

Nielsen, Hannah

Working Paper

Inflation Expectations in the EU: Results from Survey Data

SFB 373 Discussion Paper, No. 2003,13

Provided in Cooperation with:

Collaborative Research Center 373: Quantification and Simulation of Economic Processes,
Humboldt University Berlin

Suggested Citation: Nielsen, Hannah (2003) : Inflation Expectations in the EU: Results from Survey Data, SFB 373 Discussion Paper, No. 2003,13, Humboldt University of Berlin, Interdisciplinary Research Project 373: Quantification and Simulation of Economic Processes, Berlin,
<https://nbn-resolving.de/urn:nbn:de:kobv:11-10049942>

This Version is available at:

<https://hdl.handle.net/10419/22228>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Inflation Expectations in the EU - Results from Survey Data

Hannah Nielsen*

March 2003

Inflation expectations are extracted from the Consumer Survey, which is conducted by the European Commission for the European Union. Using the probability method to quantify the qualitative answers different distribution functions and scaling parameters are assumed to cope with the properties of the data properly. The forecasting ability of respective series is assessed also compared to the balance statistic. Furthermore the time horizon of the survey participants while answering the questionnaire is analyzed, because the empirical results show that it might not coincide with the time horizon implied by the formulation of the question.

Keywords: Inflation expectations; survey data; quantification methods

JEL classification: C42, C22, E37, E58

*FU and HU Berlin, Institut für Statistik und Ökonometrie, Sonderforschungsbereich 373, Boltzmannstr. 20, D-14195 Berlin, Germany, e-mail: hannahni@zedat.fu-berlin.de. Financial support of the Deutsche Forschungsgemeinschaft, SFB 373, is gratefully acknowledged. I thank Jürgen Wolters, FU Berlin, Stefan Daske and Matthias Fengler, SFB 373, for helpful comments and suggestions.

1 Introduction

Expectations are an important ingredient and tool of economic theory and policy. Particularly if the decisive factors are real variables the expected inflation rate plays a prominent role. If consumers expect the inflation rate to be very low for the next years it is more likely that they postpone expenditures than if they anticipate it to be particularly high. Trade unions as well will try to achieve higher nominal wages if they anticipate the inflation rate to be rather high.

Within the context of the transmission mechanism of monetary policy inflation expectations should be carefully regarded. Like many other central banks, the European Central Bank pursues price stability as its main goal. To keep inflation at a low level, expected inflation as well should be held at a low level, due to its substantial influence on the actual inflation rate (European Central Bank, 2000).

To analyze the behaviour of the expected inflation rate to obtain results concerning its characteristics some direct measure of expectations is needed. Possible direct measures are financial market instruments and surveys (Chan-Lee, 1980). Even if suitable financial market instruments exist, e.g. inflation indexed bonds, their liquidity is mostly not sufficient to produce reliable estimates. Therefore survey based data are a good choice to obtain time series of inflation expectations.

There exists a great variety of surveys concerning the expectations of consumers, producers or so called experts regarding the future development of prices, production, employment or other economic variables. One well-known survey is, for example, the Livingston survey, which is being conducted already since 1946 and is directed to professional economists. Other popular surveys that have been exploited by various economists are e.g. the one of the Michigan Survey Research Center, the Consensus Forecasts, the U.K. Gallup Poll or the survey conducted by the ifo-Institute.

These surveys can be differentiated with respect to several characteristics, e.g. the number of answer possibilities, the choice of consumers or producers as target group or the frequency of the questioning, but the probably most decisive difference is whether it is a quantitative or qualitative survey. Quantitative surveys ask the participants directly for their expectations and receive a specific point estimate as answer. Qualitatively conducted surveys instead merely request a tendency and therefore have to be quantified prior to further empirical investigation. For this quantification process some assumptions have to be made that are crucial for the resulting series. For the quantification the probability method, the regression method and the simple balance statistic can be employed. In the following the main focus will lie on the probability method as this allows the most flexible modelling. In the context of the probability method a certain distribution function has to be specified as well as a parameter to scale the expected inflation rate.

This paper is organized as follows. The next section contains a description of the quantification technique used for the empirical application especially for the design of the consumer survey conducted by the European Commission (EC). In section 3 the empirical results concerning the distribution function, the time horizon of the individuals and the forecasting ability of the different scaling parameters are presented as well as a comparison of the probability method with the balance statistic. The paper is closed with some concluding remarks.

2 Quantification technique

2.1 Probability method

The probability method was first employed by Theil (1952) and has been reused very frequently by various authors.¹ Due to their seminal article it is also well known as Carlson-Parkin method (Carlson and Parkin, 1975).

The original method has been derived for a trichotomous survey, i.e. the survey participants have three possible answer categories. Focusing on price expectations, these are 'price will increase', 'price will decrease' and 'no change in price'.²

As in this paper data from the EU consumer survey is used, the technique has to be adapted to the design of the respective questionnaire (Batchelor and Orr, 1988). Therefore not the trichotomous, but the pentachotomous case³ will be considered, which has the five following answer categories: Prices will 'fall slightly', 'be stable', 'increase at a slower rate', 'increase at the same rate' or 'increase more rapidly'.

In general, the probability method is based on the following assumptions:⁴

Assumption 2.1 *The survey participants form their expectations according to a subjective probability distribution defined over the percentage change of prices expected for the following period.*

Assumption 2.2 *The individual subjective probability distributions can be aggregated to give the joint probability distribution $f(x_{t+1}|\Omega_t)$, where x_{t+1} is the future percentage change of prices at time t for the period $t + 1$ and Ω_t the information set at time t . It is*

¹Studies using data from the EU consumer survey are e.g. Berk (1999, 2000), Geberding (2001), Reckwerth (1997) or Papadia (1983).

²In some surveys there is an additional answer category 'don't know', but these answers will be divided up proportionally and added to the other categories as this category is not relevant for quantification.

³The terms trichotomous and pentachotomous originate from the Greek words $\tau\rho\acute{\iota}\chi\alpha$ and $\pi\acute{\epsilon}\nu\tau\alpha\chi\alpha$, which mean threefold and fivefold.

⁴For a comprehensive description of this method see e.g. Pesaran (1987) or Visco (1984).

assumed that this distribution has finite first and second order moments and that

$$E[x_{t+1}|\Omega_t] = {}_t\mu_{t+1},$$

where ${}_t\mu_{t+1}$ is the expected value of x at time t for the period $t + 1$.

In this context the individual expectations can be seen as independent drawings from this joint probability distribution.

These preceding assumptions are valid for all kinds of surveys while the following assumptions and corresponding results depend on the design of the survey and will therefore be presented only for the pentachotomous survey of the European Commission.

Assumption 2.3 *There exists an interval $(-\delta_t^L, \delta_t^U)$ around 0, with $\delta_t^L, \delta_t^U > 0$, such that the participants report 'no change' in prices if the price change expected by them lies within this interval. There exists also an interval $(\tilde{\mu}_t - \epsilon_t^L, \tilde{\mu}_t + \epsilon_t^U)$ around the subjective mean perceived inflation rate $\tilde{\mu}_t$, with $\epsilon_t^L, \epsilon_t^U > 0$, such that the individuals report that prices 'increase at the same rate' if the expected price change is covered by this interval. The participants answer therefore in the following manner: Prices will*

- (i) fall slightly, if $x_{t+1} \leq -\delta_t^L$
- (ii) be stable, if $-\delta_t^L < x_{t+1} \leq \delta_t^U$
- (iii) increase at slower rate, if $\delta_t^U < x_{t+1} \leq \tilde{\mu}_t - \epsilon_t^L$
- (iv) increase at same rate, if $\tilde{\mu}_t - \epsilon_t^L < x_{t+1} < \tilde{\mu}_t + \epsilon_t^U$
- (v) increase more rapidly, if $\tilde{\mu}_t + \epsilon_t^U \leq x_{t+1}$.

Writing the proportions of the total response, denoted as ${}_tA_{t+1}$ 'fall slightly', ${}_tB_{t+1}$ 'be stable', ${}_tC_{t+1}$ 'increase at slower rate', ${}_tD_{t+1}$ 'increase at same rate' and ${}_tE_{t+1}$ 'increase more rapidly' in terms of the aggregated probability distribution leads to⁵

$$P(x_{t+1} \leq -\delta_t^L) = \int_{-\infty}^{-\delta_t^L} f(x_{t+1})dx_{t+1} = F(-\delta_t^L) = {}_tA_{t+1} \quad (1)$$

$$\begin{aligned} P(-\delta_t^L < x_{t+1} < \delta_t^U) &= \int_{-\delta_t^L}^{\delta_t^U} f(x_{t+1})dx_{t+1} \\ &= F(\delta_t^U) - F(-\delta_t^L) = {}_tB_{t+1} \end{aligned} \quad (2)$$

⁵The variable x_{t+1} stands from now on for the future percentage price conditional on the information set Ω_t . For notational simplification it is abstained from an additional super- or subscript Ω_t .

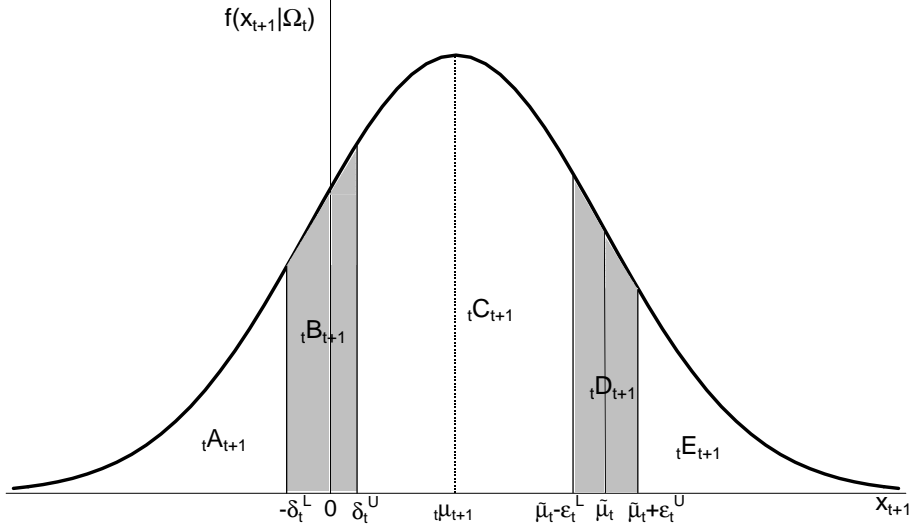


Figure 1: Quantification of pentachotomous survey data

$$\begin{aligned}
 P(\delta_t^U < x_{t+1} < \tilde{\mu}_t - \epsilon_t^L) &= \int_{\delta_t^U}^{\tilde{\mu}_t - \epsilon_t^L} f(x_{t+1}) dx_{t+1} \\
 &= F(\tilde{\mu}_t - \epsilon_t^L) - F(\delta_t^U) = {}_tC_{t+1}
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 P(\tilde{\mu}_t - \epsilon_t^L < x_{t+1} < \tilde{\mu}_t + \epsilon_t^U) &= \int_{\tilde{\mu}_t - \epsilon_t^L}^{\tilde{\mu}_t + \epsilon_t^U} f(x_{t+1}) dx_{t+1} \\
 &= F(\tilde{\mu}_t + \epsilon_t^U) - F(\tilde{\mu}_t - \epsilon_t^L) = {}_tD_{t+1}
 \end{aligned} \tag{4}$$

$$\begin{aligned}
 P(x_{t+1} \geq \tilde{\mu}_t + \epsilon_t^U) &= \int_{\tilde{\mu}_t + \epsilon_t^U}^{\infty} f(x_{t+1}) dx_{t+1} \\
 &= 1 - F(\tilde{\mu}_t + \epsilon_t^U) = {}_tE_{t+1},
 \end{aligned} \tag{5}$$

where $F(\cdot)$ is the cumulative distribution function of $f(x_{t+1})$. Figure 1 illustrates this classification for an arbitrary distribution function. The shaded regions are the two indifference intervals. Using a standardized variable and specifying a distribution function yields⁶

$$\frac{-\delta_t^L - {}_t\mu_{t+1}}{{}_t\sigma_{t+1}} = F^{-1}({}_tA_{t+1}) = {}_ta_{t+1} \tag{6}$$

$$\frac{\delta_t^U - {}_t\mu_{t+1}}{{}_t\sigma_{t+1}} = F^{-1}({}_tA_{t+1} + {}_tB_{t+1}) = {}_tb_{t+1} \tag{7}$$

⁶As ${}_tA_{t+1} + {}_tB_{t+1} + {}_tC_{t+1} + {}_tD_{t+1} + {}_tE_{t+1} = 1$, one of them is redundant.

$$\frac{\tilde{\mu}_t - \epsilon_t^L - {}_t\mu_{t+1}}{{}_t\sigma_{t+1}} = F^{-1}({}_tA_{t+1} + {}_tB_{t+1} + {}_tC_{t+1}) = {}_tc_{t+1} \quad (8)$$

$$\frac{\tilde{\mu}_t + \epsilon_t^U - {}_t\mu_{t+1}}{{}_t\sigma_{t+1}} = F^{-1}({}_tA_{t+1} + {}_tB_{t+1} + {}_tC_{t+1} + {}_tD_{t+1}) = {}_td_{t+1}. \quad (9)$$

From now on it will be assumed that the indifference intervals are symmetric, i.e. $\delta_t^L = \delta_t^U = \delta_t$ and $\epsilon_t^L = \epsilon_t^U = \epsilon_t$.⁷ Rearranging equations (6)-(9) leads to the general solution of the unknown parameters:

$${}_t\mu_{t+1} = \tilde{\mu}_t \cdot ({}_ta_{t+1} + {}_tb_{t+1}){}_tq_{t+1} \quad (10)$$

$${}_t\sigma_{t+1} = -\tilde{\mu}_t \cdot 2{}_tq_{t+1} \quad (11)$$

$$\delta_t = \tilde{\mu}_t \cdot ({}_ta_{t+1} - {}_tb_{t+1}){}_tq_{t+1} \quad (12)$$

$$\epsilon_t = \tilde{\mu}_t \cdot ({}_tc_{t+1} - {}_td_{t+1}){}_tq_{t+1}, \quad (13)$$

with ${}_tq_{t+1}^{-1} = {}_ta_{t+1} + {}_tb_{t+1} - {}_tc_{t+1} - {}_td_{t+1}$.

As the proportions ${}_tA_{t+1}$, ${}_tB_{t+1}$, ${}_tC_{t+1}$ and ${}_tD_{t+1}$ are known, ${}_ta_{t+1}$, ${}_tb_{t+1}$, ${}_tc_{t+1}$ and ${}_td_{t+1}$ can be computed assuming a specific distribution function. Hence, the parameters depend crucially on the choice of the distribution function as well as on the perceived inflation rate $\tilde{\mu}_t$.

Distribution function The choice of the distribution function is not a simple task. Carlson and Parkin (1975) propose to use a normal distribution and justify this assumption by appeal to the Central Limit Theorem. Many empirical studies follow this suggestion also out of convenience, because the normal distribution is easy to handle and extensively explored and tabulated.

Assuming a normal distribution, mean and standard deviation of the expectations are given by equation (10) and (11) with

$${}_ta_{t+1} = \Phi^{-1}({}_tA_{t+1}) \quad (14)$$

$${}_tb_{t+1} = \Phi^{-1}({}_tA_{t+1} + {}_tB_{t+1}) \quad (15)$$

$${}_tc_{t+1} = \Phi^{-1}({}_tA_{t+1} + {}_tB_{t+1} + {}_tC_{t+1}) \quad (16)$$

$${}_td_{t+1} = \Phi^{-1}({}_tA_{t+1} + {}_tB_{t+1} + {}_tC_{t+1} + {}_tD_{t+1}), \quad (17)$$

where $\Phi(\cdot)$ is the cumulative standard normal distribution function.

⁷This is not a necessary assumption, but is made to simplify matters. Seitz (1988) e.g. estimates asymmetric indifference intervals, which could possibly improve the forecasts.

Despite these advantages the normal distribution might not cope with the empirical findings. There are theoretical and empirical reasons to reject the assumption of normality. One deviation observed e.g. by Carlson (1975) and Lahiri and Teigland (1987) while analyzing inflation forecasts and correspondingly by Vining and Elwertowski (1976) for actual price changes is the peakedness which is not in line with the normal distribution. To account for this deviation the logistic and the central t -distribution, the latter suggested by Carlson (1975), are employed, both are more peaked than the normal distribution.

The logistic distribution function is defined as

$$H(x_{t+1}|\Omega_t) = \frac{1}{1 + e^{-\frac{x_{t+1} - t\mu_{t+1}}{\beta_t}}}, \quad (18)$$

where β_t is a scaling parameter and $t\sigma_{t+1} = \frac{\pi}{\sqrt{3}}\beta_t$. Using this definition the mean is calculated as given in equation (10) and the standard deviation as:⁸

$$t\sigma_{t+1} = -\tilde{\mu}_t \cdot \frac{2\pi}{\sqrt{3}} \cdot tq_{t+1}, \quad (19)$$

where

$$t a_{t+1} = \ln\left(\frac{tA_{t+1}}{1 - tA_{t+1}}\right) \quad (20)$$

$$t b_{t+1} = \ln\left(\frac{tA_{t+1} + tB_{t+1}}{1 - (tA_{t+1} + tB_{t+1})}\right) \quad (21)$$

$$t c_{t+1} = \ln\left(\frac{tA_{t+1} + tB_{t+1} + tC_{t+1}}{1 - (tA_{t+1} + tB_{t+1} + tC_{t+1})}\right) \quad (22)$$

$$t d_{t+1} = \ln\left(\frac{tA_{t+1} + tB_{t+1} + tC_{t+1} + tD_{t+1}}{1 - (tA_{t+1} + tB_{t+1} + tC_{t+1} + tD_{t+1})}\right). \quad (23)$$

The central t -distribution is defined as⁹

$$T_C = \frac{Y_1}{\sqrt{Y_2/n}},$$

where Y_1 follows the standard normal distribution and Y_2 is independently distributed as χ^2 with n degrees of freedom. The variance of the central t -distribution is given by $\frac{n}{n-2}$, $n > 2$. Praetz (1972) shows that to model the distribution of share price changes best a central t -distribution, scaled with its standard deviation, is used. Therefore the

⁸Remind that this π is not connected with the inflation, but only the number 3.14159...

⁹See Dudewicz and Mishra (1988).

standardized variable is scaled with $\theta^{(1)} = \sqrt{\frac{n}{n-2}}$ and equations (6)-(9) change to

$${}_t\check{a}_{t+1} = \theta^{(1)}{}_t a_{t+1} = T_C^{-1}({}_t A_{t+1}) \quad (24)$$

$${}_t\check{b}_{t+1} = \theta^{(1)}{}_t b_{t+1} = T_C^{-1}({}_t A_{t+1} + {}_t B_{t+1}) \quad (25)$$

$${}_t\check{c}_{t+1} = \theta^{(1)}{}_t c_{t+1} = T_C^{-1}({}_t A_{t+1} + {}_t B_{t+1} + {}_t C_{t+1}) \quad (26)$$

$${}_t\check{d}_{t+1} = \theta^{(1)}{}_t d_{t+1} = T_C^{-1}({}_t A_{t+1} + {}_t B_{t+1} + {}_t C_{t+1} + {}_t D_{t+1}), \quad (27)$$

where $T_C(\cdot)$ is the central t -distribution with n degrees of freedom. Mean and variance are now given by

$${}_t\mu_{t+1} = \tilde{\mu}_t \cdot ({}_t\check{a}_{t+1} + {}_t\check{b}_{t+1}){}_t\check{q}_{t+1} \quad (28)$$

$${}_t\sigma_{t+1} = -\tilde{\mu}_t \cdot 2\theta^{(1)}{}_t\check{q}_{t+1}, \quad (29)$$

with ${}_t\check{q}_{t+1}^{-1} = {}_t\check{a}_{t+1} + {}_t\check{b}_{t+1} - {}_t\check{c}_{t+1} - {}_t\check{d}_{t+1}$.

Another non-normal feature found by Carlson (1975) and Lahiri and Teigland (1987) and discussed e.g. by Foster and Gregory (1977) and Batchelor (1981, 1982) is the asymmetric behaviour of price changes. According to Lahiri and Teigland (1987) and Batchelor (1981) inflation expectations are predominantly positively skewed. Carlson (1975) relates the skewness parameter to the level of inflation, i.e. the expectations tend to be positively skewed in periods with high inflation and exhibit negative skewness when the inflation rate is rather low. Besides the empirical findings already the design of the possible answers indicates that the price expectations are positively skewed, because there are three potential answers for rising prices and only one for falling prices.

To model this possible asymmetric behaviour, two different skewed distributions are suggested, the noncentral t -distribution and the χ^2 -distribution.

The noncentral t -distribution is defined as¹⁰

$$T_N = \frac{X_1}{\sqrt{Y_2/n}},$$

where X_1 follows a normal distribution with mean γ and variance 1 and Y_2 is again an independent χ^2 -distribution with n degrees of freedom. Mean and variance depend now on the noncentrality parameter γ . According to Evans et al. (1993) the standard deviation of the noncentral t -distribution is

$$\theta^{(2)} = \sqrt{\frac{n}{n-2}(1 + \gamma^2) - \frac{n}{2}\gamma^2 \left[\frac{\Gamma((n-1)/2)}{\Gamma(n/2)} \right]^2},$$

¹⁰See Dudewicz and Mishra (1988).

where n are again the degrees of freedom and $\Gamma(\cdot)$ is the gamma function, i.e. $\Gamma(c) = \int_0^\infty e^{-u} u^{c-1} du$. Mean and standard deviation are calculated similarly to those of the central t -distribution, only the scaling parameter $\theta^{(1)}$ has to be replaced by $\theta^{(2)}$ in equation (24)-(29).

The noncentrality parameter γ cannot be determined within the system since it is related to the distribution function, which is assumed to be given. Regarding the empirical results and the theoretical argument a time-variant parameter should be chosen that is positive over most of the analyzed time period. Possible measures are the difference between the last official inflation rate and the average of inflation rates in the previous 12 months, proposed by Berk (1999), or the deviation of actual inflation during each month from its mean over the whole sample period, used by Batchelor (1981). Problems can arise, when these parameters are negative for quite a lot of sample points. The second measure is also questionable, because it uses information that was not available to the respondents at the time the questionnaire was completed. To ensure that the time-variant parameter of asymmetry is positive and resembles the development of the prices, the inflation rate itself regarding the publication lag can be chosen as well.

The second positively skewed distribution is the χ_n^2 -distribution, whose shape depends on n , the degrees of freedom. The mean of the χ_n^2 -distribution is n and the variance $2n$. The parameter n should not be chosen too low to ensure that the distribution function copes with the empirical findings. Because the χ_n^2 -distribution is originally defined for values that are greater or equal 0 it has to be shifted. To base the shift-parameter on empirical outcomes it is chosen such that the mean of the resulting distribution equals the mean of the actual inflation over the whole sample. Besides this the mean of the expected series is given by equation (10) with ${}_t a_{t+1}$, ${}_t b_{t+1}$, ${}_t c_{t+1}$ and ${}_t d_{t+1}$ defined as in equation (14) - (17), where the $\Phi^{-1}(\cdot)$ is replaced by the inverse of the χ_n^2 -distribution function. Due to the structure of this distribution, the variance of the expected series cannot be expressed in a way similar to the preceding distributions.

It is not clear whether the allowance for these deviations actually improves the accuracy of the forecasts or not. Balcombe (1996) allows in a general framework for skewed and kurtotic distributions and concludes that the reduction to the normal distribution cannot be rejected and that the standard model by Carlson and Parkin is the best. Berk (1999) furthermore states that the results based on the noncentral t -distribution are less accurate than those based on symmetric distributions and also Carlson (1975) admits that by incorporating skewness just a marginal improvement can be obtained.

Therefore all five distribution functions are applied in the empirical application to assess the possibility of improvements by allowing for non-normal features.

Threshold parameter In the case of a pentachotomous survey the perceived inflation rate $\tilde{\mu}_t$ performs a scaling role for the expected inflation rate and is consequently important as soon as the level of the expected time series is subject of investigation. Various measures for this scaling parameter can be thought of and have been used in the literature.

As it should reflect the observed inflation rate, the most recent rate available to the survey participants, i.e. π_{t-1} , where π_t is the officially published inflation rate, is one choice. Due to the delay in publication the lagged inflation is considered rather than π_t . A second possibility is the mean of the actual inflation rate over the whole observed period, $\frac{1}{T} \sum_{t=1}^T \pi_t$, but this would imply that the participants base their decisions in part on information that is not available at the time the decision is made. Therefore not the mean over the whole sample can be used, but instead the mean over the period that precedes the time of the decision.

Another possibility that does not necessarily rely on the officially published rate is to further exploit the survey results. In the context of the EU consumer survey and also some other surveys it is not only asked for the future development of prices, but also for the perception of the price development in the past. The question is designed in a similar way as the one discussed above. It is asked: 'Compared to 12 months ago, prices are...?' and the possible answers are: 'lower', 'the same', 'a little higher', 'quite a bit higher' and 'very much higher'. The quantification of this question can now be accomplished with two different methods. On the one hand it can be quantified similarly to the question discussed above and on the other hand it can be interpreted as trichotomous question. The answer possibilities 'a little higher', 'quite a bit higher' and 'very much higher' can be comprised within a category 'up', which leaves three possible answers.

But whatever quantification approach is followed, still a scaling parameter is needed. Considering the question as pentachotomous the scaling parameters discussed above can be applied, i.e. the lagged actual inflation rate or its mean. Taking it as trichotomous survey the indifference interval is the decisive variable.

2.2 Balance statistic

To compute the balance statistic is the easiest way to quantify qualitative data. This balance statistic is also published for various surveys.

It is based on the assumption that the expectations follow a discrete random variable. Depending on the design of the survey, the possible outcomes are -1, 0 and 1 for a trichotomous survey and -1, -0.5, 0, 0.5 and 1 for a pentachotomous survey. These outcomes are associated with the sample proportions ${}_tA_{t+1}$, ${}_tB_{t+1}$, ${}_tC_{t+1}$ and ${}_tA_{t+1}$, ${}_tB_{t+1}$, ${}_tC_{t+1}$, ${}_tD_{t+1}$, ${}_tE_{t+1}$ respectively, which are defined in the previous section. The expected mean

of this random variable, denoted as ${}_t\mu_{t+1}^B$ is then for a trichotomous survey defined as:

$$\begin{aligned} {}_t\mu_{t+1}^B &= -1 \cdot {}_tA_{t+1} + 0 \cdot {}_tB_{t+1} + 1 \cdot {}_tC_{t+1} \\ &= {}_tC_{t+1} - {}_tA_{t+1}, \end{aligned} \quad (30)$$

and for a pentachotomous as:

$$\begin{aligned} {}_t\mu_{t+1}^B &= -1 \cdot {}_tA_{t+1} - 0.5 \cdot {}_tB_{t+1} + 0 \cdot {}_tC_{t+1} + 0.5 \cdot {}_tD_{t+1} + 1 \cdot {}_tE_{t+1} \\ &= {}_tE_{t+1} + 0.5{}_tD_{t+1} - 0.5{}_tB_{t+1} - {}_tA_{t+1}. \end{aligned} \quad (31)$$

This balance statistic is easily calculated, but also rather restrictive compared to the probability method, which allows for a more flexible modelling.

3 Empirical application

3.1 Data

The data used have been obtained from the European Commission, Directorate General for Economic and Financial Affairs.¹¹ The European Commission (EC) conducts a monthly consumer survey in the 15 member countries of the European Union and publishes the seasonally adjusted¹² results for the single countries and for the two aggregates 'European Union' (EU) and 'Euro Area' (EA).¹³ This questionnaire contains questions about the financial and general economic situation, price expectations and unemployment. Concerning the price expectations two questions are of interest, which have already been introduced in the context of the quantification techniques. One question asks how prices are now compared to 12 months ago and the other aims to find out what the survey participants expect of the future price development. Both questions offer five answer possibilities,¹⁴ so this is a pentachotomous survey, for which the quantification techniques have been explained in the previous section.

The availability of the data restricts the time period to January 1985 to October 2001. In the following the aggregate of the member countries of the EU will be considered, not

¹¹The help of the DG ECFIN A-3, especially of Antonio Fuso is gratefully acknowledged.

¹²For copyright reasons it is not possible to obtain seasonally unadjusted data from the EU. For seasonal adjustment the program DAINTRIES, developed by EUROSTAT, has been used.

¹³The member countries of the EU are for the whole analyzed period Belgium, The Netherlands, Luxembourg, France, Germany, Italy, Ireland, the United Kingdom, Denmark and Greece, from 1986 on Portugal and Spain, and since 1995 Finland, Sweden and Austria. The EA encloses the participants of the monetary union, which means all countries of the EU except Denmark, the United Kingdom, Sweden and Greece (only until the end of 2000).

¹⁴Actually there is a sixth possible answer 'don't know', which will be divided up proportionally and added to the other five categories as this category is not relevant for the quantification.

the results for the single countries.¹⁵ In Figure 3 and 4 the monthly and in Figure 5 and 6 the annual proportions for the EU are depicted. From Figure 5 and 6 it is obvious that some answer categories, especially 'prices are lower' and 'prices will fall slightly' appear with very low percentages and that most participants perceive and expect an increase in prices.

To compute the actual inflation rate the Consumer Price Index for the EU is used, provided by the OECD¹⁶ and shown (in logarithms) in Figure 2, together with the annual, semiannual and three-months inflation rate.

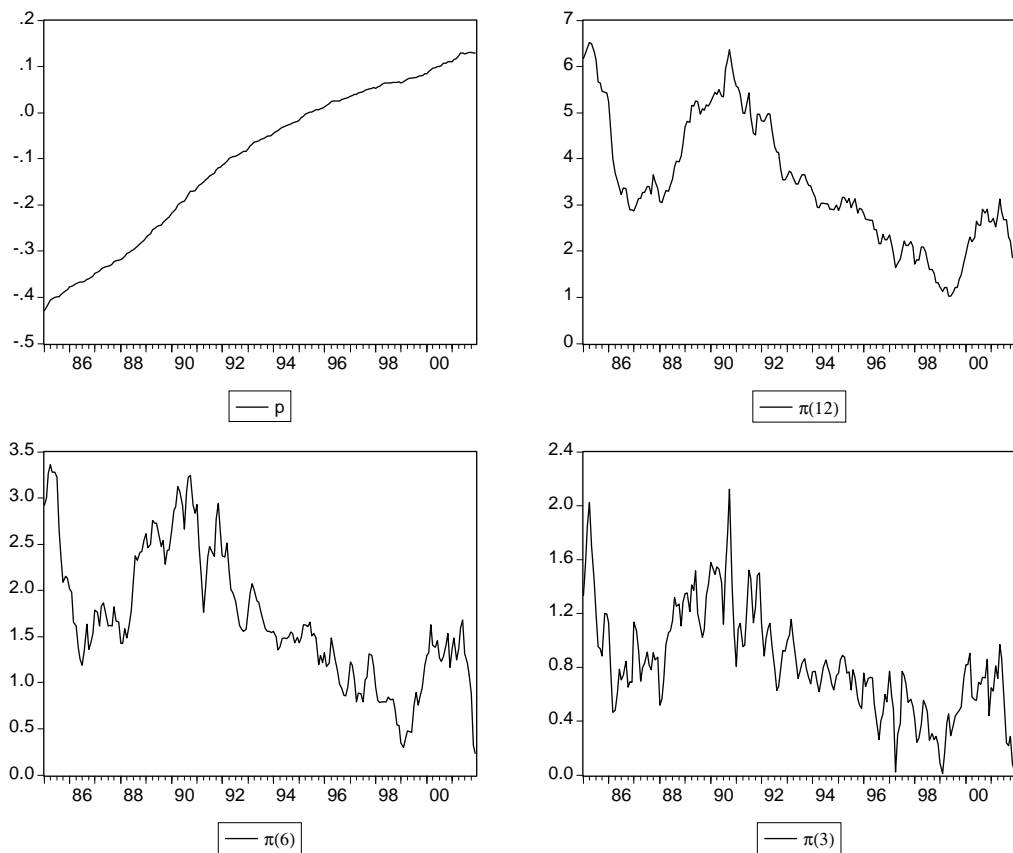


Figure 2: Consumer Price Index (p), annual ($\pi(12)$), semiannual ($\pi(6)$) and three-months ($\pi(3)$) inflation rate

¹⁵The survey is not conducted in Luxembourg, which is therefore not part of the sample. The single results are aggregated with a certain weighting scheme published by the EU, which bases on the value of consumers' expenditure, see European Economy, Supplement B (1979-).

¹⁶OECD, Main Economic Indicators, 025241K.

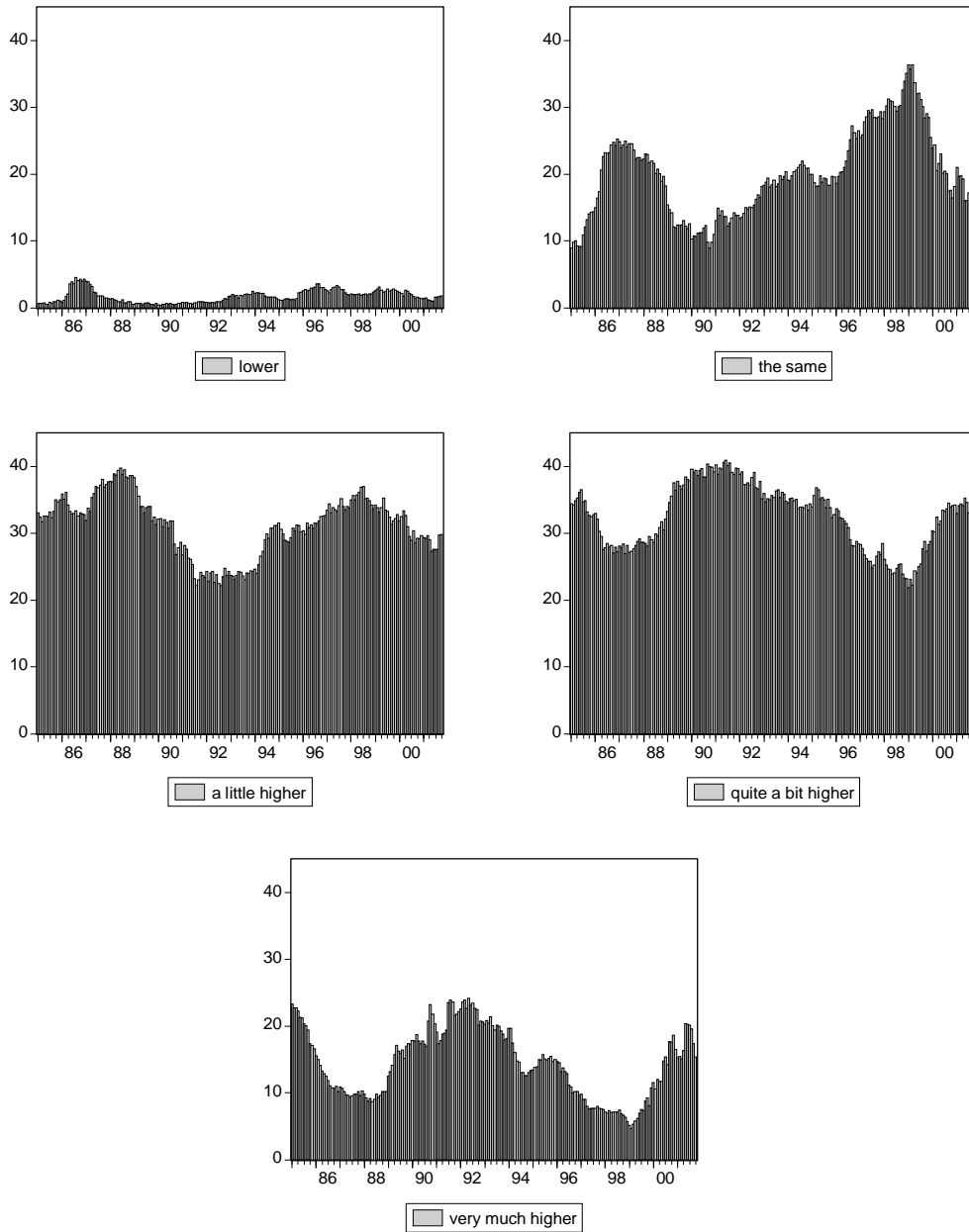


Figure 3: Compared to 12 months ago, prices are.... (in percent)

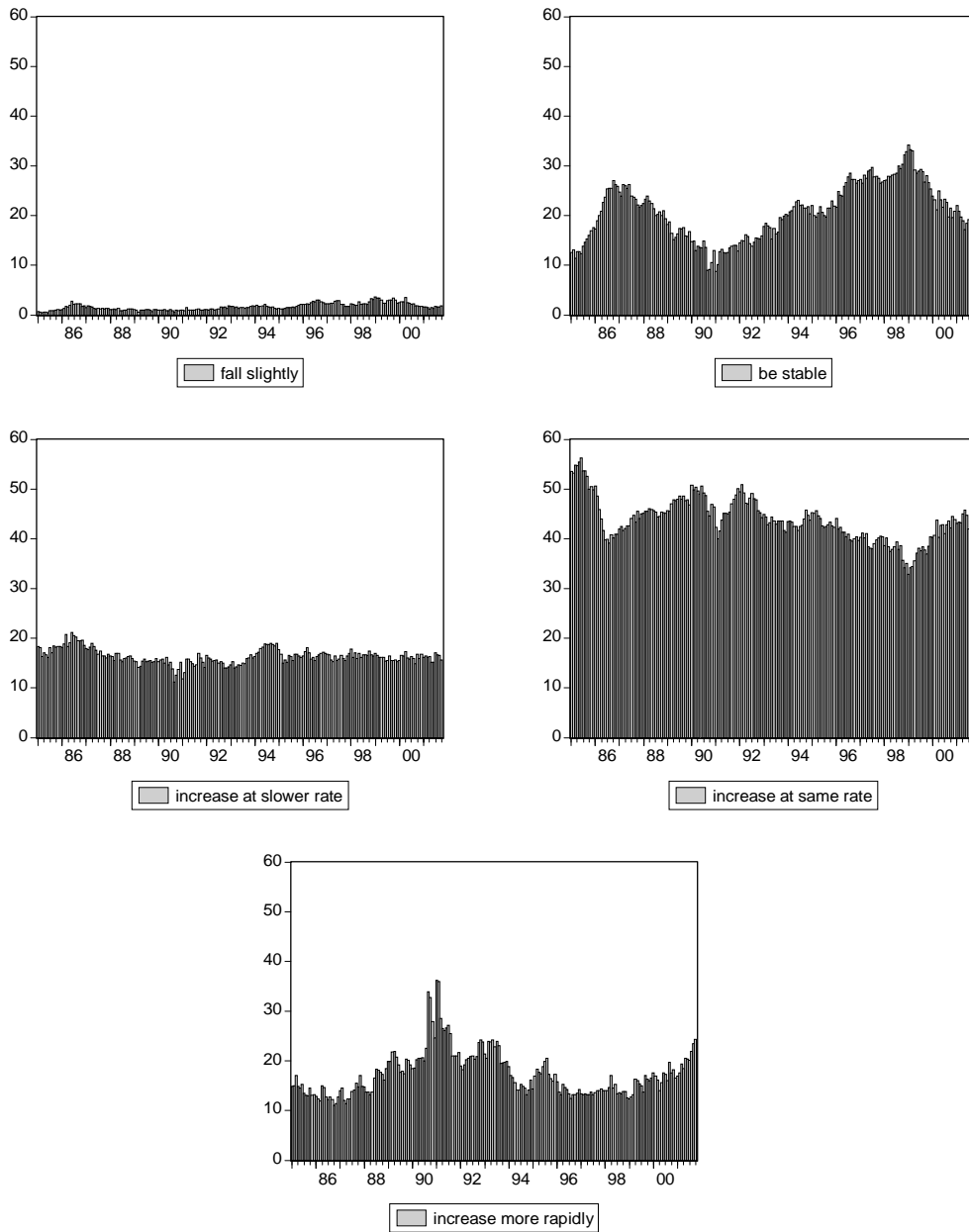


Figure 4: In the next 12 months, prices will.... (in percent)

Figure 5: Compared to 12 months ago, prices are....

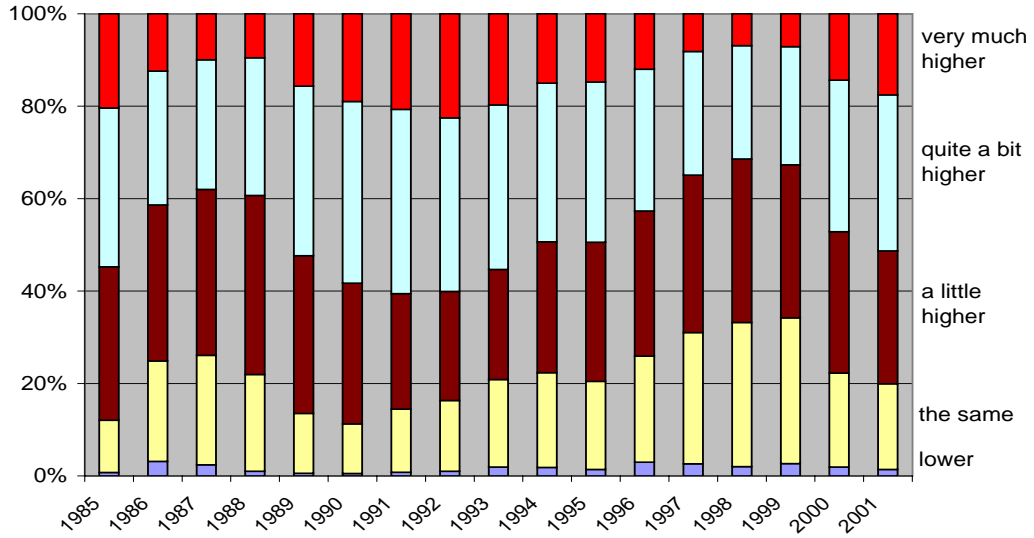
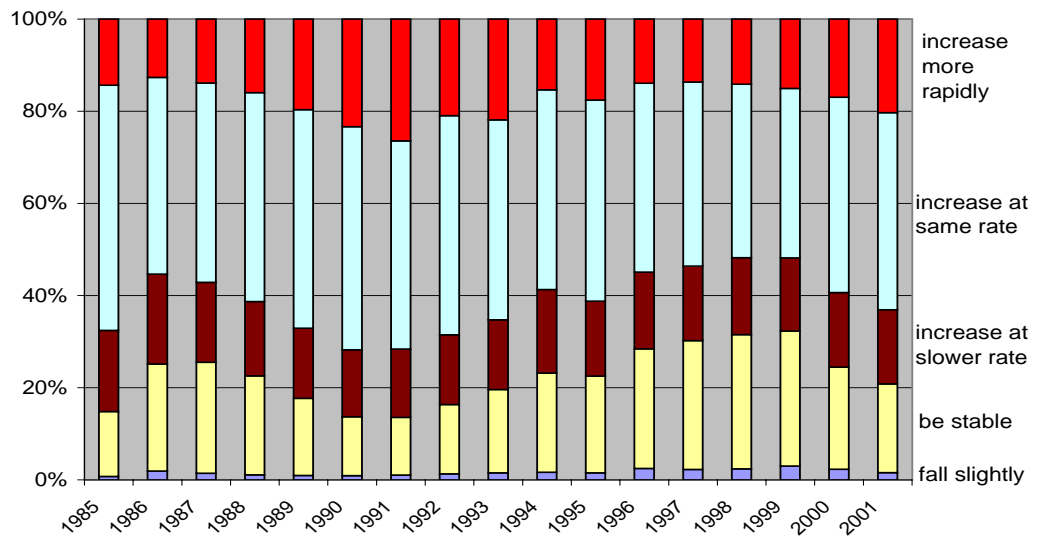


Figure 6: In the next 12 months, prices will....



3.2 Distribution function

In a first step the non-scaled expected inflation and its also non-scaled standard deviation is analyzed, i.e. referring to equation (10) and (11) $\frac{{}_t\mu_{t+12}}{\bar{\mu}_t} = ({}_t a_{t+12} + {}_t b_{t+12}) {}_t q_{t+12}$ and $\frac{{}_t\sigma_{t+12}}{\bar{\mu}_t} = -2{}_t q_{t+12}$. Because of the time horizon of the question, which is 12 months, and the use of monthly data, the expected inflation for $t + 12$ is calculated. As discussed in the previous section, the choice of the distribution function could be crucial for the resulting expected series.

To allow for peakedness and skewness deviating from normal, five different distribution functions are employed, the normal, logistic, central and non-central t -distribution and the χ^2 -distribution. Regarding both t -distributions the result obtained by Carlson (1975) on the basis of χ^2 -tests with grouped data is used, that six degrees of freedom provide the best estimates. The respective formulae for mean and standard deviation that have been derived in section 2.1 are used.

At first the symmetric distributions, i.e. the normal, the logistic and the scaled central t -distribution are compared.¹⁷ The two latter distributions are introduced, because they are more peaked than normal and could therefore indicate if the consideration of this feature changes the outcome. In Figure 7 it becomes clear that as long as only symmetric distributions are presumed, no large differences exist between the expected inflation resulting from them.¹⁸

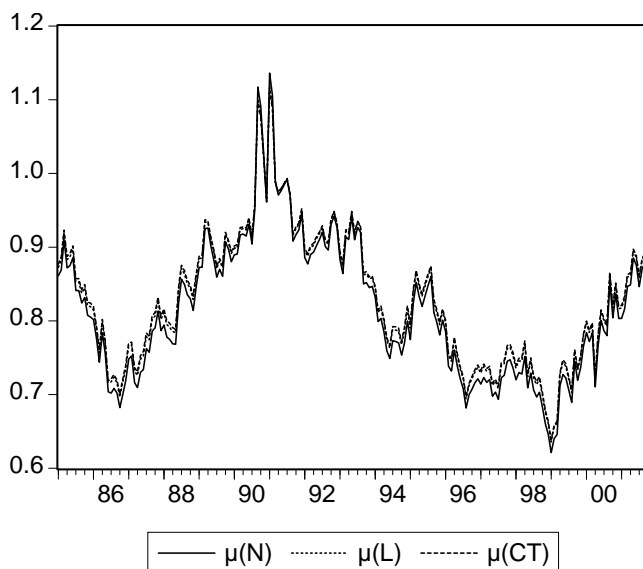


Figure 7: Non-scaled expected inflation

¹⁷Calculations have been made with EViews 4.1 and Gauss 3.5.

¹⁸In Figure 7 and 8 N, L and CT denote normal, logistic and central t .

The two peaks in September/October 1990 and January/February 1991 can be associated with the Gulf war and the threat of accelerating prices.

Also the standard deviation, shown in Figure 8 underpins that the symmetric distributions do not differ much. There are some deviating movements at the end of the observed period, but these are neither large enough to seriously distort the results nor can they be associated with some specific event and will therefore be left unaccounted for. No decisive improvements can therefore be achieved by introducing non-normal peakedness.

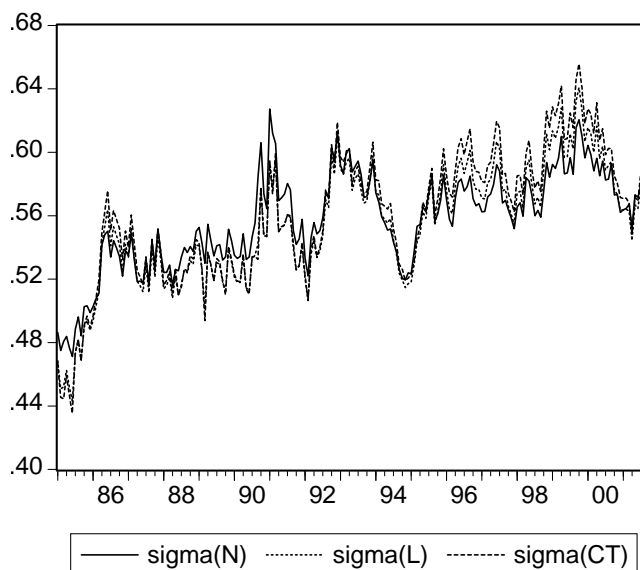


Figure 8: Non-scaled variance

To incorporate also possibly existing skewness, the scaled noncentral t -distribution and the χ^2 -distribution are assumed. In the case of a noncentral t -distribution with constant noncentrality parameter, e.g. the mean of the inflation over the whole sample, the shape of the resulting expected series does not change, it is only shifted downward, a fact that is not relevant any longer as soon as the series is scaled. Therefore a time-variant noncentrality parameter has been employed. Following the explanations in section 2.1 it has to be ensured that this parameter is positive over most of the sample and resembles the development of the prices. This rules out the measures proposed by Berk (1999) and Batchelor (1981), because they turn out to be negative for quite a lot of months within the sample. The postulated criteria are met by the inflation rate itself regarding the publication lag. But also the utilization of this measure does not provoke an expected series that differs significantly from the shape generated by the symmetric distributions and is for this reason not depicted here.

A similar result can be obtained by using the χ^2 -distribution. Considering the number of degrees of freedom to be between 5 and 10 and shifting the distribution to the left to equalize the mean of the resulting distribution and the mean of the actual inflation over the whole sample does again lead to an expected series that is shifted downwards, but has the same shape as the ones achieved by the symmetric distributions. This finding corroborates the results of Berk (1999) and Balcombe (1996), who also reject that asymmetric distribution functions could be of advantage.

Concluding, it can be stated that peakedness and skewness do not change the shape of the expected inflation series and can therefore not improve the accuracy of the forecasting ability of this series.

Hence, for the following analysis the scaled central t -distribution with 6 degrees of freedom is chosen, but this choice is somehow arbitrary. In Figure 9 the non-scaled threshold parameters δ_t and ϵ_t for this distribution are shown. The series of the threshold parameters are obviously not perfectly constant, but their variation is not very large. Referring to the mean $\pm 2 \cdot$ standard deviation of the respective series, which is also depicted, most of the data lies within these bands, leading to the conclusion that the assumption of constancy would not be inappropriate.

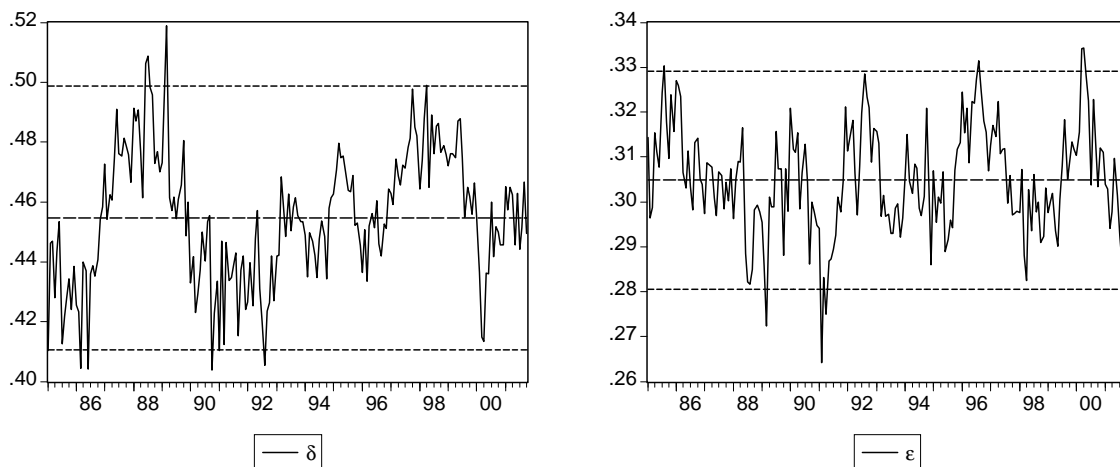


Figure 9: Non-scaled threshold parameters (with mean and mean $\pm 2 \cdot$ standard deviation of the respective series)

3.3 Time horizon

To compare the expected inflation with the actually realized inflation without considering the problem of scaling, both time series have been standardized.¹⁹ In the questionnaire

¹⁹That means that the respective variable x_t has been transformed in the following manner to obtain the standardized variable z_t : $z_t = \frac{x_t - \bar{x}}{\sqrt{s_x^2}}$, such that $E[z_t] = 0$ and $Var(z_t) = 1$, where \bar{x} and s_x^2 are the

it is asked for the expected inflation concerning the next 12 months. Therefore one of the series, either the actual or the expected inflation, has to be shifted such that both samples coincide. In the following always the expected inflation is shifted backwards to match the actual series, i.e. the actual inflation is compared with the expectation that has been formed 12 months before. Due to the shifting the analyzed time period changes to January 1986 - December 2001. In Figure 10 the standardized expected inflation and the standardized actual annual inflation rate are shown.

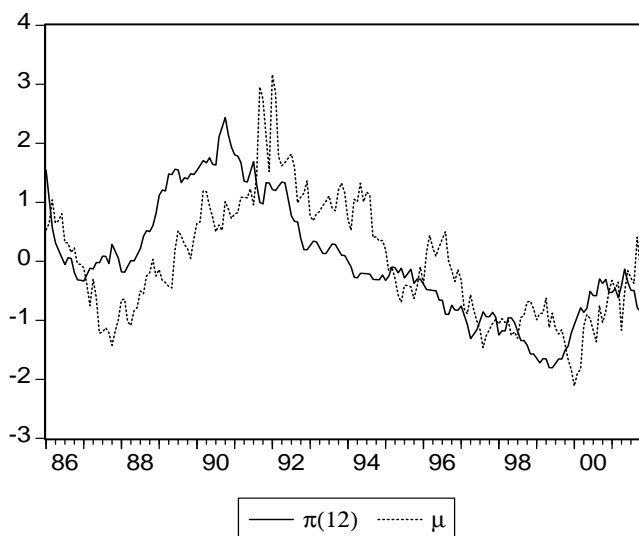


Figure 10: Standardized expected, μ , and actual annual inflation, $\pi(12)$

The fact that the expected inflation rate lags behind the actual inflation can lead to two different interpretations. On the one hand this can be explained by an adaptive expectations formation of the individuals. They revise their expectations according to the errors they have made with past forecasts and are consequently at least one period behind. On the other hand this could result from a time horizon of the participants deviating from the given 12 months. To examine this further, the standardized expected inflation rate, shifted backwards 6 months and 3 months respectively, has been compared with the semi-annual and the three-months actual inflation rate, both standardized as well. The result is shown in Figure 11.

empirical moments of x_t .

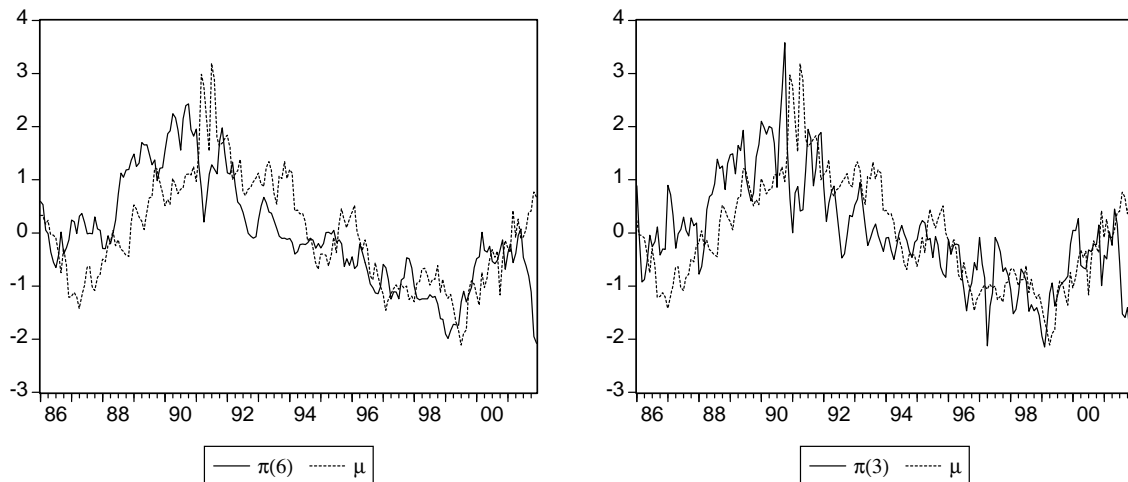


Figure 11: Standardized expected, μ , and standardized actual semi-annual, $\pi(6)$ (left), and three-months inflation rate, $\pi(3)$ (right)

It becomes clear that the second interpretation is suitable, because the expected series comes closer to the actual rate as the time horizon decreases, while the lagging should persist in the context of adaptive expectations.

It should, however, be noted that at the end of the observed time period the expected and the actual inflation diverge for all three analyzed actual inflation rates. It seems that during this time the expectations were not in line with the actually realized inflation.

Nevertheless, based on these results it can be concluded that the survey participants do not consider a twelve-months period when they are answering the questionnaire, but rather a shorter time span like three or six months. This will be regarded in the context of the following empirical analysis.

3.4 Scaling parameter

After having chosen a certain distribution function, the expected series has to be scaled with the perceived inflation rate $\tilde{\mu}_t$. As discussed in section 2.1 different scaling parameters are possible. It is now the goal to find the scaling parameter that delivers the best forecast, which is done by means of the root mean square error (RMSE). The RMSE is calculated in general by²⁰

$$RMSE = \sqrt{\frac{1}{n} \sum_{t=1}^n (y_t - \hat{y}_t)^2}, \quad (32)$$

²⁰See Greene (2003).

where y_t is the actual time series, i.e. in this case the actual non-standardized inflation rate, \hat{y}_t the forecasted time series, here the various scaled expected series, and n the number of observations. By selecting the scaled series with the minimal RMSE the scaling parameter can be determined that provides the best forecast.

Two different approaches will be followed. First the expected inflation is scaled directly with

- (i) the most recent inflation rate available to the survey participants, or
- (ii) the mean of the actual inflation including all data points up to the time the answer is made.

This approach will be denoted as 'direct' in Table 1.

As a second option the survey can be exploited further, denoted as 'survey based'. In the context of the survey the participants are asked: How are prices compared to 12 months ago? Referring to the previous section this question can be interpreted either as pentachotomous or as trichotomous. Considering it as pentachotomous it can be quantified like described above, but then again the perceived inflation as scaling parameter is needed. For this, once more the two measures (i) and (ii) can be applied.

Regarding it, in contrast, as trichotomous, not the perceived inflation, but the indifference interval is used as scaling parameter. To obtain it, two different methods are employed. One is to follow the presumption of Carlson and Parkin (1975) and to impose that the expectations are on average unbiased. The other adopts the approach of Bennett (1984), suggesting to relate the official data with the expected data and to assume that the indifference interval is the same for the realized and the expected series. Hence, one obtains this interval by regressing the official inflation rate on the unscaled mean expected inflation rate.

In the light of the results obtained by analyzing the standardized series, not only a time horizon of twelve months, but also a 6- and 3-months horizon is considered. The results for these 18 differently scaled series are shown in Table 1.

It is consistent for all time horizons that the option 'survey based (pentachotomous)' scaled with the mean leads to the minimal RMSE.²¹ That means that by taking the information delivered by the question of the survey concerning the past price development into account, regarding it as pentachotomous, and scaling this with the mean of the past inflation, the most accurate forecast can be achieved.

It is not surprising that the two survey based measures assuming trichotomy lead to very similar results. The first option, to propose unbiasedness and the second choice, regressing

²¹The different time horizons cannot be compared directly, because different reference series have been used.

Table 1: Root mean square error of different scaling procedures

Scaling parameter		Time horizon		
		12 months	6 months	3 months
direct	recent inflation	1.068	0.523	0.320
	mean inflation	1.425	0.676	0.364
survey based (pentachotomous)	recent inflation	1.411	0.704	0.392
	mean inflation	1.033	0.518	0.303
survey based (trichotomous)	unbiasedness	1.057	0.587	0.347
	regression	1.040	0.575	0.340

Due to the shifting to obtain synchronous series the samples are different for the different time horizons: 12 months 1986:01-2001:12 (n=192), 6 months 1985:7-2001:12 (n=198), 3 months 1985:4-2001:12 (n=201).

the official inflation rate on the unscaled mean, induce basically the same estimators, and should therefore not produce different empirical results.

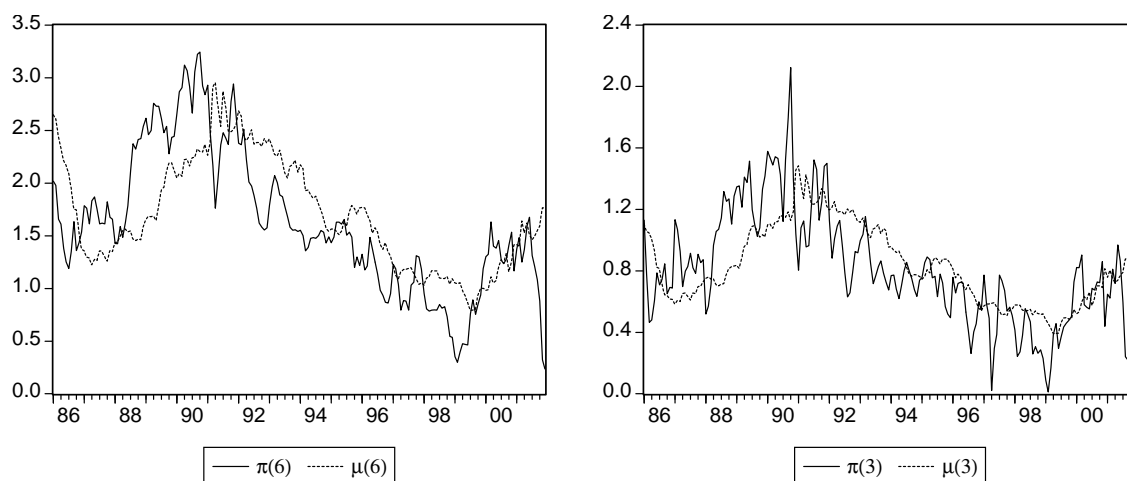


Figure 12: Expected and actual semi-annual inflation rate (left) and three-month inflation rate (right)

Consequently the three expected inflation rates obtained by using this scaling parameter are included in the further analysis. The scaled series, again shifted backward the respective months, and the actual inflation rates for the three time horizons are shown in

Figure 12 and 13.

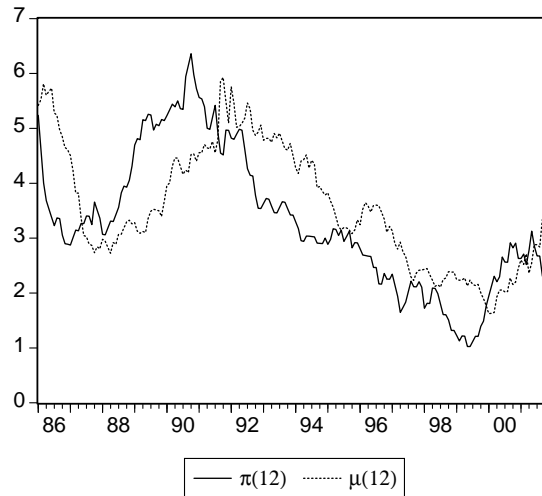


Figure 13: Expected and actual annual inflation rate

Similar to section 3.3 it is obvious that the expected inflation lags behind the actual inflation when a time horizon of 12 months is considered. That changes with the reduction of that time period.

3.5 Comparison with balance statistic

To compare the balance statistic, calculated according to equation (31), with the non-scaled expected mean obtained with the probability method, both series have been standardized. The result is shown in Figure 14. As can be seen the balance statistic, a rather simple measure, does not perform worse than the one achieved by applying the probability method.

This fact is not very surprising, but instead validates the result from Lankes and Wolters (1988). In their work they demonstrate that the probability method results can be approximated by the weighted balance statistic. Lankes and Wolters (1988) show that this relationship exist for a trichotomous survey, but it should be adaptable to a pentachotomous survey and in general to a polychotomous one.

Nevertheless, the balance statistic is rather restrictive. The flexible modelling possible with the probability method, especially in the case of a pentachotomous survey, allows not only to extract the expected mean, but also the inflation variance and the threshold parameters, that can be interpreted economically. Therefore the further examination of the probability method is necessary and reasonable, if the aim is to analyze the expected series in detail.

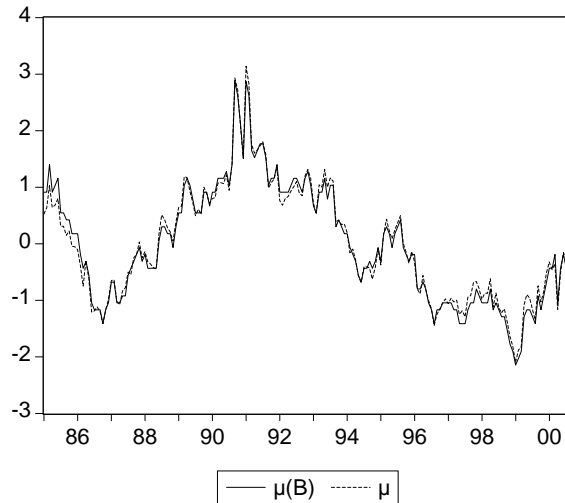


Figure 14: Standardized balance statistic, $\mu(B)$, and non-scaled expected inflation (probability method) μ

4 Concluding remarks

Qualitative survey data from the Consumer Survey conducted by the European Commission is used to calculate inflation expectations for the European Union for the period from January 1985 to October 2001. The probability method is employed to quantify the qualitative responses. Investigating non-scaled, but standardized series of expected and actual inflation leads to the conclusion that the time horizon survey participants consider, while answering the questionnaire, is not 12 months, as implied by the question, but rather 6 or even 3 months.

Different distribution functions are presumed to allow for peakedness and skewness deviating from normal, but as the empirical analysis shows, no improvement of the forecast can be achieved by incorporating these properties.

Concerning the scaling parameter various measures are used and the forecasting ability of the constructed series is assessed. It turns out that the best forecasts can be achieved by employing a survey based measure scaled with the mean of the past inflation.

A comparison with the balance statistic shows that there is no large difference between this and the series obtained by applying the probability method. Still, the probability method has advantages in modelling the other parameters, like the uncertainty and the threshold parameters.

Nevertheless, there are many topics that can be analyzed in future work. Asymmetric indifference intervals e.g. should be included. An important issue is moreover to assess the other parameters of the resulting series, especially the uncertainty.

References

- Balcombe, K. (1996), The Carlson-Parkin method applied to NZ price expectations using QSBO survey data, *Economics Letters*, 51, 51–57.
- Batchelor, R. (1981), Aggregate Expectations under the Stable Law, *Journal of Econometrics*, 16, 199–210.
- (1982), Expectations, Output and Inflation: The European Experience, *European Economic Review*, 17, 1–25.
- Batchelor, R. and A. Orr (1988), Inflation Expectations Revisited, *Economica*, 55, 17–31.
- Bennett, A. (1984), Output Expectations of Manufacturing Industry, *Applied Economics*, 16, 869–879.
- Berk, J. (1999), Measuring Inflation Expectations: A Survey Data Approach, *Applied Economics*, 31, 1467–1480.
- (2000), *Consumers' Inflation Expectations and Monetary Policy in Europe*, De Nederlandsche Bank, Staff Reports, No. 55/00.
- Carlson, J. (1975), Are Price Expectations Normally Distributed?, *Journal of the American Statistical Association*, 70 (352), 749–754.
- Carlson, J. and M. Parkin (1975), Inflation Expectations, *Economica*, 42, 123–137.
- Chan-Lee, J. (1980), A Review of Recent Work in the Area of Inflationary Expectations, *Weltwirtschaftliches Archiv*, 45–85.
- Dudewicz, E. and S. Mishra (1988), *Modern Mathematical Statistics*, John Wiley, New York.
- European Central Bank (2000), Monetary Policy Transmission in the Euro Area, *Monthly Bulletin*, July, 43–58.
- European Economy, Supplement B (1979-), Business and Consumer Survey Results.
- Evans, M., N. Hastings and B. Peacock (1993), *Statistical Distributions*, 2nd ed. , John Wiley, New York.
- Foster, J. and M. Gregory (1977), Inflation Expectations: The Use of Survey Data, *Applied Economics*, 9, 319–329.
- Geberding, C. (2001), *Der Informationsgehalt von Umfragedaten zur erwarteten Preisentwicklung für die Geldpolitik*, Volkswirtschaftliches Forschungszentrum der Deutschen Bundesbank, Discussion Paper, No. 09/01.
- Greene, W. (2003), *Econometric Analysis*, 5th ed. , Prentice Hall, New Jersey.
- Lahiri, K. and C. Teigland (1987), On the Normality of Probability Distributions of Inflation and GNP Forecasts, *International Journal of Forecasting*, 3, 269–279.
- Lankes, F. and J. Wolters (1988), *Das IFO-Geschäftsklima und seine Komponenten als vorlaufende Indikatoren. Empirische Ergebnisse für die Verbrauchs- und Investitionsgüterindustrie für 1975-1986*, FU Berlin, Fachbereich Wirtschaftswissenschaft, Diskussionsarbeit, No. 5/1988.

- Papadia, F. (1983), Rationality of Inflationary Expectations in the European Economic Communities Countries, *Empirical Economics*, 8, 187–202.
- Pesaran, M. (1987), *The Limits to Rational Expectations*, Basil Blackwell, Oxford.
- Praetz, P. (1972), The Distribution of Price Changes, *Journal of Business*, 45, 49–55.
- Reckwerth, J. (1997), *Der Zusammenhang zwischen Inflation und Output in Deutschland unter besonderer Berücksichtigung der Inflationserwartungen*, Volkswirtschaftliche Forschungsgruppe der Deutschen Bundesbank, Discussion Paper, No. 5/97.
- Seitz, H. (1988), The Estimation of Inflation Forecasts from Business Survey Data, *Applied Economics*, 20, 427–438.
- Theil, H. (1952), On the Time Shape of Economic Microvariables and the Munich Business Test, *Revue de l'Institut International de Statistique*, 20, 105–120.
- Vining, D. and T. Elwertowski (1976), The Relationship Between Relative Prices and the General Price Level, *American Economic Review*, 66 (4), 699–708.
- Visco, I. (1984), *Price Expectations in Rising Inflation*, North-Holland, Amsterdam.