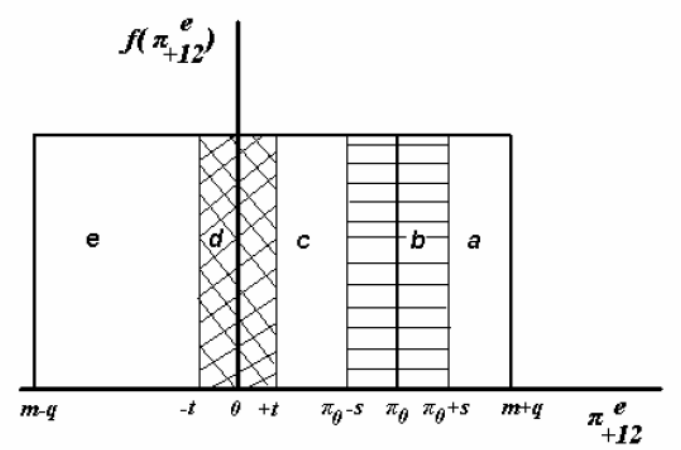
where, $A = Nz^{-1}(1-a)$, $B = Nz^{-1}(1-a-b)$, $C = Nz^{-1}(1-a-b-c)$, $D = Nz^{-1}(e)$.

The equation [12] defines the mean of the expected rate of inflation.

1.2.2. Uniform distribution – adjusted method

Similarly, the primary version of the uniform distribution method, designed for surveys containing three decisive responses to the question regarding inflation expectations, may be adjusted to the Ipsos-Demoskop survey question. As shown in Figure 3, it is assumed that the expected rate of inflation is uniformly distributed and falls within an interval *(m-q, m+q)*.

Figure 3. Adjusted uniform distribution method



On the basis of the assumptions depicted above, the following equations may be recorded:

[16] $a = \frac{1}{2q} \cdot m + q - \pi_0 - s$

[17] $b = \frac{s}{q}$

[18] $c = \frac{1}{2q} \cdot (\pi_0 - s - t)$

[19] $d = \frac{t}{q}$

[20] $e = \frac{1}{2q} \cdot (-t - m + q)$

In equations [16] – [20], the set of dependant variables comprises *m* (mean of the expected rate of price change), *q* (half of the range between the minimum and maximum expected inflation) and also *s* and *t* (sensibility intervals). There are six explanatory variables, *a, b, c, d, e* (fractions of respondents choosing the respective replies to the survey question) and π_0 (current rate of inflation). The solution of equations [16] – [20] may be expressed as:

[21] $s = \frac{b \cdot \pi_0}{2c + b + d}$

[22] $q = \frac{\pi_0}{2c + b + d}$

[23] $t = \frac{d \cdot \pi_0}{2c + b + d}$

[24] $m = \frac{\pi_0 \cdot (1 - d - 2e)}{2c + b + d}$

The equation [24] defines the inflation expectation rate.