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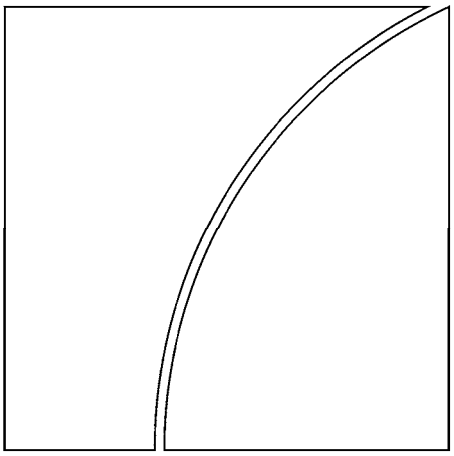

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MEASUREMENT OF PERCEIVED AND EXPECTED INFLATION ON THE BASIS OF CONSUMER SURVEY DATA

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Abstract

This paper discusses measurement techniques used in the literature to quantify inflation perception and expectations on the basis of qualitative survey data. Description of quantification methods and assessment of their strengths and weaknesses is supplemented with an overview of direct measures of consumer inflation expectations in the European Union quantified with a number of techniques. Except presenting quantification methods, constraints in their interpretation and their results, the paper describes how direct measures of inflation expectations are used in central banks nowadays.

JEL: C83, D84

Keywords: Inflation Expectations, Consumers, Survey, EU

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Introduction

As underlined by the macroeconomic theory, efficient conduct of monetary policy depends crucially on the way, in which the private sector agents form their expectations.

As central banks nowadays are focused primarily on achieving and maintaining price stability, monitoring inflation expectations of economic agents and understanding their nature is extremely important for them. An assessment of subjective perception of current price movements is also needed by monetary policymakers. In particular, differences between subjectively perceived price dynamics and official inflation figures could undermine the confidence in official statistics and might exert negative influence on inflation expectations. The unobservable character of both variables makes it necessary to develop methods of measuring them on the basis of existing information. The focus of this paper is to discuss measurement of perceived and expected inflation on the basis of consumer survey data. A variety of existing approaches to quantify those variables makes it necessary to be aware of the constraints in interpreting their outcomes, resulting from the assumptions being imposed.

The paper has the following structure. Section 1 describes theoretical models of expectations' formation and their implications for monetary policy. Section 2 presents how direct measures of inflation expectations are used in central banks nowadays. Section 3 describes the most popular quantification methods enabling conversion of qualitative survey data into numerical measures of perceived and expected inflation. To illustrate the impact of the selection of a particular quantification method on resulting measures of inflation expectations, Section 4 provides an overview of the measures of consumer inflation expectations in the European Union quantified with a number of techniques. The final section concludes.

1. Models of expectations in macroeconomic theory

Macroeconomic theory underlines the importance of expectations in determining economic outcomes. Various specifications of the Phillips curve suggested by different schools of economic thought – i.e. the expectations-augmented Phillips curve (Phelps 1967, Friedman 1968), the New Keynesian Phillips curve (Goodfriend and King 1997) or the hybrid Phillips curve (Fuhrer and Moore 1995, Roberts 1997) – predict that inflation expectations matter a lot in affecting prices in the economy. Moreover, the way, in which they are formed, has immense importance for central banks, by influencing the effectiveness of the monetary transmission mechanism.

There are different theoretical models describing the formation of inflation expectations. In monetarist models an adjustment of expectations to macroeconomic news was relatively slow and expectations were of backward-looking nature. It is the main feature of adaptive expectations (Cagan 1956), which depend on their past values and past expectational errors. Inflation expectations formed according to the adaptive model can be expressed in the following way:

$$\pi_t^{e(ad)} = \pi_{t-1}^{e(ad)} + \lambda \cdot \left(\pi_{t-1} - \pi_{t-1}^{e(ad)} \right) \tag{1}$$

where $\pi^{e(\bullet)}$ denotes inflation expectations and π – actual inflation. After rearranging equation (1), it can be shown that adaptive expectations depend on past values of inflation with the weight of past observations decreasing with the number of lags:

$$\pi_t^{e(ad)} = (1-\lambda)\cdot\sum_{j=1}^{\infty}\lambda^j\pi_{t-j} \tag{2}$$

Static expectations constitute a special case of adaptive expectations. They depend only on the most recent inflation, i.e.:

$$\pi_t^{e(st)} = \pi_{t-1} \tag{3}$$

Neoclassical economics replaced the assumption of adaptive expectations with the rational expectations hypothesis (REH, Lucas 1972).[1] It assumes that economic agents fully exploit available information in the absence of information asymmetries and do not make systematic errors in assessing future macroeconomic performance. Therefore inflation expectations are equal to actual future inflation on average, i.e. they are unbiased predictors of future inflation:

$$\pi_t^{e(REH)} = \pi_t + \varepsilon_t \tag{4}$$

Although in most New Keynesian models inflation expectations are treated as rational, New Keynesian school uses also hybrid models of the formation of inflation expectations (e.g.: Roberts 1997, Galí and Gertler 1999). Due to heterogeneity of economic agents, inflation expectations are treated as a combination of rational and adaptive/static expectations:

$$\pi_t^{e(hyb)} = \varpi\pi_t^{e(REH)} + (1-\varpi)\pi_t^{e(ad/st)} \tag{5}$$

where the weight w denotes a share of economic agents forming their expectations in a rational, forward-looking manner.

The way, in which economic agents form their expectations, has vital implications for the effectiveness and costs of monetary policy. If inflation expectations are formed on the basis of the adaptive/static model, i.e. they depend on past inflation, monetary policy actions aimed at reducing inflation are less effective – the transmission of interest rate changes to price decisions takes more time and is costly in terms of the loss of output and employment. If economic agents are characterized by higher degree of rationality, exploiting efficiently available information and making informed forward-looking forecasts, monetary policy actions are more effective and the disinflation cost (so-called sacrifice ratio) is smaller.

2. The use of direct measures of inflation expectations in central banks

Central banks, aware of the macroecomomic importance of expectations, monitor closely inflation expectations of different groups of economic agents and use different sources of information on inflation expectations. Table 1 provides a summary of the results obtained from two surveys carried out among central banks. The first of them (BoE 1999) was conducted by the Bank of England in 1999 (see: Mahadeva and Sterne, eds., 2000), while the second one (CCBS-NBP 2009) – jointly by the National Bank of Poland and the Bank of England's Centre for Central Banking Studies in 2009 (see: Kokoszczyński and Łyziak 2009). In both cases the results are presented separately for complete samples of banks and for inflation targeters.

[1] It should be noted that the concept of rational expectations had emerged long before (see e.g.: Tinbergen 1932, Muth 1961).

The results of the recent survey show that more than 71% of central banks in the sample use market information on inflation expectations derived from financial market data. Even a higher percentage of banks (81%) use direct measures of inflation expectations obtained from surveys of different groups of economic agents and surveys of outside (professional) forecasters. A large share of central banks publishes information on inflation expectations, especially in the case of measures based on surveys and financial market data.

Comparison of findings from both surveys is constrained due to sizeable differences in the total number of banks participating in them (94 central banks in the 1999 survey; 21 central banks in the 2009 survey). However, it seems that the results for the sub-sample of inflation targeters (15 inflation targeters in the 1999 survey; 14 inflation targeters in the present survey) may be compared. They suggest that relative to 1999, surveys of consumers, producers or other groups of economic agents are more frequently used now – by all the inflation targeters in the sample compared to approximately 79% in the 1999 survey. Moreover, information on inflation expectations is published by a higher fraction of those banks, which suggests that the importance of those indicators has increased.

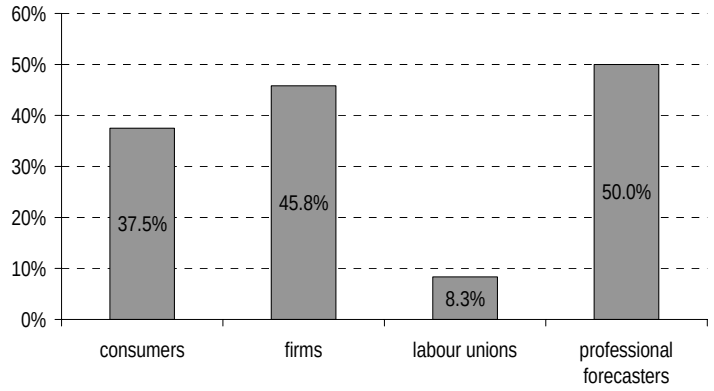
Table 1. Measures used in analyses of inflation expectations – CCBS-NBP 2009 questionnaire results vs. Bank of England 1999 survey results

Information category	Categories of answers	Distribution of results			
		Total sample		Banks describing themselves as *inflation targeters*	
		BoE 1999(1)	**CCBS-NBP 2009**(2)	***BoE 1999***(3)	**CCBS-NBP 2009**(4)
Market information	**used:**	**44.7%**	**71.4%**	**73.3%**	**71.4%**
	and published at least quarterly	*12.8%*	*42.0%*	*26.7%*	*41.5%*
	and published	*13.8%*	*23.3%*	*26.7%*	*27.7%*
	but not published	*18.1%*	*4.7%*	*20.0%*	*0.0%*
	not used	**55.3%**	**28.6%**	**26.7%**	**28.6%**
Surveys of consumers/ producers/ others	**used:**	**42.6%**	**81.0%**	**60.0%**	**100.0%**
	and published at least quarterly	*18.1%*	*71.5%*	*53.3%*	*85.7%*
	and published	*7.5%*	*9.4%*	*0.0%*	*14.3%*
	but not published	*17.0%*	*0.0%*	*6.7%*	*0.0%*
	not used	**57.4%**	**19.0%**	**40.0%**	**0.0%**
Surveys of outside forecasts	**used:**	**41.5%**	**81.0%**	**73.3%**	**78.6%**
	and published at least quarterly	*14.9%*	*32.9%*	*46.7%*	*35.0%*
	and published	*8.5%*	*14.1%*	*13.3%*	*14.0%*
	but not published	*18.1%*	*32.9%*	*13.3%*	*28.0%*
	not used	**58.5%**	**19.0%**	**26.7%**	**23.1%**

(1) 94 central banks, source: own calculations based on Mahadeva, Sterne [eds.] (2000).
(2) 21 central banks, source: the CCBS-NBP survey.
(3) 15 central banks, source: own calculations based on Mahadeva, Sterne [eds.] (2000). This group included the central banks of: Albania, Armenia, Australia, Botswana, Canada, Chile, Czech Republic, Israel, Jamaica, Mexico, Mongolia, New Zealand, Poland, Sweden and the UK.
(4) 14 central banks, source: the CCBS-NBP survey. This group includes the central banks of: Canada, Chile, Colombia, Czech Republic, Hungary, Iceland, Israel, New Zealand, Norway, Poland, Romania, South Africa, UK and Turkey.

The CCBS-NBP survey results show that central banks responding to the questionnaire use different surveys. Some of them are prepared and conducted by central banks themselves, which refers especially to business surveys and surveys of professional analysts. As far as surveys conducted by central banks themselves are concerned, there are interesting results collected by the Bank for International Settlements for emerging market central banks. They indicate that approximately 35% of those banks handle surveys of professional forecasters, 32% of them conduct surveys among enterprises and 27% – surveys among households (Figure 1, see Annex for details).

Figure 1. Groups of economic agents covered by inflation expectations surveys conducted by central banks in emerging economies



Source: BIS questionnaires carried out between mid 2007 and early 2008 (see Annex for details).

The CCBS-NBP questionnaire reveals that a majority of central banks analyse not only raw survey data, but also implement some statistical procedures to eliminate extreme observations in the case of quantitative responses or to quantify expectations in the case of qualitative surveys. Also a majority of central banks analyses the quality/reliability of survey data – usually either by cross-checking available measures of inflation expectations, or comparing direct measures of expectations to actual outcomes, the current inflation rate or the previous values of expected inflation (see Kokoszczyński and Łyziak 2009 for details).

Analysing principal areas of use of direct measures of inflation expectations in central banks it seems that communication with the public, conducting economic research and testing central bank credibility constitute the most important ones, indicated respectively by 81%, 76% and 71% of banks participating in the NBP-CCBS survey (Table 2). 57% of banks use direct measures of inflation expectations in modelling and approximately half of banks – as the leading indicator of inflation. Banks describing themselves as inflation targeters are more active in using direct measures of inflation expectations in all the areas under consideration compared to the total sample of banks included in the survey.

Table 2. Areas of use of direct measures of inflation expectations in central banks

Areas of use	% of banks using direct measures of inflation expectations in respective areas	
	Total sample[1]	Banks describing themselves as *inflation targeters*[2]
Communication with the public	81.0%	92.9%
Economic research (e.g. testing theoretical hypotheses concerning expectations' formation such as rational expectations hypothesis, sticky information etc.)	76.2%	92.9%
Testing central bank credibility	71.4%	85.7%
Modelling (e.g. estimating the Phillips curve, explanatory variable in macroeconomic models etc.)	57.1%	71.4%
Inflation leading indicator	47.6%	57.1%

[1] 21 central banks, source: the CCBS-NBP survey.
[2] 14 central banks, source: the present survey. This group includes the central banks of: Canada, Chile, Colombia, Czech Republic, Hungary, Iceland, Israel, New Zealand, Norway, Poland, Romania, South Africa, UK and Turkey.

3. Quantification of consumer inflation perception and expectations on the basis of survey data

As reflected in the results of both surveys mentioned in the previous section, surveys constitute an important information source concerning inflation perception and expectations used in central banks nowadays. Although useful in macroeconomic analysis and monetary policy considerations, survey data on inflation perception and expectations are far from giving perfect proxies of economic agents' opinions. Survey results are sensitive to sampling errors and the phrasing of the questions; moreover, the respondents may express opinions different from those inspiring their actions (Nardo 2003, p. 646).

3.1. Survey questions and balance statistics

Survey questions on inflation perception and expectations are broadly classified into quantitative and qualitative, depending on whether the respondents are required to give precise quantitative responses or their qualitative assessments only (Pesaran 1987, p. 208). Most consumer surveys examining inflation perception and expectations are designed in a qualitative way, even if their results have to be later quantified. Except tendency surveys with three response categories (*"go up"*, *"stay the same"*, *"go down"*), the polychotomous surveys with more than three but a finite number of response categories are used. For example, questions on inflation perception and expectations included in the European Commission Consumer Survey, carried out every month in the EU economies, have the following form: *"In your opinion, is the price level now compared to that 12 months ago: (1) much higher; (2) moderately higher; (3) a little higher; (4) about the same; (5) lower"*; *"Given what is currently happening, do you believe that over the next 12 months prices will: (1) rise faster than at present, (2) rise at the same rate, (3) rise more slowly, (4) stay at their present level, (5) go down"*.[2]

Analyses of survey responses are frequently conducted with the use of balance statistics. Indicators of this kind attach constant, predefined weights to fractions of respondents selecting subsequent response categories. The simplest balance statistic of inflation expectations [perception], proposed by Anderson (1952), is a difference between fractions of respondents expecting [noticing] price increase and their decrease, which in the case of polychotomous survey questions may be expressed as:

$$BS_1^e = A_1^e + A_2^e + A_3^e - C^e\,,\ BS_1^p = A_1^p + A_2^p + A_3^p - C^p \tag{6}$$

where A_1^e [A_1^p] denotes the percentage of respondents expecting prices to increase more rapidly [noticing that price level is much higher than 12 months ago]; A_2^e [A_2^p] – the percentage of respondents expecting prices to rise at the same rate [noticing that price level is moderately higher]; A_3^e [A_3^p] – the percentage of respondents expecting prices to increase at slower rate [noticing that price level is slightly higher] and C^e [C^p] – the percentage of respondents expecting prices to go down [noticing that prices are lower than 12 months ago].

A slightly modified version of the balance statistic proposed by Anderson (1952) is calculated as a difference between proportions of respondents expecting [noticing] an increase in prices and their stabilisation or decrease:

[2] Both questions have the *"difficult to say"* response category in addition.

$$BS_2^e = A_1^e + A_2^e + A_3^e - B^e - C^e,\ BS_2^p = A_1^p + A_2^p + A_3^p - B^p - C^p \tag{7}$$

where B^e [B^p] stands for the percentage of respondents expecting prices to stay at their present level [noticing that prices are about the same].

There are also balance statistics that capture different magnitudes of expected [perceived] price changes as expressed in polychotomous surveys, whose weights are different for each of the response categories. The balance statistic BS_3^e [BS_3^p], is a weighted one, frequently used in the literature (e.g. Del Giovane, Sabbatini 2004; ECB 2002, 2003, 2005, 2007), attaching weight 1, ½, 0, -½, -1 to subsequent fractions of respondents:

$$BS_3^e = A_1^e + \frac{1}{2}A_2^e - \frac{1}{2}B^e - C^e,\ BS_3^p = A_1^p + \frac{1}{2}A_2^p - \frac{1}{2}B^p - C^p \tag{8}$$

In another weighted balance statistic, BS_4^e [BS_4^p], the respective weights are: 3, 2, 1, 0 and -1:

$$BS_4^e = 3A_1^e + 2A_2^e + A_3^e - C^e,\ BS_4^p = 3A_1^p + 2A_2^p + A_3^p - C^p \tag{9}$$

Balance statistics provide a useful and synthetic measure of survey opinions; however, they should not be interpreted as proxies of inflation perception or expectations.[3] The same distribution of responses to the survey question may reflect significantly different values of expected [perceived] inflation in economies or time periods characterized by high or low inflation. Interpreting balance statistics as the measures of the average expected [perceived] inflation imposes certain conditions on implied values of expected [perceived] price dynamics by individual fractions of respondents. Let us assume that π_i^p denotes the average price change perceived by the *i*-th fraction of respondents. In this case the average perceived inflation may be calculated in the following way:

$$\pi^p = A_1^p\pi_1^p + A_2^p\pi_2^p + A_3^p\pi_3^p + B^p\pi_4^p + C^p\pi_5^p \tag{10}$$

Treating a given balance statistic BS_k^p, $k = \{1,2,3,4\}$, as the measure of the level of perceived rate of price change that (i.e. as proportional to the average perceived inflation), would imply that:

$$\underbrace{\alpha_1 A_1^p + \alpha_2 A_2^p + \alpha_3 A_3^p + \alpha_4 B^p + \alpha_5 C^p}_{BS_k^p} = m \cdot \underbrace{\left(\pi_1^p A_1^p + \pi_2^p A_2^p + \pi_3^p A_3^p + \pi_4^p B^p + \pi_5^p C^p\right)}_{\pi^p} \tag{11}$$

where α_i denotes the weight of the *i*-th fraction of respondents assumed while calculating the balance statistic BS_k^p and *m* is a constant. From the above equation one can easily notice that the weights used to calculate the balance statistic impose certain relationships on implied values of perceived inflation in individual fractions of respondents, such as:

[3] Problems generated by such interpretation of balance statistics may be illustrated with the discussions concerning the impact of the introduction of euro banknotes and coins (January 2002) on inflation perception by consumers in the euro area. Survey data show significant worsening of consumer opinions on current price changes even if official inflation measures were relatively stable. This effect, assessed with balance statistics, seems highly persistent, while analysed with probability measures of inflation perception, calculated on the basis of the same survey data seems only temporary (see Dias, Duarte and Rua 2007 for details).

$$\frac{\pi_1^p}{\pi_2^p} = \frac{\alpha_1}{\alpha_2}, \frac{\pi_1^p}{\pi_3^p} = \frac{\alpha_1}{\alpha_3}, \ldots \tag{12}$$

As a result, the commonly used balance statistic BS_1^p can be treated as a proxy of perceived inflation under the assumption that the average increase in prices perceived by respondents declaring that *"prices have risen"* has the same magnitude as the average decrease in prices reported by respondents claiming that *"prices have fallen"* (Cunningham 1997).

Interpretation of balance statistics as the measures of expected inflation is particularly problematic in the case of polychotomous survey questions, such as the European Commission Consumer Survey question. In line with such survey questions, revealing their predictions concerning price changes in the near future respondents express them relative to their perception of current price changes, so the expected inflation depends not only on the distribution of responses to the survey question, but also on the perceived rate of current price changes, which serves respondents as a benchmark value in revealing their expectations. Those two factors may reinforce each other, but they may also operate in opposite directions. Thus, even if changes in the distribution of responses to the survey question, as disclosed by balance statistics, indicate an improvement in opinions regarding future price movements, this does not necessarily mean that inflation expectations have been reduced. If these changes are accompanied by a sufficiently sizeable increase in the perceived rate of inflation, it may mean that consumer inflation expectations have increased (Łyziak 2003, pp. 23-24).

Due to interpretation constraints in using balance statistics[4] different quantification methods were developed in order to obtain numerical measures of perceived and expected inflation. Probability and regression methods are the most popular among them.

3.2. Quantification of inflation expectations with probability methods

Probability methods used in the empirical literature refer to the seminal Carlson-Parkin (1975) approach. It was originally tailored to survey questions with three response categories (i.e. *"prices will increase"*, *"prices will stay the same"*, *"prices will fall"*). To suit survey questions with five response categories the method was modified with the aim to use all information embodied in the survey data (e.g. Batchelor and Orr 1988). It is important to note that in this case – in contradiction to the original Carlson and Parkin (1975) method – the modified method does not impose unbiasedness of inflation expectations. There are however two other assumptions to be made. The first one refers to the type of distribution of the expected inflation in the population, while the second one concerns a scaling variable, i.e. a measure of perceived inflation, to which respondents compare their predictions in line with the survey question.

As far as the first assumption is concerned, the expected rate of price change is usually assumed to be normally distributed in the population. In the seminal article by Carlson and Parkin (1975) it is argued that survey respondents have similar information set, containing publicly available

[4] Even if interpretation of balance statistics as the measures of the level of perceived or expected inflation is constrained, it does not mean that they are useless. Their advantage is that they are not influenced by the assumptions imposed in quantification methods, which means that for some areas of research balance statistics are likely to be better suited than quantified measures of expectations. For example, balance statistics can be used in assessing some aspects of the formation of inflation expectations, such as the degree of their backward-lookingness. Łyziak (2010) treats the correlation between balance statistics of past price changes and of future price changes as a proxy for the backward-lookingness of expectations, testing it empirically for the EU economies. Such approach allows avoiding problems caused by quantification methods, whose assumptions – as shown in the section 3.5 of this paper – impose some correlation between current inflation and the quantified measures of inflation expectations.

professional forecasts, so a unimodal distribution of their expectations around the consensus can be expected. The authors claim that if individual distributions are independent across respondents, have a common form and finite first and second moments, the survey results can be interpreted as a sampling from some aggregate distribution, which under the Central Limit Theorem is normally distributed. However, some empirical studies, based on financial market data or quantitative data on expectations[5], suggest that the actual distribution of expectations can be positively skewed in times of high inflation and more peaked than normal. Therefore alternatively other types of distributions are applied in the literature, such as the uniform distribution (e.g. Pesaran 1987, Łyziak 2003), the logistic distribution (e.g. Batchelor and Orr 1988, Nielsen 2003), the central and non-central *t* distributions (e.g. Berk 1999, Nielsen 2003) and the triangular distribution (Łyziak 2010).[6] The results of empirical applications of non-normal distributions in probability methods are not much different from those based on the assumption that inflation expectations are normally distributed (Berk 2000, Nielsen 2003).

As far as the measure of the perceived price change used in probability methods to scale survey responses is concerned, there are two kinds of proxies used in the literature, i.e. either the most recent official inflation figure available to respondents when the survey is carried out (e.g.: Batchelor and Orr 1988, Berk 1999, Forsells and Kenny 2004) – in this case the resulting measures of inflation expectations may be described as 'objectified' – or the measure derived on the basis of an additional survey question concerning price past developments (e.g.: Batchelor and Orr 1988; Forsells and Kenny 2004; Dias, Duarte and Rua 2007) – in this case the resulting measures of inflation expectations are called 'subjectified'.

Another feature of the probability approach is thinking in terms of 'sensitivity intervals' or 'indifference intervals'. It is assumed that among respondents reporting that prices will be stable there are not only individuals expecting that future inflation will be equal exactly to zero, but also agents, whose expectations fall within a sensitivity interval centred on zero: $(-l, l)$. In the case of polychotomous survey question there is another sensitivity interval surrounding the perceived rate of price change, π^p. It is assumed that the response that *"prices will increase at the same rate"* will be chosen by respondents expecting that future inflation will fall within an interval centred on the perceived rate of inflation: $\left(\pi^p - s\,,\, \pi^p + s\right)$. As a result, respondents are supposed to declare that *"prices will increase more rapidly"* if their expectations exceed the upper limit of the sensitivity interval centred on the perceived inflation. The response *"prices will increase at slower rate"* is chosen by respondents whose expectations are between the upper limit of the sensitivity interval surrounding zero and the lower limit of the sensitivity interval centred on the perceived inflation, while the response that *"prices will fall"* by individuals whose expectations are below the lower limit of the sensitivity interval centred on zero.

The logic of probability methods may be expressed in the set of following equations, in which individual percentages of respondents are expressed in terms of the probabilities of future inflation being in certain intervals:

[5] There are some doubts concerning reliability of the data obtained from quantitative survey questions conducted among economic agents whose forecasting capabilities are limited – see section 3.6 of this paper for details.

[6] This type of the distribution has three main advantages: firstly, it allows for asymmetry of the expected rate of inflation; secondly, it determines minimum and maximum value of expected inflation in the population; thirdly, no adjustments in the survey data are needed, when one of the marginal fractions of respondents (claiming that prices will increase more rapidly or prices will fall) equals zero.

$$a_{1t}^e = \Pr\left(\pi_t^e > \pi_t^p + s_t\right) = \int_{\pi_t^p + s_t}^{\infty} f_t\left(\pi_t^e\right) d\pi_t^e \tag{13}$$

$$a_{2t}^e = \Pr\left(\pi_t^p - s_t < \pi_t^e < \pi_t^p + s_t\right) = \int_{\pi_t^p - s_t}^{\pi_t^p + s_t} f_t\left(\pi_t^e\right) d\pi_t^e \tag{14}$$

$$a_{3t}^e = \Pr\left(l_t < \pi_t^e < \pi_t^p - s_t\right) = \int_{l_t}^{\pi_t^p - s_t} f_t\left(\pi_t^e\right) d\pi_t^e \tag{15}$$

$$b_t^e = \Pr\left(-l_t < \pi_t^e < l_t\right) = \int_{-l_t}^{l_t} f_t\left(\pi_t^e\right) d\pi_t^e \tag{16}$$

$$c_t^e = \Pr\left(\pi_t^e < -l_t\right) = \int_{-\infty}^{-l_t} f_t\left(\pi_t^e\right) d\pi_t^e \tag{17}$$

where $f_t\left(\pi_t^e\right)$ denotes density function of the expected inflation. This system of equations illustrates a general idea of probability methods, independently of the type of the distribution of expected inflation assumed. It should be noted that in the equations above individual fractions of respondents are subject to a transformation in order to account for the existence of a fraction D^e of individuals selecting *"do not know"* response category, i.e.: $a_1^e = \frac{A_1^e}{1 - D^e}$, $a_2^e = \frac{A_2^e}{1 - D^e}$, $a_3^e = \frac{A_3^e}{1 - D^e}$, $b^e = \frac{B^e}{1 - D^e}$ and $c^e = \frac{C^e}{1 - D^e}$.

Assuming the normal distribution of the expected inflation and solving the above equations leads to the following results for its mean, standard deviation and both sensitivity intervals:

$$\overline{\pi_t^e} = \frac{\pi_t^p \cdot \left(G_t + H_t\right)}{G_t + H_t - \left(E_t + F_t\right)} \tag{18}$$

$$\sigma_t = \frac{-2 \cdot \pi_t^p}{G_t + H_t - \left(E_t + F_t\right)} \tag{19}$$

$$s_t = \frac{\pi_t^p \cdot \left(F_t - E_t\right)}{G_t + H_t - \left(E_t + F_t\right)} \tag{20}$$

$$l_t = \frac{\pi_t^p \cdot \left(H_t - G_t\right)}{G_t + H_t - \left(E_t + F_t\right)} \tag{21}$$

where $E_t = Nz^{-1}\left(1 - a_{1t}^e\right)$, $F_t = Nz^{-1}\left(1 - a_{1t}^e - a_{2t}^e\right)$, $G_t = Nz^{-1}\left(1 - a_{1t}^e - a_{2t}^e - a_{3t}^e\right)$, $H_t = Nz^{-1}\left(c_t^e\right)$ and Nz^{-1} denotes the inverse standard-normal cumulative distribution function. In line with the construction of the survey question, a quantitative measure of inflation expectations and its standard deviation depends upon two factors, that is on responses to the survey question and on the perceived rate of inflation.

There are different probability methods to quantify perceived rate of inflation on the basis of qualitative survey data. One of them, employed in some studies on European consumer inflation expectations (e.g. Berk 1999, Forsells and Kenny 2004), uses the condition of unbiasedness of the perceived inflation. However, due to some limitations of that approach – caused mainly by the need to aggregate fractions of respondents claiming that *"prices are much higher"*, *"moderately higher"*

and *"a little higher"*[7] – the approach suggested by Batchelor and Orr (1988) and Dias, Duarte and Rua (2007), seems more adequate. The logic behind it is the same as in the case of quantification of the expected inflation on the basis of five-response survey questions. Response categories are reinterpreted by assuming that answering the survey question respondents compare price dynamics perceived by them with a 'natural' rate of inflation or a 'moderate' rate of inflation, which reflects the permanent or trend rate of price change and can be approximated by smoothing the actual inflation (with HP filter, moving averages etc.). Respondents declaring that *"prices have risen a lot"* are assumed to think that current inflation is higher than trend inflation plus a sensitivity parameter. Inflation perceived by respondents claiming that *"prices have risen moderately"* is assumed to fall within sensitivity interval surrounding trend inflation. Implied price changes perceived by the remaining fractions of respondents are determined in analogous way.

3.3. Quantification of inflation expectations with regression methods

Regression methods, introduced by Anderson (1952) and Pesaran (1984, 1987), constitute alternative way of quantifying inflation expectation on the basis of qualitative survey data. Those methods are based on the estimation of the relationship between current inflation as measured by official statistics and its survey perception by respondents. It is assumed then that the same relationship[8] holds then between qualitative opinions of respondents concerning future price changes and expected inflation, so it serves as a yardstick for quantification of respondents' expectations (Pesaran 1987, p. 221). It should be underlined that estimating the regression model of inflation perception – with the official current inflation on its left hand side and survey responses to the question on inflation perception on its right hand side[9] – regression methods impose unbiasedness of inflation perceptions. It seems a restrictive assumption, although it does not necessarily imply unbiasadness of inflation expectations.

There are several models which can be employed to approximate the relationship between inflation and the survey data. The simplest one was proposed by Anderson (1952). The estimated equation has current inflation (π_0) on its left hand side and fractions of respondents claiming that prices have risen (in the case of polychotomous survey questions three fractions of respondents perceiving increase in prices of different magnitudes are aggregated into one homogenous category) and that prices have fallen on the right hand side, i.e.:

$$\pi_{0t} = \alpha \cdot \sum_{i=1}^{3} A_{it}^{p} - \beta \cdot C_t^{p} + \varepsilon_t \tag{22}$$

The estimated coefficients have an economic interpretation, showing implied average price dynamics perceived by the group of respondents claiming that prices have risen (π_+^p) and the group of respondents declaring that prices have fallen (π_-^p), i.e.:

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[7] There is another problem faced while implementing this quantification method, namely its limited flexibility, caused by having only one sensitivity interval and such a method of its estimation, in which new observations have a small impact on its length. As a result, even small changes in the distribution of responses to the survey question may have disproportional or even counterintuitive impact on the estimate of the perceived rate of inflation.

[8] This relationship should not be treated as causative, but rather as a simple tool to approximate the unknown values.

[9] Most regression methods use official inflation as the dependent variable, while survey responses as independent ones. The model proposed by Cunningham (1997) is the exception. Cunningham (1997) argues that official data (after revisions) give unbiased indicator of the state of the economy, while survey data may contain measurement errors, therefore survey data, not official statistics, should be on the left-hand side of any regression.

$$\pi_{t+}^{p} = \hat{\alpha} \tag{23}$$

$$\pi_{t-}^{p} = -\hat{\beta} \tag{24}$$

The expected inflation is calculated on the basis of survey responses to the question on inflation expectations and the coefficients estimated from the regression model, i.e.:

$$\pi_{t}^{e} = \hat{\alpha} \cdot \sum_{i=1}^{3} A_{it}^{e} - \hat{\beta} \cdot C_{t}^{e} \tag{25}$$

In the regression model by Anderson (1952) both coefficients are constant, while in the more complicated regression models that assumption is relaxed. For example, in the model proposed by Pesaran (1984, 1987) inflation perceived by agents declaring that prices have risen depends on actual price dynamics, while the dynamic nonlinear regression models developed by Smith and McAleer (1995) assumes that implied price changes perceived by respondents declaring positive and negative changes in the price level depend on current and (in the extended version of the model) past inflation rates (Table 3).

Table 3. Examples of regression models

Model	Feature	Value
Anderson (1952)	estimated equation:	$\pi_{0t} = \alpha \cdot \sum_{i=1}^{3} A_{it}^{p} - \beta \cdot C_{t}^{p} + \varepsilon_{t}$
	implied price change perceived by respondents claiming that prices have risen:	$\pi_{t+}^{p} = \hat{\alpha}$
	implied price change perceived by respondents claiming that prices have fallen:	$\pi_{t-}^{p} = -\hat{\beta}$
Pesaran (1984, 1987)	estimated equation:	$\pi_{0t} = \dfrac{\alpha \cdot \sum_{i=1}^{3} A_{it}^{p} - \beta \cdot C_{t}^{p}}{1 - \lambda \cdot \sum_{i=1}^{3} A_{it}^{p}} + \varepsilon_{t}$
	implied price change perceived by respondents claiming that prices have risen:	$\pi_{t+}^{p} = \hat{\alpha} + \hat{\lambda} \cdot \pi_{0t}$
	implied price change perceived by respondents claiming that prices have fallen:	$\pi_{t-}^{p} = -\hat{\beta}$
Smith and McAleer (1995)	estimated equation:	$\pi_{0t} = \dfrac{\alpha \cdot \sum_{i=1}^{3} A_{it}^{p} - \beta \cdot C_{t}^{p}}{1 - \lambda \cdot \sum_{i=1}^{3} A_{it}^{p} - \nu \cdot C_{t}^{p}} + \varepsilon_{t}$
	implied price change perceived by respondents claiming that prices have risen:	$\pi_{t+}^{p} = \hat{\alpha} + \hat{\lambda} \cdot \pi_{0t}$
	implied price change perceived by respondents claiming that prices have fallen:	$\pi_{t-}^{p} = -\hat{\beta} + \nu \cdot \pi_{0t}$
Smith and McAleer (1995), extended version	estimated equation:	$\pi_{0t} = \dfrac{\alpha \cdot \sum_{i=1}^{3} A_{it}^{p} - \beta \cdot C_{t}^{p} + \sum_{i=1}^{3} A_{it}^{p} \cdot \sum_{j=1}^{J} \gamma_{1j} \pi_{0,t-j} + C_{t}^{p} \cdot \sum_{k=1}^{K} \gamma_{2k} \pi_{0,t-k}}{1 - \gamma_{10} \cdot \sum_{i=1}^{3} A_{it}^{p} - \gamma_{20} \cdot C_{t}^{p}} + \varepsilon_{t}$
	implied price change perceived by respondents claiming that prices have risen:	$\pi_{t+}^{p} = \hat{\alpha} + \hat{\gamma}_{10} \cdot \pi_{0t} + \sum_{j=1}^{J} \gamma_{1j} \pi_{0,t-j}$
	implied price change perceived by respondents claiming that prices have fallen:	$\pi_{t-}^{p} = -\hat{\beta} + \hat{\gamma}_{20} \cdot \pi_{0t} + \sum_{k=1}^{K} \gamma_{2k} \pi_{0,t-k}$

In contradiction to probability methods, regression methods do not make assumptions concerning the distribution of expected inflation; however, resulting measures of expectations are functions of a specific regression model. Regression methods do not break down if one of two ex-

treme responses to the survey question is chosen by none of the respondents, which does generate problems in those probability methods, in which the distribution is defined over $(-\infty, +\infty)$. There is also another advantage of regression methods over probability methods used to quantify expectations on the basis of three-response category survey questions; namely a shift from "[prices are] *about the same"* category to the *"prices have fallen"* category does not result in an increase in price expectations (Pesaran 1987, p. 224). However, comparing regression methods and more advanced probability methods designed for five-response category survey question it seems that the latter methods outperform the former ones significantly. Firstly, regression methods require adequately long time series of survey data on inflation perception. Secondly, as highlighted above, they impose unbiasedness of inflation perceptions. Thirdly, they are not well suited to work with polychotomous survey questions; so in this case aggregation of three fractions of respondents perceiving or expecting increase in prices of different magnitudes into one homogenous category is usually required.[10] It leads to a loss of information, which may be substantial given that those three fractions of respondents are usually dominant.[11] Fourthly, reestimations of regression models lead to changes in the historical values of inflation expectations calculated on their basis.

3.4. Quantification of inflation expectations with the logistic function method

Probability and regression methods, although the most popular, are not the only ones used to convert qualitative survey responses into numerical measures of inflation perception and expectations. There are other methods used in the literature, for example the logistic function method developed by Papadia and Basano (1981) – the first method used to quantify consumer inflation expectations in the EU economies on the basis of European Commission Consumer Survey data. There are three main assumptions in that method. Firstly, it is assumed that each respondent's perceived and expected inflation has a common component and individual (random) component, i.e.:

$$\pi_{it}^{p} = \pi_{t}^{*} + z_{it}\,,\ E\left(z_{it}\right) = 0 \tag{26}$$

$$\pi_{it}^{e} = \pi_{t}^{e} + u_{it}\,,\ E\left(u_{it}\right) = 0 \tag{27}$$

Secondly, some numbers Y_1, Y_2, Y_3, Y_4, Y_5, are assigned to respective fractions of respondents; it is assumed that there is a constant difference C between subsequent numbers, i.e.:

$$Y_3 = x\,,\ Y_k = Y_{k+1} + C\,, k = 1,2,...,5 \tag{28}$$

Finally, individuals are assumed to respond to the survey question on the basis of the transformation function h. In line with the design of survey question, expected response depends on the difference between common component of inflation expectations and perceived inflation:

$$Y_{it} = h_{it}\left(\pi_{it}^{e} - \pi_{it}\right) = h_{it}\left(u_{it} + \pi_{t}^{e} - z_{it} - \pi_{t}^{*}\right) \tag{29}$$

Then the transformation function is approximated by a continuous, linear function over all individuals:

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[10] The regression model used by Simmons and Weiserbs (1992) is designed to work with five-response survey questions.

[11] For example in the case of the euro area, the sum of three fractions of respondents noticing (expecting) increase in prices in 1985-2007 was approximately 80% (71%) on average (source: European Commission Consumer Survey).

$$E(Y_{kt}) = \alpha_t + \beta_t \cdot (\pi_t^e - \pi_t^*) \tag{30}$$

Solving the model we get the solution, in which the expected inflation is a product of the perceived inflation and survey responses:

$$\pi_t^e = \pi_t^* \cdot \frac{3a_{1t} + 2a_{2t} + a_{3t} - c_t}{2} \tag{31}$$

However, the range of possible outcomes from the above formula lies between minus 0.5 of perceived inflation when all respondents claim that *"prices will fall"* and 1.5 of perceived inflation when all respondents select the response that *"prices will increase more rapidly"*. To enlarge the range of possible outcomes Papadia and Basano (1981) use a logistic transformation with the final specification of expected inflation taking the following form:

$$\pi_t^e = \pi_t^* \cdot \left(0.5 - 0.4552 \cdot \ln \frac{2 - 2a_{1t} - a_{2t} + b_t + 2c_t}{2 + 2a_{1t} + a_{2t} - b_t - 2c_t} \right) \tag{32}$$

If the fraction of respondents claiming that *"prices will increase more rapidly"* is close to 100%, expected inflation goes to infinity. Similarly when all respondents think that *"prices will fall"*, expected inflation goes to minus infinity.

3.5. Current inflation and quantified measures of inflation expectations

Even if quantification methods provide more reliable estimates of the level of expected or perceived inflation than balance statistics, there is an interpretation constraint that should be considered while using those measures in macroeconomic analysis. In line with the survey question, all the quantification methods impose some correlation between current inflation and inflation expectations. To illustrate this point let us assume that current inflation, available to respondents when answering the survey question, increases from 2% to 3% and remains at this level. Table 4 presents the responses of different probability measures of inflation expectations and the logistic function measure to changes in observed inflation. The probability measure *INFE_1* is calculated under the assumption that the expected inflation is normally distributed and that consumers' perception of price changes currently observed corresponds to the most recent CPI inflation figure (similarly as in Batchelor and Orr 1988, Berk 1999 or Forsells and Kenny 2004). The probability measure *INFE_2* uses the same proxy for the perceived inflation, but the density function of the expected inflation is triangular (see: Łyziak 2010). Deriving the probability measure *INFE_3* the normal distribution is applied, but the CPI measure of current inflation is replaced with a subjective indicator quantified on the basis of additional survey question (in line with Batchelor and Orr 1988 or Dias, Duarte and Rua 2007). The logistic (and linear) function method developed by Papadia and Basano (1981) is used to derive the fourth measure of consumer inflation expectations (*INFE_4*). As far as regression measures are concerned, their response to changes in current inflation is model-dependant, therefore it is not analysed in the experiment.

We analyse four cases different from each other in terms of the distribution of responses to survey questions on inflation perception and expectations. In the first case 20% of respondents choose every single response to both survey questions. The second case differs in terms of the distribution of responses to the survey question on inflation perception, which is relatively worse (a percentage of respondents declaring increase in prices amounts to 90%). The remaining two cases differ from the first one in terms of the distribution of responses to the question on infla-

tion expectations, which is relatively better in the third case (85% of respondents declare that prices will increase at the same rate or at slower rate) and worse in the fourth case (40% of respondents claim that prices will increase more rapidly).

Analysing the data presented in Table 4 it is difficult to find much regularity – analysed measures of inflation expectations react quite differently for different distributions of responses to survey questions. However, it is clear that all of them react to changes in current inflation and that the reaction of subjectified measure of inflation expectations is delayed. It should be underlined that the exercise is purely technical in a sense that we do not consider the impact of current inflation on survey responses, which could magnify its impact on quantified indicators. However, the experiment clearly shows that the current inflation affects all the quantified measures of inflation expectations, although to different degree.

Table 4. Response of different measures of inflation expectations to a change in current inflation (*INF_0*)

		change in current inflation	response (in p.p.)			
			INFE_1	***INFE_2***	***INFE_3***	***INFE_4***
Case I	maximum response [lag]	1 [0]	0.50 [0]	0.56 [0]	0.25 [12]	0.50 [0]
	response in the long-run	1	0.50	0.50	0.25	0.50
Case II	maximum response [lag]	1 [0]	0.50 [0]	0.56 [0]	0.55 [12]	0.50 [0]
	response in the long-run	1	0.50	0.50	0.55	0.50
Case III	maximum response [lag]	1 [0]	0.66 [0]	0.66 [0]	0.33 [12]	0.71 [0]
	response in the long-run	1	0.66	0.66	0.33	0.71
Case IV	maximum response [lag]	1 [0]	1.07 [0]	1.25 [0]	0.54 [12]	0.83 [0]
	response in the long-run	1	1.07	1.07	0.54	0.83

Case I: A_1^p=20%, A_2^p=20%, A_3^p=20%, B^p=20%, C^p=20%, A_1^e=20%, A_2^e=20%, A_3^e=20%, B^e=20%, C^e=20%;
Case II: A_1^p=40%, A_2^p=30%, A_3^p=20%, B^p=5%, C^p=5%, A_1^e=20%, A_2^e=20%, A_3^e=20%, B^e=20%, C^e=20%;
Case III: A_1^p=20%, A_2^p=20%, A_3^p=20%, B^p=20%, C^p=20%, A_1^e=5%, A_2^e=50%, A_3^e=35%, B^e=5%, C^e=5%;
Case IV: A_1^p=20%, A_2^p=20%, A_3^p=20%, B^p=20%, C^p=20%, A_1^e=40%, A_2^e=25%, A_3^e=10%, B^e=15%, C^e=10%.
In all the cases: D^p=0, D^e=0.

INFE_1: probability measure, objectified, normal distribution, *INFE_2*: probability measure, objectified, triangular distribution, *INFE_3*: probability measure, subjectified, normal distribution, *INFE_4*: logistic function measure.

Source: own calculations.

3.6. Are quantitative survey data on inflation expectations reliable?

Except qualitative surveys there are also quantitative ones, aimed at assessing economic agents' inflation perception and expectations in a more straightforward way. There are some experiments with asking consumers in such a manner[12]; however opinions about reliability of quantitative survey data are mixed. As shown by Jonung (1986), when asked about numerical estimates of the perceived and expected rate of inflation, uncertainty increases considerably. Pesaran and Weale (2006) suggest that it is easier to obtain reliable responses to qualitative questions than to more precise quantitative questions. They indicate a trade-off between the loss of information caused by a qualitative nature of survey questions and the costs in terms of the response rate and therefore possible bias from asking more precise questions. In their view responses to more precise questions yield more precise, but not necessarily more accurate answers (the 'truth elicitation problem'). Conclusions from empirical studies using quantitative survey data on consumer inflation expectations in EU economies are ambiguous. Lindén (2004) concludes that the quantitative

[12] E.g. Swedish Household Survey, the University of Michigan survey on consumer attitudes. At the workshop on business and consumer surveys in Brussels in November 2002, it was decided to introduce new questions into the European Commission Consumer Survey. As a result, qualitative survey questions concerning price perceptions and expectations were supplemented with the quantitative ones. Consumers declaring qualitatively that the price level has changed [will change] are asked about their numerical estimates.

and qualitative data in the euro area countries are similar and even if the qualitative data have a long time series, measuring the interest variable directly offers substantial advantages. In his view quantification methods applied to qualitative data do no more than scale the qualitative data to inflation rate, which means that any information on too high or too low perceptions and expectations is lost. Furthermore, some quantification procedures smooth the data in such a way that any structural shifts in the resulting perceived and expected inflation rates are concealed. Poncet (2003) shows that French consumers' quantitative assessment of future price changes seems consistent with qualitative responses, but quantitative survey questions do not add any new significant information. Contradictory results are provided by Buiten and Rooijakkers (2003), who demonstrate that in the Netherlands aggregate (point) estimates are not representative, contain a statistical bias, are in part arbitrary and imprecise. Quantitative questions seem to be difficult for a substantial part of consumer population, which leads to inconsistencies in the point estimates for people expecting higher price increases than currently: about one third of the respondents actually give a lower point estimate. Polish experiences with the use of quantitative questions on inflation perception and expectations are even more disappointing (Łyziak and Stanisławska 2006, pp. 15-17). On the one hand there is consistency between qualitative and quantitative responses on the aggregate level, which means that respondents declaring higher inflation perception or expectations in the qualitative part of the survey provide higher quantitative responses on average. However, inconsistency of individual responses is even more visible than in the Dutch case. In addition, respondents asked to state their opinions in the quantitative manner tend to declare specific numbers, such as 5%, 10%, 15%, 20%, etc. The effect of this kind – called 'digit preference' – is a widespread phenomenon, exhibited in responses to open, numeric questions (e.g. Baker 1992, Curtin 2009).[13] Problems mentioned above suggest a low reliability of quantitative data. Quantitative questions seem to be excessively difficult for a significant part of respondents, who declare internally inconsistent and random numbers.

4. Quantified measures of consumer inflation expectations in the EU economies

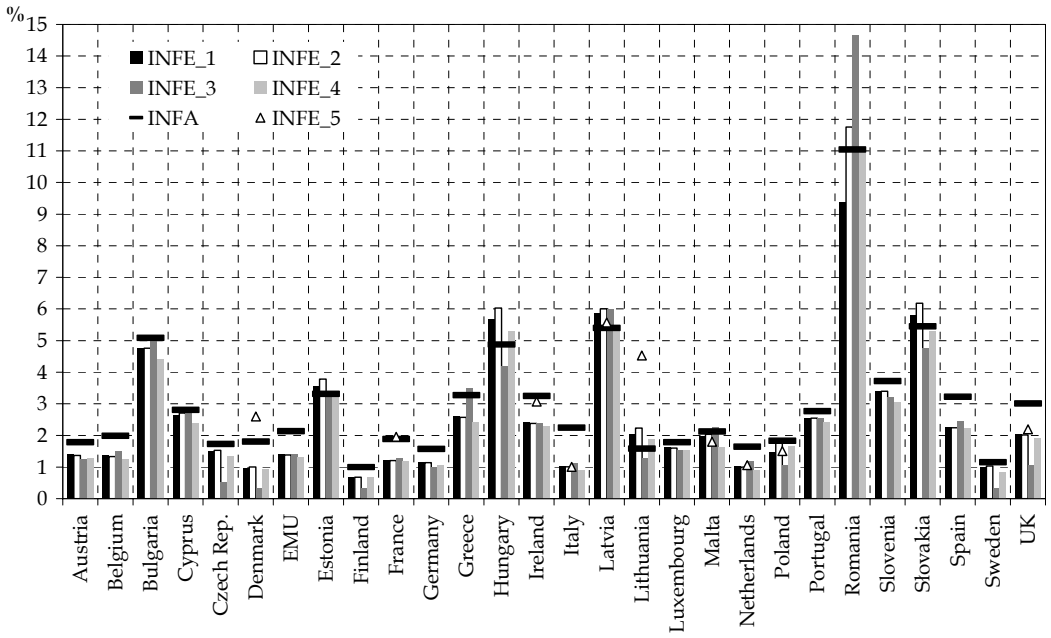
This section presents European consumers' inflation expectations derived on the basis of qualitative data from the European Commission Consumer Survey. Three kinds of quantification methods are used, namely: the probability method, the regression method and the logistic (and linear) function method.

Quantifying probability measures of inflation expectations we refer to the canonical Carlson and Parkin (1975) approach modified in order to use all information embodied in the survey data. However, different assumptions concerning the density function of the expected rate of inflation and a measure of perceived inflation are made. Except for measures *INFE_1*, *INFE_2*, *INFE_3* and *INFE_4*, whose quantification method was described in the previous section of the paper, the final measure of inflation expectations considered (*INFE_5*) is based on the regression method. Five regression models were estimated, namely: a simple model based on the balance statistic (weighting fractions of respondents to the survey question on inflation perception with weights: 3, 2, 1, 0, -1) as well as the models proposed by Anderson (1952), Pesaran (1984, 1987), Smith and McAleer (1995) and Cunningham (1997). The choice of the final specification reflected both statistical properties of the estimated regressions as well as their economic interpretation (e.g. correct signs of the estimated coefficients).

[13] According to this study, in 2003-2005 the percentage of respondents declaring that prices will rise at a faster [slower] rate and giving inconsistent numbers approached 37% [47%] on average. In the case of 78% [76%] of respondents giving positive numbers from the range 0%-40%, their perceived [expected] inflation was dividable by 5.

The measures of inflation expectations described above were calculated for all the European Union economies and for the Economic and Monetary Union as a whole. Probability and logistic function measures are available for all the economies under consideration, while the regression measure – only for some of them. Figure 2 presents averages of available measures of inflation expectations and average inflation (*INFA*) for the common sample period, starting in November 2002.

Figure 2. Averages of actual inflation (*INFA*) and different measures of inflation expectations (*INFE_1*, *INFE_2*, *INFE_3*, *INFE_4*, *INFE_5*), common sample: 2002:11-2007:05



Source: own calculations based on EC and IFS data.

To assess uncertainty in measuring inflation expectations differences between maximum and minimum estimates were calculated. Table 5 shows the results.

Table 5. Differences between inflation expectations' measures, common sample: 2002:11-2007:05

	Data availability		Wedge (in p.p.), INFE_i, i=1, 2, 3, 4				average correlation: INFE_i, 1<i<5 with INFE_1	Wedge (in p.p.), INFE_i, i=1, 2, 3, 4, 5				average correlation: INFE_i, 1<i<5 with INFE_1
	INFE_1 – INFE_4	INFE_5	mean	minimum	maximum	relative to mean		mean	minimum	maximum	relative to mean	
Austria	x		0.25	0.06	0.61	18.7%	0.95	0.25	0.06	0.61	18.7%	0.95
Belgium	x		0.30	0.06	0.81	23.5%	0.96	0.30	0.06	0.81	23.5%	0.96
Bulgaria	x		1.19	0.08	3.78	23.6%	0.97	1.19	0.08	3.78	23.6%	0.97
Cyprus	x		0.86	0.02	2.86	45.4%	0.91	0.86	0.02	2.86	45.4%	0.91
Czech Rep.	x		1.06	0.00	2.96	68.2%	0.94	1.06	0.00	2.96	68.2%	0.94
Denmark	x	x	0.70	0.19	2.18	74.9%	0.95	1.60	1.19	2.18	193.6%	0.90
EMU	x		0.19	0.06	0.47	14.3%	0.91	0.19	0.06	0.47	14.3%	0.91
Estonia	x		1.00	0.24	2.87	40.8%	0.95	1.00	0.24	2.87	40.8%	0.95
Finland	x		0.42	0.00	1.15	36.5%	0.96	0.42	0.00	1.15	36.5%	0.96
France	x	x	0.17	0.02	0.47	14.8%	0.90	0.81	0.35	1.14	71.5%	0.75
Germany	x		0.25	0.05	0.73	22.3%	0.95	0.25	0.05	0.73	22.3%	0.95
Greece	x		1.09	0.20	1.98	43.8%	0.94	1.09	0.20	1.98	43.8%	0.94
Hungary	x		1.88	0.10	6.29	33.2%	0.97	1.88	0.10	6.29	33.2%	0.97
Ireland	x	x	0.54	0.05	1.43	23.8%	0.93	0.99	0.16	1.80	45.0%	0.92
Italy	x	x	0.28	0.10	0.65	27.4%	0.94	0.33	0.11	0.71	32.1%	0.90
Latvia	x	x	1.55	0.09	3.31	30.9%	0.97	2.78	1.24	3.90	74.2%	0.90
Lithuania	x	x	1.29	0.45	3.46	47.4%	0.97	3.43	0.81	9.16	92.6%	0.91
Luxembourg	x		0.21	0.06	0.73	13.8%	0.95	0.21	0.06	0.73	13.8%	0.95
Malta	x	x	1.00	0.09	2.49	54.9%	0.94	1.41	0.09	3.61	70.8%	0.78
Netherlands	x	x	0.46	0.09	1.78	45.5%	0.80	1.00	0.10	3.25	107.9%	0.71
Poland	x	x	0.84	0.03	2.86	48.0%	0.97	0.97	0.26	2.86	51.1%	0.95
Portugal	x		0.37	0.06	0.86	15.1%	0.96	0.37	0.06	0.86	15.1%	0.96
Romania	x		3.73	0.25	9.08	29.3%	1.00	3.73	0.25	9.08	29.3%	1.00
Slovakia	x		1.61	0.11	4.68	30.8%	0.98	1.61	0.11	4.68	30.8%	0.98
Slovenia	x		0.77	0.15	1.93	24.1%	0.98	0.77	0.15	1.93	24.1%	0.98
Spain	x		0.30	0.03	0.83	15.0%	0.96	0.30	0.03	0.83	15.0%	0.96
Sweden	x		0.74	0.02	2.38	51.3%	0.96	0.74	0.02	2.38	51.3%	0.96
United Kingdom	x	x	0.98	0.56	1.83	50.4%	0.94	1.27	0.90	2.19	66.9%	0.81
minimum			*0.17*	*0.00*	*0.47*	*13.8%*	*0.80*	*0.19*	*0.00*	*0.47*	*13.8%*	*0.71*
maximum			*3.73*	*0.56*	*9.08*	*74.9%*	*1.00*	*3.73*	*1.24*	*9.16*	*193.6%*	*1.00*
mean			***0.86***	***0.11***	***2.34***	***34.6%***	***0.95***	***1.10***	***0.24***	***2.71***	***48.4%***	***0.92***

Source: own calculations based on EC and IFS data.

Summarizing the 2002-2007 results the following points should be made: Firstly, regression measures seem quite different from the remaining ones. The difference between the extreme estimates of inflation expectations equals 1.1 pp on average for all the measures and 0.9 pp for probability and logistic function measures, which corresponds, respectively, to 48.4% and 34.6% of their average. Secondly, taking into consideration absolute and relative wedge between probability and logistic function measures, it occurs that uncertainty in measuring consumer expectations is relatively low in France, EMU as a whole, Luxembourg, Spain, Austria, Portugal, Germany, Belgium and Italy, while relatively high in Romania, Czech Republic, Hungary, Denmark, Lithuania, Slovakia, Malta, Latvia and the United Kingdom. Thirdly, all the measures of consumer inflation expectations are highly correlated with each other, which suggests that even in economies, where measurement uncertainty is elevated, all the proxies follow similar tendencies.

Conclusions

Central banks need direct measures of consumer inflation perception and expectations for a number of reasons. They comprise: communication of monetary policy, understanding the formation of perceptions and expectations, using those measures in modelling and forecasting as well as in the assessment of central bank credibility.

There is an array of methods that can be applied to summarize survey responses or to quantify consumer inflation perception and expectations on the basis of qualitative survey data. However interpreting those measures one should keep in mind their nature and related interpretation constraints. For example, it should be underlined that balance statistics – although useful in some analyses – do not measure perceived or expected inflation directly, because of the fact that a set of constant, predetermined weights selected in ad hoc manner is applied. Regression methods impose unbiasedness of inflation perception and they do not use efficiently all survey information (some fractions of respondents must be aggregated). Finally, in line with the survey question, all quantification methods impose some correlation between current inflation and inflation expectations.

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Annex

Table 6. Surveys containing questions on inflation expectations conducted by central banks in emerging market economies – BIS questionnaire results

Country	Survey(s)	Population / Respondents	Frequency	Inflation expectations measure(s)
Argentina	REM (Market Expectations Survey)	49 participants, institutions that provide well-grounded forecasts on a regular basis (10 banks, 7 investment banks and brokerage firms, 14 financial and economic consultants, 8 foundations and think tanks and 10 universities).	monthly, since December 2003	expected CPI change in 1, 2 and 12 months and in the current year and the next year (average and year-end)
Bahrain	*The Central Bank of Bahrain does not conduct any survey on inflation expectations.*			
Brazil	Focus Report	firms, financial institutions and economic consultancies.	weekly	CPI and PPI inflation two and three years ahead. Expectations of the same variables on a monthly basis
Chile	Economic Expectations Survey	financial institutions' consultants, executives and advisors (around 40 participants)	monthly, since February 2000	CPI m/m in the current month, average CPI m/m in the next 12 months, year-end CPI y/y in the current and next year
Colombia	Encuesta de expectativas económicas	business managers, 170 participants	quarterly, since 2000	expected annual inflation 1, 2, 3 and 4 quarters ahead
	Encuesta de inflación y tasa de cambio a expertos financieros	professional forecasters in the financial sector, 41 participants	monthly, since 2003	expected inflation: current month, year-end and 12 months ahead
Czech Rep.	Inflation expectations of financial markets	financial markets analysts very active in capital and money markets from large banks and brokerages (15 participants)	monthly, since May 1999	expected CPI changes in 1 year and 3 years ahead
	Inflation expectations of managers of non-financial corporations	stratified sample of non-financial corporations and companies of the region, by activity and role in the Czech economy (fixed sample, 62 respondents)	quarterly, since June 1999	year-on-year consumer price changes in the next 12 and 36 months
	Inflation expectations of households	household members between 15-79 years old randomly selected in 14 regions (600 respondents)	quarterly, since June 1999	year-on-year consumer price changes in the next 12 and 36 months
Hungary	Households' inflation expectations survey	households	quarterly	perceived inflation in the last 12 months; expected inflation in next 12 months
	Firms' inflation expectation survey	firms	quarterly	perceived and expected change in general domestic sale prices and in perceived and expected inflation
Israel	Companies Survey Professional forecasters	private companies (excluding banks)	quarterly, since September 1983	expected change in CPI, 3 months and 1 year forward
Mexico	Survey on the private sector's economic expectations	37 private sector economic groups analysts	monthly, since September 1994	expected CPI and core CPI inflation: monthly for the next 12 months; end of years; 4-year average after 5 years from the current date
Oman	*The Central Bank of Oman does not conduct any survey on inflation expectations.*			
Poland	NBP producer survey	approximately 900 enterprises	quarterly, since 1996	prices of produced goods: +3 months; CPI and PPI: +3 months, +12 months
South Africa	Survey of Inflation expectations	2,500 representative households are sampled. Also fixed sample of nonfinancial firms, financial analysts, and trade unions	quarterly, since 4th quarter 2000	expectations for the current and next two years on: average CPI inflation, average CPIX inflation rate
Turkey	Survey of expectations	experts and decision makers from the financial and corporate sectors and professionals (120 respondents)	twice a month, since August 2001 (1st and 3rd week)	expected CPI for the current month, next month, 2 months ahead, end of year, next 12 months and 24 months
	Consumer tendency survey	approximately 8,000 individuals at the age of 15 and above, having a job in urban and rural areas of Turkey that provides income	monthly, since December 2003	price expectations
Saudi Arabia	*The Saudi Arabia Monetary Authority does not produce any inflation expectation survey.*			
Hong Kong	*The HKMA does not conduct any survey on inflation expectations.*			

Country	Survey(s)	Population / Respondents	Frequency	Inflation expectations measure(s)
India	Inflation expectation survey for households	households	quarterly, since September 2005	expected inflation for next quarter and year
Indonesia	Consumer survey	approximately 4,650 households from 18 cities	monthly, since October 1995	price change expectations
	Markets perception survey	100 respondents from 11 big cities including economists, economic researchers, capital market analysts, academic societies and bankers	quarterly since from September 2001 to December 2006	inflation rate expectations
	Business Survey	respondents (± 2,000 companies) are selected by sampling from 32 provinces	quarterly, since 2003Q1	inflation rate expectations in the end of the year
	Retail Sales Survey	respondents (± 270 retailers) are selected by sampling from 5 major cities	monthly, since January 2001	price change expectations
Korea	Consumer sentiment survey	stratified sample of 2,000 households	monthly	expected CPI change in one year
	Survey of inflation expectations of experts	45-50 professional forecasters	quarterly	expected CPI change in two quarters
Mongolia	Inflation expectation survey of consumers, analysts and companies	individuals (1000), analysts (11), companies (350)	semi annual, since December 2008	expected annual inflation
Malaysia	*No survey available*			
Nepal	*No survey available*			
Philippines	Business expectations survey (BES)	top 5,000 corporations registered with the Securities and Exchange Commission (SEC)	quarterly, since June 2001	outlook for inflation
Pakistan	*No survey done by central bank.*			
Sri Lanka	Inflation expectation survey	households (123), investors (148), professional economists (30), trade unionists (12)	monthly	inflation expectations
Taiwan, R.O.C.	*Taiwan dose not have surveys on inflation expectations.*			
Thailand	Survey of the Business Sentiment Index	around 800 firms, including the businesses in production, trade, and service sectors	monthly, since January 2007	expected inflation for the next 12 months.

Source: BIS questionnaires carried out between mid 2007 and early 2010.