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An Alternative to the Carlson-Parkin Method for the Quantification of Qualitative Inflation Expectations: Evidence from the Ifo World Economic Survey

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Abstract

This paper presents a new methodology for the quantification of qualitative survey data. Traditional conversion methods, such as the probability approach of Carlson and Parkin (1975) or the time-varying parameters model of Seitz (1988), require very restrictive assumptions concerning the expectations formation process of survey respondents. Above all, the unbiasedness of expectations, which is a necessary condition for rationality, is imposed. Our approach avoids these assumptions. The novelty lies in the way the boundaries inside of which survey respondents expect the variable under consideration to remain unchanged are determined. Instead of deriving these boundaries from the statistical properties of the reference time-series (which necessitates the unbiasedness assumption), we directly queried them from survey respondents by a special question in the *Ifo World Economic Survey*. The new methodology is then applied to expectations about the future development of inflation obtained from the *Ifo World Economic Survey*.

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Keywords: Inflation expectations, survey data, quantification methods.

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1 Introduction

Expectations play a crucial role in macroeconomics. In consumption theory the life-cycle and permanent income approaches stress the role of expected future income. In New Keynesian Macroeconomics firms set prices as a mark-up over a weighted average of current and expected future nominal marginal costs. Central banks closely monitor the private sector's inflation expectations. Exchange rates and share prices depend on the expected future development of their fundamental determinants. Many other examples could be given.

In empirical work expectations on future macroeconomic variables can be treated in two ways. One is to set-up a theory on how private agents form their expectations. The current standard methodology for modeling expectations is to assume rationality of economic agents which goes back to the seminal paper of Muth (1961). Assuming rational expectations has the effect that empirical models model can only be tested by putting up a joint hypothesis on the model and on the expectations' formation process simultaneously. The second way to introduce expectations into empirical models is through direct measures of expectations derived from surveys of households, firms and other economic agents (see Theil (1952) for an early paper). The advantage of survey data is that expectations are given exogenously in the context of a model, and that the nature of the expectations' formation process can be investigated separately.

This paper focuses on inflation expectations obtained from the *Ifo World Economic Survey (WES)*. So far, these variables have only been presented in the form of a qualitative balance statistic, indicating whether the majority of the polled economic experts expect the inflation rate to rise, to remain constant, or to decline by the end of the next six months. Qualitative surveys therefore only provide a direction of change for a given variable, rather than an exact figure. Even though this survey technique is quite common (see for example the *Consumer Survey* conducted by the European Commission)[1], balance statistics are often of limited use for econometric anal-

[1] The reasons why survey participants are not directly asked to quantify their expectations can be divided into two categories. The first reason is of practical nature and has to do with incentives. Since the participation at the survey is voluntary, the completion of the questionnaire must be as simple as possible in order to not discourage respondents from participating. Typically, they are asked to forecast a broad set of macroeconomic variables (such as GDP growth, inflation, unemployment, interest rates, exchange rates, share prices, etc.) so that it would be relatively time-consuming to provide a precise quantitative estimate for all these variables. The second reason is of statistical nature. It is often claimed that qualitative surveys are less susceptible to measurement errors: "(...) to the extent that expectations are 'attitudes or states of mind' of the respondents and are

yses. For this reason, expectations which are collected as qualitative survey data are often converted into quantitative estimates of the variables under consideration.

The most widely used conversion method goes back to a paper by Carlson and Parkin (1975). Their method assumes that respondents have a common subjective probability distribution over the future development of a variable and that they report a variable to go up or down if the median of their subjective probability distribution lies above or below a threshold level. The upper and lower threshold which mark the so-called indifference limen are derived from the respondents' aggregate answers and the time-series properties of past realizations of the macroeconomic variable under consideration. Most crucially, Carlson and Parkin (1975) assumed that the answers are normally distributed with symmetric thresholds and they imposed that the average value of past realizations and the average value of expectations must be equal,which is typically referred to as the unbiasedness of expectations.

As these assumptions are rather restrictive a number of authors suggested extensions and alternatives to the Carlson-Parkin Method (see Nardo (2003) and the papers cited there). An important extension was the Time-Varying Parameters Method which was introduced by Seitz (1988). Using the Kalman filter for the estimation of the indifference limen the method explicitly allows for a non-symmetric and time-varying threshold. The main criticism concerns the way the thresholds were modeled by the estimation technique. As pointed out by Nardo (2003), there are no economic or psychological reasons to suppose that individuals have an indifference limen that follows a random walk. As an alternative to the Carlson-Parkin Method, Pesaran (1984) developed the Regression Method. The basic idea is to use the relationship between realizations (measured by official statistics) and respondents' perceptions of the past (which is additionally queried in many surveys) and to estimate the indifference limen on the basis of this observable data. In order to quantify the respondents' expectations about the future development of the variable under consideration, Pesaran (1984) then used these estimates and imposed them on the qualitative expectations data. Thus, in contrast to the aforementioned methods, quantitative expectations calculated by the Regression Method are a function of a specific regression model, rather than a function of a specific probability distribution. But, as stressed by Batchelor and Orr (1988), the regression approach also assumes unbiased expectations, because the indifference limen is inferred from a regression of

not merely forecasts, methods based on the measurement of ordinal responses seem less likely to be subject to measurement errors than direct attempts at cardinal measurement of expectations" (Pesaran, 1984, p. 34).

actual inflation on the respondents' perceived inflation.

The novelty of the present paper is that we do not rely on the unbiasedness assumption of expectations for converting the qualitative survey responses into quantitative measures for inflation expectations. In contrast to the three traditional methods (Carlson-Parkin, Time-Varying Parameters, Regression) we do not implicitly derive the response thresholds from the qualitative survey responses and from the statistical properties of the reference time-series, but from a special question in the July 2004 *Ifo WES* in which we directly query the repondents' thresholds for a given current inflation rate. This allows us to address two important issues. First, we can explicitly test whether the thresholds are asymmetric and time-dependent. Our main result will be that the symmetry of the thresholds cannot be rejected and that the thresholds are an increasing function of the perceived current rate of inflation. Second, we can test whether the inflation expectations that are computed on the basis of the queried indifference limen are indeed unbiased, which is a necessary condition for rationality in expectations. We find that the unbiasedness assumption holds for most of the countries in our sample, but not for all. In addition to that we test whether inflation expectations are efficient forecasters of future inflation and we find that the efficiency hypothesis can be rejected in all cases.

The remainder of the paper proceeds as follows. In section 2 we shortly present the *Ifo WES*. Section 3 gives an overview of the general method of quantification, the so-called *Probability Method*, and presents an outline of its basic assumptions. In section 4 we discuss the Carlson and Parkin (1975) method for the quantification of the indifference limen and its main shortcomings. As these shortcomings are mainly due to the rather strong assumptions, we gradually relax some of them. In particular, we apply two alternative methods that relax the assumption of constant and symmetric indifference boundaries. For a small selection of countries we present the resulting time-series of inflation expectations for each quantification method and, indeed, we show that the outcomes differ quite a lot. Our proposal of a survey based quantification method of the indifference limen is presented in section 5. The results are presented for France, Germany, Italy, Japan, the UK, the US and for the Euro zone as a whole. Section 6 investigates the nature of the inflation expectations obtained in the previous sections using standard rationality tests. The paper concludes with a summary of the main findings.

2 The Ifo World Economic Survey

The *Ifo WES* assesses trends in the world economy by polling transnational as well as national organizations worldwide about economic developments in the respective country. It is conducted in co–operation of *Ifo Institute for Economic Research* in Munich and the *International Chamber of Commerce (ICC)* in Paris.

The questionnaire of the *Ifo WES* is distributed four times a year (January, April, July and October). The participants are asked to give their assessment of the general economic situation and expectations regarding important macroeconomic indicators of the country they inhabit. Currently, the *Ifo WES* asks about 1100 experts in 90 countries. The survey was first conducted in 1983. A question on the expected inflation rate, which is in the focus of the present paper, was only included since July 1991. Survey participants are asked to give their expectations on the inflation rate by the end of the next six months. They indicate UP for an expected rise in the inflation rate, SAME for no change in the inflation rate and DOWN for an expected fall in the inflation rate.

The questionnaire therefore reveals qualitative information on the participants' expectations of the future inflation rate. The individual replies are combined for each country without weighting. The 'grading' procedure consists in giving a grade of 9 to positive replies (UP), a grade of 5 to indifferent replies (SAME) and a grade of 1 to negative replies (DOWN). The country average which may range from 1 to 9 is published as a balance statistic[2]. Average grades within the range of 5 to 9 indicate that a majority expects inflation to rise, whereas grades within the range of 1 to 5 reveal predominantly expectations of decreasing inflation rates. What is lacking is a precise estimate of the inflation rate that is expected on average.

3 The Probability Method

At the heart of all methods for converting qualitative survey data into quantitative estimates lies the Probability Method. It was first developed by Theil (1952) and was rediscovered by Carlson and Parkin (1975) and Knoebl (1974) who used the method to construct quantitative measures for inflation expectations.

[2] $Balance\ Statistic = \frac{[(9\times UP)+(5\times SAME)+(1\times DOWN)]}{(UP+SAME+DOWN)}$

3.1 The Conception

The Probability Method basically requires two types of ingredients: the qualitative answers and the basis of the variable under consideration. The basis is simply the last value that is observable for the individual being asked. In our case this is the inflation rate which is published for the current quarter[3].With these variables, the Probability Method enables us to construct an estimate of the expected value of the inflation rate. As the poll usually asks for the change in a variable it must be taken care to refer to the correct basis with regard to the question being asked. As far as the *Ifo WES* is concerned, this is the change in the inflation rate, as opposed to the change in the price level which was originally analyzed by Carlson and Parkin. The question in the *Ifo WES* is put in the following way:

> Expected **inflation rate** by the end of the next six months (change of the consumer prices compared to the same month previous year):
>
> HIGHER   ABOUT THE SAME   LOWER

The following input variables are required for the Probability Method:

- Basis on which expectations are built (the historical change in the inflation rate): $\Delta\pi_t$.
- Fraction of respondents in per cent who indicated *HIGHER* on the questionnaire: UP_t.
- Fraction of respondents in per cent who indicated *LOWER* on the questionnaire: DO_t.

The fraction of respondents who indicated *SAME* remains as the residual value. The individual answer is assumed to emerge from an individual probability distribution. The respondent is supposed to report the mean of the distribution and indicates a rise *(UP)* if the mean of the individual distribution is above an upper threshold value. In the same way the respondent indicates a fall *(DO)* if the mean is below a lower threshold value. Thus, there exists a so called 'indifference limen' which identifies a the boundaries of a band around the basis within which the respondent would indicate 'no change' ($SAME$).

[3]A publication or an information lag can be ruled out in our case. In section 5 this point will be treated more in detail.

For the conversion of qualitative answers into quantitative measures two problems have to be addressed: first, the identification of the form of the individual probability distribution and its aggregation to a single measure, and second, the identification of the individual indifference limen. The Probability Method is mainly concerned with the first problem. It is based on the following assumptions.

3.2 Basic Assumptions

As the individual answer underlies some degree of uncertainty the respondent should have some kind of distribution with a certain variance in mind when answering the question.

> **Assumption 1:** The individual answer i is a result of an individual probability distribution $f(\Delta\pi_{i,t})$ over the possible values of the variable in question.
>
> **Assumption 2:** The individual $f(\Delta\pi_{i,t})$ are statistically independent and have the same shape. Here they are assumed to be normally distributed with finite mean and variance.
>
> **Assumption 3:**
>
> - The individual answer is $DO_{i,t}$, if the expected value of the change in inflation by the end of time $t+k$, $E_t\Delta\pi_{i,t+k}$, is smaller than some value $a_{i,t}$ ($E_t\Delta\pi_{i,t+k} < a_{i,t}$).
> - The individual answer is $UP_{i,t}$, if the expected value of the change in inflation by the end of time $t+k$, $E_t\Delta\pi_{i,t+k}$, is larger than some value $b_{i,t}$ ($E_t\Delta\pi_{i,t+k} > b_{i,t}$).
> - The individual answer is $SAME_{i,t}$, if the expected value of the change in inflation by the end of time $t+k$, $E_t\Delta\pi_{i,t+k}$, is within the band which is bounded by $a_{i,t}$ and $b_{i,t}$ ($a_{i,t} \leq E_t\Delta\pi_{i,t+k} \leq b_{i,t}$).

For the moment we assume that $a_{i,t}$ and $b_{i,t}$ which represent the lower and upper threshold of the indifference band of the individual respondent are exogenously given. The decision-making process is illustrated in figure (1), where we set, somewhat arbitrarily, $-a_{i,t} = b_{i,t} = 0.2$. In this case the expectation of the individual probability distribution lies to the right of the upper threshold and the respondent would mark *HIGHER* in the questionnaire.

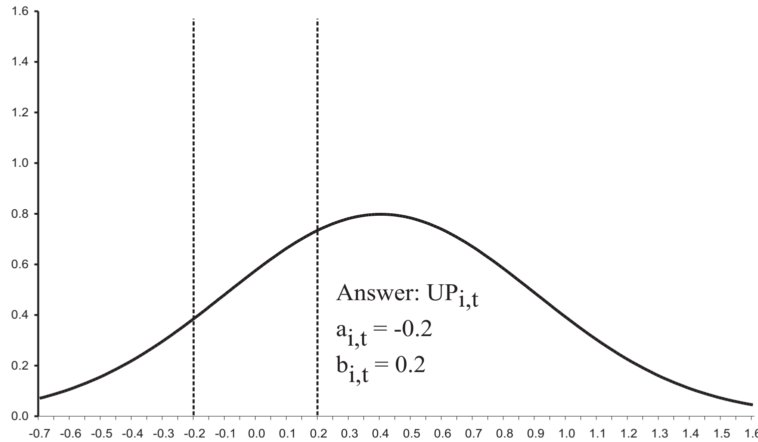


Figure 1: Answer of individual i

> **Assumption 4:** The aggregate distribution of the basic population can approximately be described by a normal distribution[4].

This assumption can be justified by the 'central limit theorem'.

> **Assumption 5:** The upper respectively lower thresholds are identical for all respondents in the population and do not vary over time:
> $a_{i,t} = a$,
> $b_{i,t} = b$.

This is a rather strong assumption for two reasons: On the one hand every individual has its own perception, and on the other hand the perception may change with the environment. The latter point will be discussed in more detail in section 4.3.

3.3 Calculation

Following Nardo (2003) the survey results can now be interpreted as the probability to obtain a certain answer from the specified population which is in turn represented by the aggregate distribution. With the assumptions stated above the probability for an answer to become UP at some date t is:

$$UP_t = \Pr(\Delta\pi_t \geq b) \qquad \text{or} \qquad 1 - UP_t = \Pr(\Delta\pi_t < b). \tag{1}$$

[4]The form of the distribution is the subject of research papers by Berk (2000) who studied symmetric and asymmetric t-distributions or Batchelor and Orr (1988) and Fishe and Lahiri (1981) who assume a logistic distribution.

Hence, the probability for an answer to become DO at some date t is:

$$DO_t = \Pr(\Delta\pi_t \leq a). \tag{2}$$

Assuming a standard normal distribution Φ gives:

$$1 - UP_t = \Phi\left(\frac{b - E_t\Delta\pi_{t+k}}{\sigma_t}\right)$$
$$DO_t = \Phi\left(\frac{a - E_t\Delta\pi_{t+k}}{\sigma_t}\right)$$

where $E_t\Delta\pi_{t+k}$ and σ_t are the mean and the standard deviation of the aggregate distribution of inflation expectations. The quantiles can be calculated as:

$$\Phi^{-1}\left(1 - UP_t\right) = \frac{b - E_t\Delta\pi_{t+k}}{\sigma_t}, \tag{3}$$

$$\Phi^{-1}\left(DO_t\right) = \frac{a - E_t\Delta\pi_{t+k}}{\sigma_t}. \tag{4}$$

After eliminating σ_t and by solving for $E_t\Delta\pi_{t+k}$ one finally obtains the following expression for inflation expectations:

$$E_t\Delta\pi_{t+k} = \frac{b\ \Phi^{-1}(DO_t)\ -\ a\ \Phi^{-1}(1 - UP_t)}{\Phi^{-1}(DO_t)\ -\ \Phi^{-1}(1 - UP_t)}. \tag{5}$$

An illustration of this formula is given by figure (2). In the example we assumed the fraction of answers to be 10% $DOWN$, 50% $SAME$ and 40% UP. With the indifference limen from above ($-a = b = 0.2$) this yields a value for the expected change in the inflation rate of 0.13.

3.4 Shortcomings of the Probability Method

There are several shortcomings related with the Probability Method. First, from equation (5) it becomes clear that there is no expectational value whenever UP or DO are zero. If $UP_t = 0$ the value of $\Phi^{-1}(1 - UP_t)$ approaches infinity, whereas the value of $\Phi^{-1}(DO_t)$ approaches minus infinity whenever $DO_t = 0$. If such a case occurred, we corrected for that by adding $1/(2n+1)$ to the category that is equal to zero, with n being the number of respondents at time t, and by subtracting this value from the opposite category. This can be justified by the fact that the answers of the survey only approximate the basic population. With this correction we do not fundamentally change the

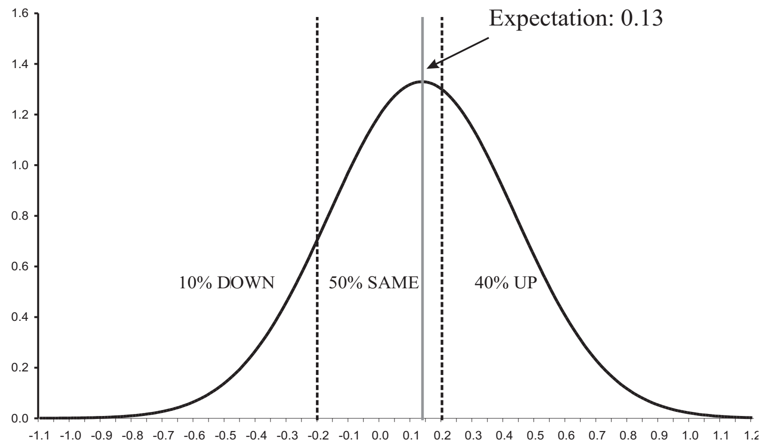


Figure 2: The Probability Method

survey result as the number of respondents stays the same when the corrected figures are rounded to nearest whole number[5]. A second problem, closely related to the first one, emerges when everybody is of the same opinion. In such a case we subtracted $1/(2n+1)$ from the respective category. In contrast to the first case the remaining two categories are increased by only $1/[2(2n+1)]$ so as to obtain a non-zero fraction in every category. The last problem emerges if no respondent is within the *SAME* category and the denominator in formula (5) is zero. To avoid this problem we subtracted $1/[2(2n+1)]$ from the *UP* and *DO* fractions and, added $1/(2n+1)$ to the *SAME* category. Despite these corrections, the occurrence of outliers cannot be avoided entirely when it comes to a violation of the normality assumption as a consequence of small sample sizes. In the subsequent analysis we accounted for that by either leaving them out of the analysis or by using dummy variables[6].

[5]Take the following outcome of the survey as an example: $UP = 0$, $SAME = 0.5$, $DO = 0.5$ and $n = 10$. Applying the correction mechanism yields the following adjusted fractions: $UP = 0.048$, $SAME = 0.5$ and $DO = 0.452$. For a number of ten respondents this gives 0.48 persons expecting a rise in inflation which is equal to zero when rounded to nearest whole number, and 4.52 persons expecting a fall in inflation which can be rounded to 5.

[6]See section 4.1.2 and 6.

4 Time-Series based Quantification of the Indifference Limen

While the Probability Method gives us a guideline on how to identify the form of the individual probability distribution and how to aggregate the individual distributions to a single measure, the identification of the indifference limen has been ignored so far. In this section we will present the methods that are traditionally used for the calculation of the upper and lower thresholds, a and b. They all have in common that the indifference limen is derived from the respondents' aggregate answers (UP_t, DO_t) and the time-series properties (above all the mean) of past changes in inflation, whence the title of this section. We begin with the Carlson-Parkin Method (section 4.1) and we will extend this approach (in sections 4.2 and 4.3) so as to work out the motivation that is behind our own proposal. Note that the Regression Method by Pesaran (1984) cannot be applied to our survey data since the *Ifo WES* does not include any question referring to the respondents' perception of past inflation rates.

4.1 The Carlson-Parkin Method

4.1.1 Conception

Carlson and Parkin (1975) originally assumed a symmetric indifference interval $c = -a = b$. In order to estimate c they imposed the unbiasedness of expectations which means that, on average, expectations are correct:

$$\frac{1}{T}\sum_{t=1}^{T} E_t \Delta\pi_{t+k} = \frac{1}{T}\sum_{t=1}^{T} \Delta\pi_t. \tag{6}$$

Using equation (5) for calculating the expected change in the inflation rate and setting $a = -c$ and $b = c$ yields the following equation:

$$\sum_{t=1}^{T} \frac{c\,(\Phi^{-1}(DO_t) \;+\; \Phi^{-1}(1-UP_t))}{\Phi^{-1}(DO_t) \;-\; \Phi^{-1}(1-UP_t)} \;=\; \sum_{t=1}^{T} \Delta\pi_t, \tag{7}$$

which can be solved for c :

$$c = \left(\sum_{t=1}^{T} \Delta\pi_t\right) \Big/ \left(\sum_{t=1}^{T} \frac{f_t + r_t}{f_t - r_t}\right), \tag{8}$$

where for simplicity $f_t = \Phi^{-1}(DO_t)$ and $r_t = \Phi^{-1}(1 - UP_t)$.

4.1.2 Results

For some countries the results of the quantification of qualitative inflation expectations on the basis of the Carlson-Parkin Method are shown in figure (3). Even though the *Ifo WES* covers 90 countries, for the analyses in this paper we only consider countries where the average number of respondents is not too small: France, Germany, Italy, Japan, the UK and the US[7]. The sample period runs from 1991:2 to 2004:2 at a quarterly frequency.

For each country the charts show the expected inflation rate at t for $t+2$ ($E_t\pi_{t+2}$) together with the prevailing inflation rate at time t (π_t) which is taken from the OECD database. In section 5.3 below we will show that the information set that is available to the survey respondents at the time they fill in the questionnaire is the past quarter (that is the first quarter for the questionnaires returned at the beginning of April, the second quarter for the questionnaires returned at the beginning of July, and so on). Thus, the April survey produces inflation expectations $E_t\pi_{t+2}$, where t refers to the first quarter and $t+2$ to the third quarter. Note that the 'prediction error' can not be inferred from the charts because actual outcome and expectation are not compared at the same point in time. In addition to $E_t\pi_{t+2}$ and π_t the charts show the balance statistic which was explained in section 2 and which is depicted on the right scale.

For Germany we obtain a value for the 'indifference limen' of $c = 0.27$. This means that an expected change in the inflation rate of 0.27 percentage points is necessary to make the respondent indicate a rise in the future inflation rate. In the July 1993 survey, for example, the basis on which respondents formed their expectations was the inflation rate in the second quarter of 1993 which amounted to 4.38 per cent. 4 out of 36 respondents expected inflation to go up by the end of the next six months, 8 expected inflation to remain the same, and 24 expected an increase. Inserting the calculated value for c and the distribution of the respondents' answers into equation (5) gives $E_t\pi_{t+2} = 3.42\%$ implying that at that time the inflation rate in six months (end of the fourth quarter) is expected to fall to 3.42 per cent. The balance statistic takes a value of 2.8 which also indicates a fall

[7] Countries in which the average number of answers is small are mainly smaller economies. This is due to the fact that the *Ifo WES* only asks domestic experts and therefore the number of respondents for a specific country may sometimes be low. In Greece, for example, in the period between July 1991 and July 2004 the average number of respondents was 6.0; in Ireland it was 6.2 and in Portugal 8.8. Violations of the normality assumption like the ones shown in tables (1), (2) or ((3)) below appear quite often in these cases. This gives rise to a large number of outliers when the probability method is applied. Thus, we decided to not correct for them as described in section 3.4 because this would probably bias our results in an unjustifiable manner.

in the expected inflation rate. Hence, in the case of Germany, the method produces results consistent with the balance statistic. The same applies to the case of Japan where the indifference limen is calculated to be $c = 0.72$.

For France, the UK and the US c becomes negative and takes a value of -0.61, -0.94 and -0.23, respectively. This means in particular that in figure (2) the upper threshold would lie to the left of the lower threshold which makes it impossible to interpret the obtained indifference limen in the way it is done for Germany or Japan. A negative value of c also shows up in the graphs. The values for the expectations turn out to be in opposition to the direction of change indicated by the balance statistic. However, from the balance statistic it can be observed that the expectations, on average, have been far from being correct in those countries for many years. Throughout the first part of the sample in the US the balance statistic shows an expected rise in the inflation rate which is clearly in contrast to the disinflation episode at the beginning of the nineties. The time series is forced into the 'correct' direction, because the Carlson-Parkin Method assumes the unbiasedness of expectations. As in this case c is used to scale the time-series of the expectations, it acts as a degree of freedom and turns the survey results upside down. For the UK and France this is not so obvious.

In these two countries the calculations suffer from another problem which is the occurrence of outliers. This problem also appears for Italy where we calculated a value of $c = 0.65$. An explanation for the occurrence of outliers can be given by taking a look at the Italian microdata of the July 1996 survey which is shown in table (1). Even after having corrected for the violation of the normality assumption as proposed in section 3.4, the inflation expectation in the second quarter of 1996 still remains an outlier. And it is important to understand that this outlier has a decisive impact on the boundary of the indifference limen when the Carlson-Parkin Method is applied. A calculation of the indifference band where this observation is dropped yields a value of $c = -8.19$. A similar argumentation can be applied to France where we observe an outlier in the third quarter of 2000. The outcome of the survey of October 2000 in France is shown in table(2). In contrast to the case before, here the violation of the normality assumption stems from the fact that there is only one respondent in the category $SAME$ and the rest is distributed over the remaining categories. Moreover, none of the corrections from section 3.4 had to be applied here. If the observation is dropped for the calculation of the indifference limen, a value for c of 1.94 results. The outcome of the survey in the UK in July 1991, where we also observe an outlier, is depicted in table (3). The calculation of the indifference limen without the outlier gives a value of -0.66. It becomes clear that the shift of the indifference interval can be quite substantial when the outlier is

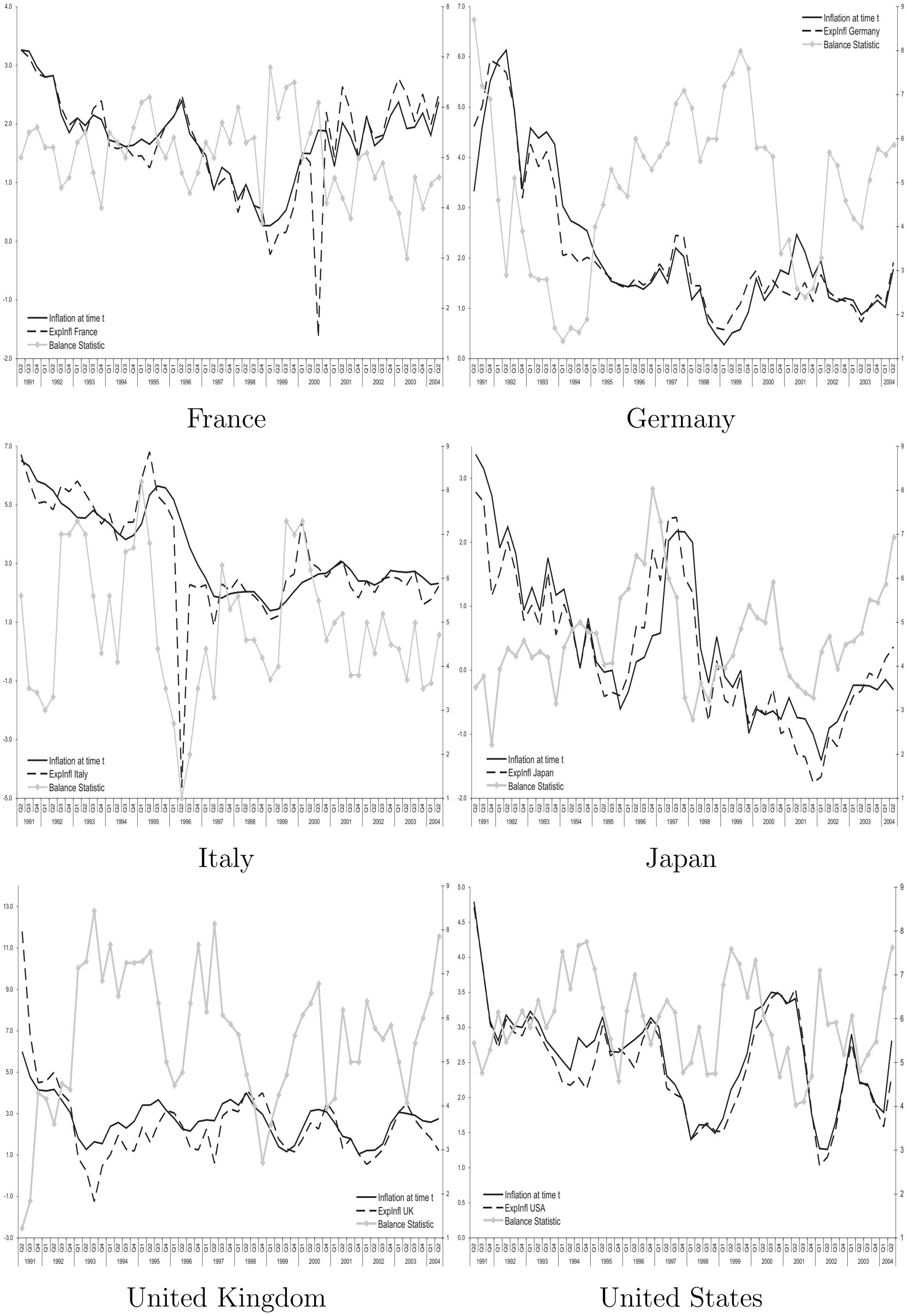


Figure 3: Expected inflation rates in selected countries with a and b calculated using the Carlson-Parkin Method

omitted.

	UP_t	$SAME_t$	DO_t
fractions before correction	0	0	1
uncorrected number of responses	0	0	16
fractions after correction	0.015	0.015	0.967
corrected number of responses	0.24	0.24	15.52

Table 1: Violation of the normality assumption, Italy (July 1996)

	UP_t	$SAME_t$	DO_t
fractions before correction	0.619	0.048	0.333
uncorrected number of responses	13	1	7

Table 2: Violation of the normality assumption, France (October 2000)

	UP_t	$SAME_t$	DO_t
fractions before correction	0	0.056	0.944
uncorrected number of responses	0	1	17
fractions after correction	0.027	0.056	0.917
corrected number of responses	0.49	1	16.51

Table 3: Violation of the normality assumption, UK (July 1991)

4.1.3 Shortcomings

A major shortcoming of the Carlson-Parkin Method is that it imposes a priori the assumption of unbiasedness which is a necessary condition for rational expectations. This is clearly not very useful when one wants to test the nature of the expectation formation process. For instance, 'bad expectations' are forced to be correct on average by way of scaling the time-series with the help of the indifference interval which, in turn, can give non-interpretable results. A further shortcoming is that the indifference limen is endogenously determined and, hence, it changes with the observed survey results and also with the corrections we had to make due to the violation of the normality assumption. Altogether, the fact that we calculated so many different indifference intervals across countries does not seem to be very plausible. In fact, there is no reason why the perception of changes in the inflation rate should be so different across countries. Two final problems are related to assumption 5 of the Probability Method. First, c was assumed to be constant in the sense that it neither varies over time nor with the inflationary environment, and second, it is symmetric meaning that people are equally sensitive to an expected rise and an expected fall of the inflation rate. These two assumptions will be relaxed in the next two sections.

4.2 The Time-Varying Parameters Method

An important extension to the Carlson-Parkin Method was introduced by Seitz (1988) who proposed to estimate a time-varying parameters model with purely random coefficients. The basic estimation equation underlying this approach can be directly derived from equation (5):

$$E_t \Delta \pi_{t+k} = b_t \frac{f_t}{f_t - r_t} + a_t \frac{r_t}{f_t - r_t}. \tag{9}$$

Note that in contrast to the Carlson-Parkin Method the boundaries of the indifference band a_t and b_t are allowed to vary over time and do not have to be identical. Equation(9) is usually called the signal equation and can be summarized as

$$E_t \Delta \pi_{t+k} = S_t A_t, \tag{10}$$

where $S_t = [\frac{f_t}{f_t - r_t} \quad \frac{r_t}{f_t - r_t}]$ and $A_t = [b_t \quad a_t]'$. The vector A_t is modeled as an autoregressive process:

$$A_t = A_t^p + \epsilon_t' \tag{11}$$

$$A_t^p = A_{t-1}^p + \eta_t, \tag{12}$$

where A_t^p is the permanent effect and ϵ_t' a transitory shock. It is obvious that with this formulation of the coefficient vector A_t^p, the boundaries are assumed to follow a random walk. Inserting these two expressions into equation (10) yields the state-space representation of the model:

$$E_t \Delta \pi_{t+k} = S_t A_t^p + \epsilon_t \tag{13}$$

$$A_t^p = A_{t-1}^p + \eta_t, \tag{14}$$

where ϵ_t and η_t are vectors of normally distributed error terms with mean zero.

The problem now is that a_t and b_t cannot be found by estimating these two equations, since $E_t \Delta \pi_{t+k}$ is unknown. In fact, it will be the outcome of the quantification procedure. Nardo (2003) solves this problem by replacing the expected change of the inflation rate with the realized changes of the past

$$E_t \Delta \pi_{t+k} = \Delta \pi_t, \tag{15}$$

and hence by imposing the unbiasedness of expectations[8].

A major disadvantage of this approach is again that the threshold values depend on the way expectations are connected to past realizations. In particular, we have to impose the additional assumption that changes in inflation expectations are an unbiased predictor of realized changes which is again only valid when expectations are formed rationally. Another criticism concerns the way the thresholds are modeled by the estimation technique. As pointed out by Nardo (2003), there are no economic or psychological reasons to suppose that individuals have an indifference limen that follows a random walk.

4.3 The Weber-Fechner Law

In this section we propose an alternative extension of the Carlson-Parkin Method that, similar to the Time-Varying Parameters Method, relaxes the assumption of a constant indifference limen (see assumption 5 in section 3.2). In contrast, however, to the Time-Varying Parameters Method we provide a simple and, in our view, plausible rationale for why the indifference limen should vary over time. In signal detection theory of psychophysics it is a well known concept that the 'just noticeable difference' varies in proportion to the base stimulus an individual faces. In other words, the higher the level of the base stimulus, the higher must be the change of this stimulus to be perceived by an individual. As this was first discovered by Weber (1834) and Fechner (1889), this concept is called the *Weber-Fechner Law*. It was originally proven in experiments for physical stimuli like sound and weight and it has already been addressed in studies by Batchelor (1986), Batchelor and Orr (1988) and Fishe and Lahiri (1981).

4.3.1 Conception

In this section we integrate the Weber-Fechner Law into the Carlson-Parkin Method. Therefore, equation (8) has to be modified in order to allow for a variable, but still symmetric, indifference limen. According to the Weber-Fechner Law, the indifference limen can be written as a linear function of the base stimulus, which is in our case π_t:

[8] In accordance with Pesaran (1984), Seitz (1988) originally used queried data on the perceived changes of the past which he regressed on the realized inflation rate to estimate the boundaries. As the *Ifo WES* does not query the perception of the past, this approach cannot be applied in our case. Note, however, that the original proposal by Seitz (1988) does not avoid the unbiasedness assumption, as it extrapolates the relationship between the respondents' perception and the actual outcome to the expected evolution of the inflation rate (see also Batchelor and Orr (1988) on this point).

$$c = \gamma \, \pi_t. \tag{16}$$

Thus, the boundary of the indifference band c varies over time in proportion to the inflation rate that prevails at the time expectations are formed. γ is the scaling factor which has to be computed in order to obtain the expectation time-series. By inserting equation (16) into equation (7) and solving for γ, the following expression results:

$$\gamma = \left(\sum_{t=1}^{T} \Delta \pi_t \right) / \left(\sum_{t=1}^{T} \frac{\pi_t \left(f_t + r_t \right)}{f_t - r_t} \right). \tag{17}$$

4.3.2 Results

For the countries in our sample the calculated values for γ are shown in table (4). Similar to the results obtained by the Carlson-Parkin Method and the Time-Varying Parameters Method, for some countries the upper and lower boundary of the indifference limen are turned upside down due to a negative value of γ. For Germany the indifference limen is plotted in figure (4) using actual German inflation rates between 1991:2 and 2004:2 on the abscissa. In addition to the problem of the correct sign the parameter γ varies remarkably across countries for which we do not find a plausible explanation. As before, the results seem to be driven to a large extent by some single observations, because the results change significantly when the outliers are dropped. Finally, the main shortcomings of the Carlson-Parkin Method are not resolved.

	γ
France	−0.67
France (dummy)	0.42
Germany	0.05
Italy	0.15
Italy (dummy)	−1.82
Japan	0.52
UK	−3.44
UK (dummy)	−0.23
US	−0.09

Note: We set a dummy variable to control for the outliers in France, Italy and the UK which are due to the conversion of inflation expectations from qualitative into quantitative data (see section 4.1.2 for details).

Table 4: Results for the Weber-Fechner Law

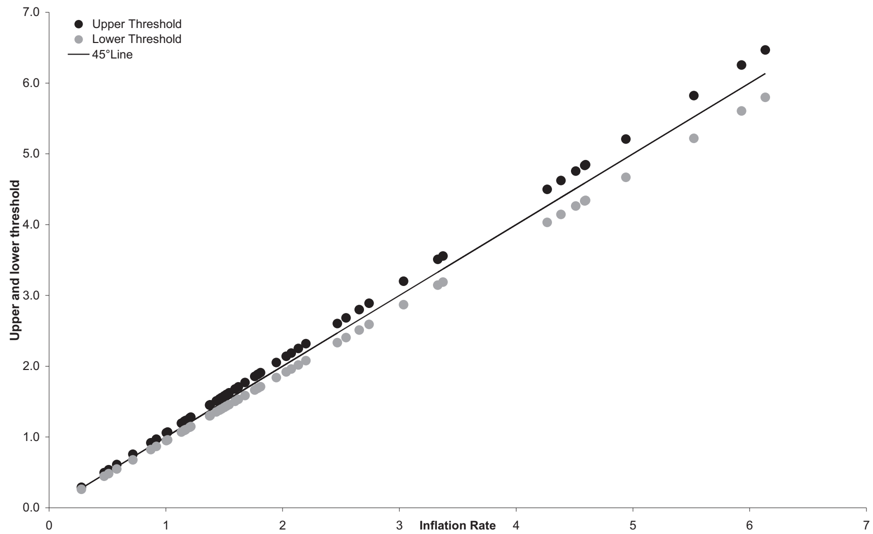


Figure 4: Indifference limen in Germany ($\gamma = 0.05$)

5 Survey-based Quantification of the Indifference Limen

The traditional conversion methods calculate the indifference limen on the basis of time-series properties of past changes in inflation (see equations (6) and (15)). To overcome the drawbacks related to this assumption, we determined the indifference interval by a survey. For this purpose we asked the participants of the *Ifo WES* in July 2004 an additional question where we wanted to observe the way the respondents actually form their expectations. It was put the following way:

> The following question focuses on the expectations regarding the rate of inflation (as asked in question 4 of the *WES* questionnaire).
>
> **a)** The current rate of inflation is (change of consumer prices compared to the same month previous year): ______%.
>
> **b)** The expected rate of inflation must rise above ______% to make you mark 'higher' in the *WES* questionnaire.
>
> **c)** The expected rate of inflation must fall below ______% to make you mark 'lower' in the *WES* questionnaire.

With the help of the answers to these questions we are able to address two important issues that are related to the conversion of qualitative into quantitative expectations. First, does the Weber-Fechner Law provide a valid explanation of the perception of the inflation rate? And if so, does this perception of the inflation rate follow a symmetric pattern? Second, what is the information set of the respondents at the time they fill in the survey?

5.1 Data Description

Before presenting the results of our analysis, we provide a short description of the responses that we received. The additional question was answered by 437 experts from all over the world. This has the advantage of obtaining a large spectrum of perceived inflation rates. The highest inflation rate was reported with a value of 580 per cent and the lowest had a value of -1.5 per cent. The mean of the answers concerning the perceived inflation rate was 10.54 per cent with a standard deviation of about 54.39 per cent. 95 per cent of the questionnaires were returned to the *Ifo Institute* between July 05 and July 15, 2004. Unfortunately, not all of the answers were interpretable and the data had to be corrected because of the following:

- No answer to question a): This was the case for 10 of the answers.
- No answer only to question b): This was the case for 13 of the answers.
- No answer only to question c): This was the case for 22 of the answers.
- No answer to questions b) and c): This was the case for 29 of the answers.
- Both values reported for the indifference limen are above or below the reported current inflation rate: This was the case for 35 of the answers.
- Same value for questions a), b) and c): This was the case for 37 of the answers.
- In the sample there is one country with an exceptionally high inflation rate (Zimbabwe). When these outliers were excluded, the sample size was reduced by 6 and included only observed inflation rates from -1.5 to 22 per cent.

When all the erroneous answers and the outliers are excluded, the number of responses amounts to 285. Sometimes only one value of the indifference band was given. If these answers are included, we get 320 responses.

5.2 Evidence on the Weber-Fechner Law

According to the Weber-Fechner Law expressed in equation (16), the indifference limen should be a linear function of the observed inflation rate[9]. As we observed a large variety of inflation rates from all over the world, it is possible to estimate the relationship and to test in a second step whether the Weber-Fechner Law holds indeed for the perception of the inflation rate.

If we denote by a the lower threshold obtained from question c) and by b the upper threshold obtained from question b), we can estimate the following two equations:

$$a = \delta_0 + \delta_1 \pi^p + \upsilon_a \quad (18)$$

$$b = \gamma_0 + \gamma_1 \pi^p + \upsilon_b. \quad (19)$$

The variable π^p denotes the perceived inflation rate of the survey respondents which was obtained from question a). The results including p-values in brackets are summarized in table (5)[10] and depicted in figures (6) and (5). Figure (7) shows the indifference limen in absolute values.

	δ_0	δ_1	R^2
Lower Threshold a	-0.2307 [0.00]	-0.1336 [0.00]	0.3877
	γ_0	γ_1	R^2
Upper Threshold b	0.2705 [0.00]	0.1530 [0.00]	0.3218

Table 5: Estimation results of the upper and lower thresholds

As the p-values indicate that the estimated parameters are all significantly different from zero at the one per-cent level, we conclude that the Weber-Fechner Law holds for the perception of the inflation rate. This result from a cross-sectional estimation can be interpreted as evidence for a time-varying indifference limen. It shows that the upper and lower boundaries

[9] In an earlier study Batchelor (1986) calculates symmetric indifference bands with the help of the Carlson-Parkin Method using qualitative survey data of eight European Community countries over the period 1974-1982. The theoretical model that he uses to describe the Weber-Fechner Law is derived from the optimizing behavior of agents that minimize a statistical error. He finds that the perception of the inflation rate cannot be described by the Weber-Fechner Law in its original version. Instead he estimates a negative influence of the base stimulus on the magnitude of the indifference limen. Nevertheless, he comes to the conclusion that the assumption of a constant indifference interval is untenable.

[10] Similar results are obtained when the outliers, which were previously eliminated from the data, are included in the regression.

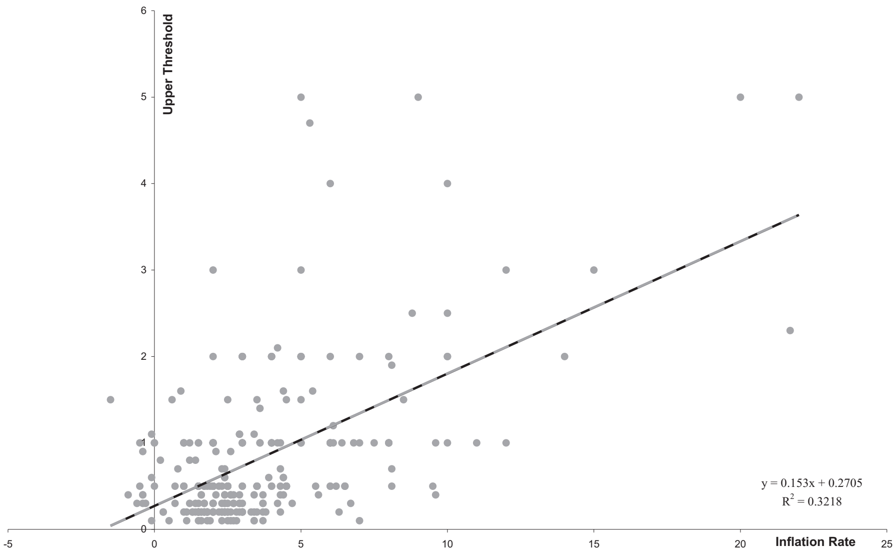


Figure 5: Estimation of the upper threshold

are functions of the inflation rate prevailing at the time the expectations are queried. Even though these boundaries are obtained from a cross-sectional estimation, we see no reason why they should not be transferred into the time domain.

Furthermore, as argued by Pesaran (1984), the perception of the inflation rate does not have to follow a symmetric pattern. For this reason in the literature the assumption of a normal distribution is sometimes replaced by other distributional assumptions like the log-normal distribution in Batchelor and Orr (1988) or a non-central t-distribution in Berk (1999). The view that inflation expectations follow an asymmetric pattern seems to be supported by the fact that only about 60% of the respondents gave a symmetric indifference band, whereas about 26% (14%) gave an upper value that was larger (smaller) than the lower threshold in absolute values. The fact that there were more respondents indicating a larger upper value is reflected in our finding that $|\gamma_1| > |\delta_1|$. For the boundaries of the indifference bands this finding together with the non-zero constant implies that $|b| > |a|$ as long as inflation is higher than -1.3 (see figure (7) for a presentation). However, we can't conclude from this, that people react less sensitively to an expected rise in the inflation rate than to a fall, because the absolute values of the slope coefficients are not significantly different [11]. As far as the size of the

[11] Confidence intervals on the 5%-level have the following values: $0.1532 < \delta_1 < 0.1141$ and $0.1271 < \gamma_1 < 0.1789$

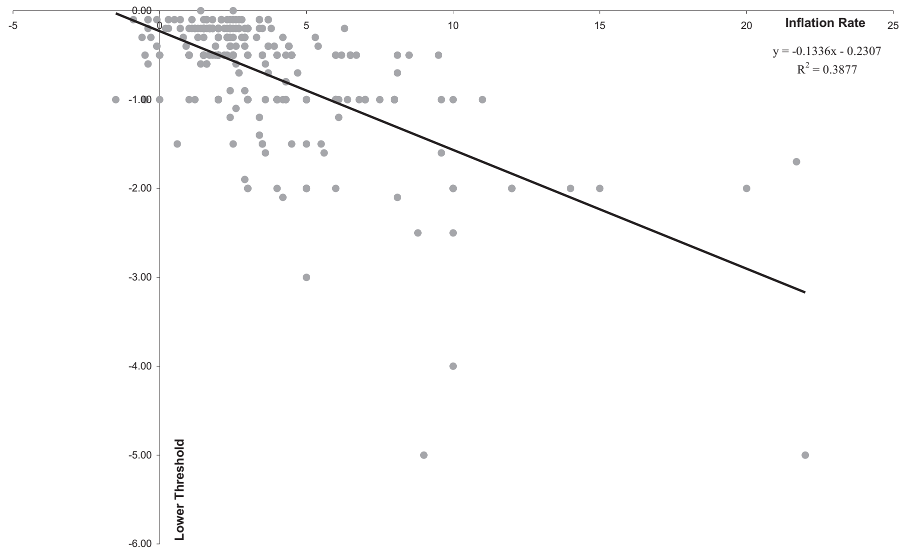


Figure 6: Estimation of the lower threshold

coefficients δ_1 and γ_1 is concerned our estimates imply that a change of the prevailing inflation rate of about 15 per cent is needed to make the respondents mark 'higher' in the questionnaire. By contrast, an expected fall of the observed inflation rate of about 13 per cent suffices to make the respondent mark 'lower'.

Note that Weber (1834) and Fechner (1889) originally did not allow for a constant term in their relationship of perception and base stimulus. As opposed to physical stimuli like weight and sound there exists no situation where the base stimulus is not present in the case of the inflation rate. It is even possible to interpret the intercept as the indifference threshold when the inflation rate is 0%.

5.3 Evidence on Information Lag

From the part a) of our special question we can infer the inflation rate which was perceived by the respondents at the time they filled in the *Ifo WES* questionnaire (between July 05 and July 15, 2004) and we can use these answers to detect the average information lag of the respondents. As the variation of the answers for each country is large, we use measures of average deviation. The *Root Mean Squared Error* (RMSE) and the *Mean Absolute Error* (MAE) can be calculated such that they measure the deviation of the inflation rate reported in response to question a) from the reference inflation rate prevailing in the current and previous quarters and months of 2004.

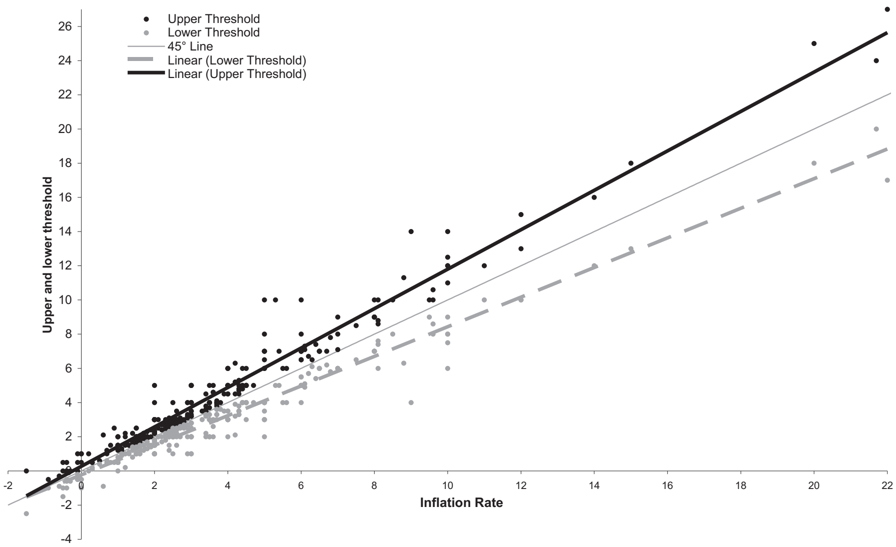


Figure 7: Indifference limen

The main difference between the RMSE and the MAE is that the RMSE puts more weight on deviations that are large.

MAE		RMSE	
M6 2004	0.612	M6 2004	0.995
M5 2004	0.563	M5 2004	0.940
M4 2004	0.599	M4 2004	1.053
M3 2004	0.792	M3 2004	1.223
M2 2004	0.846	M2 2004	1.264
M1 2004	0.735	M1 2004	1.275
Q2 2004	0.535	Q2 2004	0.952
Q1 2004	0.770	Q1 2004	1.225
Q4 2003	0.789	Q4 2003	1.452

Table 6: MAE and RMSE for the perceived current inflation rate

The calculation of the errors which are presented in table (6) show that the smallest error is calculated for the second quarter of 2004 for both measures when the analysis is done on a quarterly basis. On a monthly basis the results are qualitatively the same. The values for the RMSE and the MAE suggest that the smallest error emerges if May 2004 is taken as a reference. Nevertheless, the smallest MAE is indicated for the second quarter of 2004 and the RMSE for May 2004 is only slightly below the one calculated for the second quarter 2004.

Since inflation expectations from the *Ifo WES* are 6-months-ahead inflation expectations which are queried every three months in the first two weeks of January, April, July and October, a quarterly perspective seems to most appropriate. From the results presented in table (6) we conclude that the information set that is available to the survey respondents at the time they fill in the questionnaire is the past quarter (that is the first quarter for the questionnaires returned at the beginning of April, the second quarter for the questionnaires returned at the beginning of July, and so on). Thus, the July survey produces inflation expectations $E_t \pi_{t+2}$, where t refers to the second quarter and $t+2$ to the fourth quarter.

5.4 Results

With the indifference interval obtained from our special question it is now possible to convert qualitative inflation expectations for every country considered by the *Ifo WES* into quantitative measures of expectations without imposing any assumption on the nature of the expectations formation a priori. The results for selected Euro zone countries, Japan, the UK and the US are shown in figure (8). Note that the outliers resulting from a violation of the normality assumption still occur in France (2001:1), Italy (1996:4) and the UK (1991:4), despite our adjustments described in section 3.4.

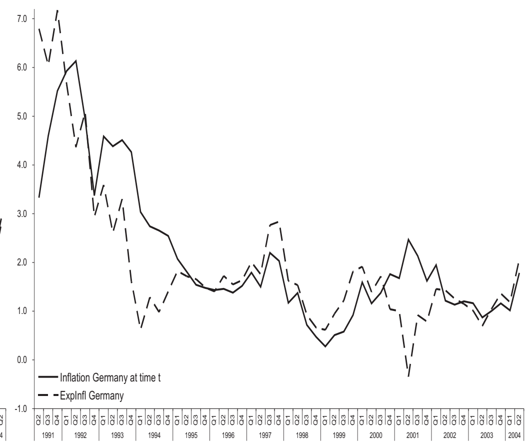
One way to avoid the problems of small sample sizes is to aggregate the individual answers. Since the *Ifo WES* contains survey data for all Euro zone member countries, a natural aggregate is given by the Euro zone as a whole. For this reason we calculated a weighted sum of responses for the individual member countries according to

$$DO_t^{EUR} = \sum_{j=1}^{J} \omega_t^j \ DO_t^j \tag{20}$$

$$UP_t^{EUR} = \sum_{j=1}^{J} \omega_t^j \ UP_t^j \tag{21}$$

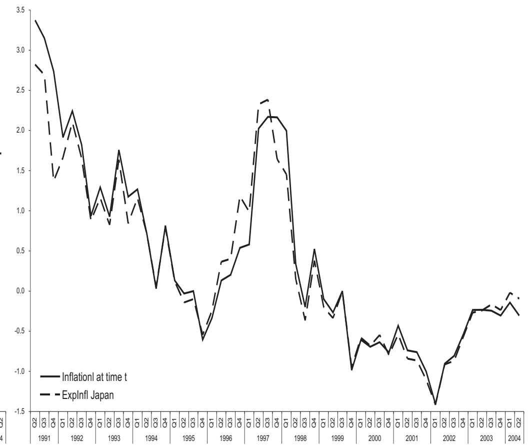
where the index j refers to each of the J Euro zone member countries, ω_t^j are the country weights used by *Eurostat* to calculate the Harmonized Index of Consumer Prices (HICP) for the Euro zone, and DO_t^j and UP_t^j are the fractions of respondents who indicated *LOWER* and *HIGHER* in country j. We then computed the expected inflation rate for the Euro zone using equation 5 in conjunction with the survey based indifference limen (equations (18) and (19)) and the Euro zone inflation rate (as published by *Eurostat*) as

France

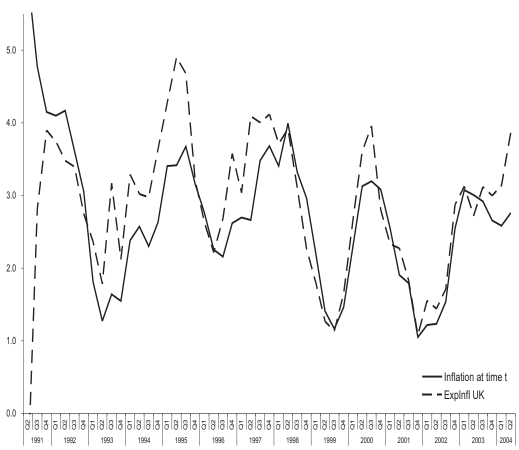


Germany

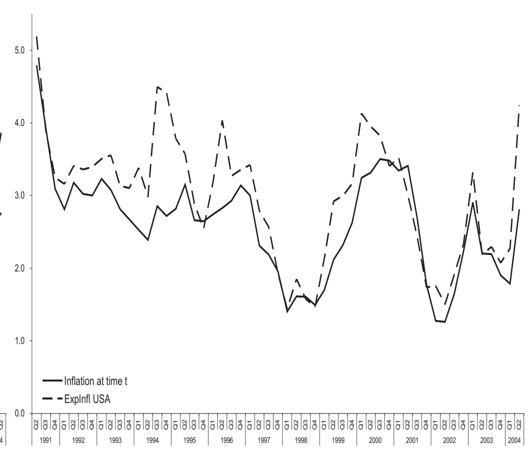
Italy



Japan



United Kingdom



US

Figure 8: Expected inflation rates in selected countries with a and b obtained from the survey

reference time-series. By doing so, we significantly increased our sample size, and we did not have to correct for any of the cases mentioned in section 3.4. The resulting inflation expectations for the Euro zone are shown in figure (9).

Figure 9: Expected inflation rate in the Euro zone

6 Rationality of Expectations

In the last section we presented an alternative to the traditional methods of quantifying qualitative expectations. This method relies on an exogenous indifference interval which we obtained by directly querying the upper and lower threshold. The main advantage of this approach is that we do not have to postulate any priors concerning the expectation formation process of the survey participants. While the Carlson-Parkin Method, the Time-Varying Parameters Method and the Regression Method impose the unbiasedness of expectations, our approach allows to test for this property. The reason why we are questioning this assumption is due to the mixed evidence reported in the literature. Many papers that have examined survey measures of inflation expectations (which were directly queried like in the US-based Livingston or Michigan survey and which have not been converted from qualitative data) have concluded that these expectations are biased forecasts of inflation (see Roberts (1997) and the papers cited there). In this section we therefore investigate the characteristics of the converted time-series of inflation expectations.

6.1 Test of Unbiasedness

A necessary condition for rational expectations in the sense of Muth (1961) is the *unbiasedness of expectations*. Unbiasedness implies that the forecast error should, on average, be equal to zero. For a forecast horizon of two quarters this hypothesis is typically tested by estimating the following equation:

$$\pi_t - E_{t-2}\pi_t = c + u_t. \tag{22}$$

If the null hypothesis that $c = 0$ can be rejected at reasonable levels, we conclude that expectations were indeed biased. The results are given in the second column of table (7). The p-values for the t-tests which have been calculated using Newey-West standard errors to correct for overlapping forecast errors, are reported in brackets. * (**) indicates significance at the 10% (5%) level.

Table (7) reveals that most of the inflation expectations were unbiased during the period 1991:2 to 2004:2. Italy, the UK and the US are the only countries in which expectations do not fulfill the necessary condition for rationality[12]. This finding is very much in line with our conjecture in section 4.1.2 where we argued that the negative indifference limen for these countries that has been derived from the Carlson-Parkin Method is a result of 'bad' expectations or, to put it more concretely, of expectations that were biased upwards throughout the period of disinflation in the beginning of the 1990s. The negative sign of the constant confirms this conjecture.

The unbiasedness tests for the inflation expectations obtained from the Carlson-Parkin Method and the the Weber-Fechner Method are shown in table (8). All the constant terms are close to zero and insignificant at the 5% level. Of course, this result does not come as a surprise as the unbiasedness is a crucial assumption for both methods.

6.2 Test of Efficiency

A further necessary condition for rational expectations is the *efficiency of expectations* which implies that no piece of information known at time $t - 2$ or earlier can be used to explain the forecast error. A first indication for the inefficiency of expectations is given by the p-values of the Ljung-Box Q test (H_0: no autocorrelation up to the fourth lag) and the serial correlation LM-test (H_0: no autocorrelation up to the second and fourth lag) in table (7) which indicate that, except for Italy and Japan, the residuals are not

[12]Using the Livingston Survey of Professional Forecasters (which queries quantitative inflation expectations) Adam and Padula (2003) find that expectations in the US were indeed biased during the nineties.

Country	c	Q 4 Lags	LM(2)	LM(4)
Euro zone	-0.02 [0.79]	0.00	0.16	0.00
France	-0.04 [0.68]	0.00	0.02	0.00
Germany	0.09 [0.61]	0.00	0.00	0.00
Italy	-0.20^{*} [0.08]	0.31	0.15	0.39
Japan	-0.06 [0.49]	0.11	0.10	0.05
UK	-0.30^{*} [0.05]	0.00	0.00	0.00
US	-0.43^{**} [0.00]	0.01	0.00	0.00

Note: We set a dummy variable to control for the outliers in France, Italy and the UK which are due to the conversion of inflation expectations from qualitative into quantitative data (see section 4.1.2 for details).

Table 7: Unbiasedness of expectations, survey-based quantification

free of autocorrelation[13]. Autocorrelation in the forecast error implies that a shock to the inflation rate or to some other economic variable was not taken into account when the inflation forecast was made and that the same mistake was repeated in subsequent periods. In other words, efficiency of expectations requires that the forecast could not have been improved by adding additional information. In order to test for this, the forecast error is regressed on a number of exogenous variables that are known at time $t-2$ (Z_{t-2}) and that are possibly relevant when forecasting inflation:

$$\pi_t - E_{t-2}\pi_t = \beta_0 + \phi Z_{t-2} + \nu_t. \tag{23}$$

The proceeding follows Roberts (1997) who introduced as potentially omitted variables the *output gap*[14] as a measure of overall economic activity, the *inflation rate* to capture the persistence of inflation, and the *three-month interest rate* as an indicator for the stance of monetary policy[15]. We also

[13]As the forecast horizon does not correspond to the frequency of the survey, shocks to the inflation rate can not be taken into account until the second period after the forecast and the same error may be repeated again. Thus, autocorrelation of order one in the error constitutes no irrationality.

[14]The output gap is measured as the percentage deviation from Hodrick-Prescott-filtered real GDP.

[15]For the member countries of the Euro zone we used the country specific interest rates up to the fourth quarter of 1998 and the *Euribor* thereafter. Since unit root tests indicated

Country	Carlson-Parkin	Weber-Fechner
Euro zone	−0.01 [0.93]	−0.01 [0.90]
France	−0.00 [0.97]	0.02 [0.91]
France (dummy)	0.03 [0.87]	0.03 [0.76]
Germany	−0.02 [0.85]	−0.02 [0.84]
Italy	0.02 [0.91]	0.00 [0.99]
Italy (dummy)	0.03 [0.99]	0.02 [0.99]
Japan	0.00 [0.96]	0.01 [0.90]
UK	0.20 [0.65]	−0.14 [0.97]
UK (dummy)	0.18 [0.50]	0.10 [0.70]
US	0.06 [0.67]	0.06 [0.67]

Note: For the countries in which outliers occurred due to the conversion of inflation expectations from qualitative into quantitative data (see section 4.1.2 for details) the analysis of the forecast error was done with and without dummy variable. In case the dummy variable was included, we used the indifference bands that were calculated excluding the outliers.

Table 8: Unbiasedness of expectations, Carlson-Parkin and Weber-Fechner Method

considered *real unit labor costs (RULC)*[16] which are the main driving force behind firms' price setting behavior. All of the variables indicate demand and cost pressures that should be considered when forming expectations about the inflation rate. Additionally, lagged terms of the *forecast error* are included to control for autocorrelation in the series.

For each explanatory variable we separately estimated equation (23) using four lags. The forecast error, real unit labor cost and the output gap enter equation (23) only from $t-3$ on, for reasons of overlapping forecast

that the time-series are non-stationary, we used first differences of the interest rate

[16]RULC are defined as the deviation of the logarithm of CPI-deflated unit labor costs (of the total economy) from a linear trend (over the period 1990:1-2004:3). Unit labor costs of the total economy are taken from the OECD database. Italian unit labor costs are only available for the business sector (which is defined as total economy minus public sector).

errors and because we assume a publication lag of one quarter. Table (9) reports p-values related to F-statistics testing the null hypothesis that the coefficients on the aforementioned lags of these regressors are jointly equal to zero[17]. In the Euro zone, France, Italy, Japan and the UK lagged values of the forecast error can explain the movement of the forecast error at the five percent level which is a hint that survey respondents seem to be sluggish when correcting their expectations after having recognized the last forecast error. Also past inflation rates are of explanatory use in all countries except Germany. This means that respondents underestimate the inertia of the inflation rate. In none of the countries the output gap has a significant influence, indicating that the respondents seem to take it into account when forming their expectations. By contrast, real unit labor costs seem to be omitted in France, Germany and the US. The three-month interest rate only helps explain the forecast error in Germany and UK[18].

Country	Error	Inflation	Output gap	RULC	3M Rate
	lags 3 to 6	lags 2 to 5	lags 3 to 6	lags 3 to 6	lags 2 to 5
Euro zone	0.000	0.002	0.093	0.090	0.129
France	0.000	0.001	0.380	0.034	0.470
Germany	0.188	0.077	0.073	0.000	0.016
Italy	0.000	0.000	0.336	0.337	0.356
Japan	0.032	0.015	0.228	0.124	0.191
UK	0.050	0.000	0.248	0.831	0.006
US	0.572	0.001	0.119	0.043	0.061

Note: We set a dummy variable to control for the outliers in France, Italy and the UK which are due to the conversion of inflation expectations from qualitative into quantitative data (see section 4.1.2 for details).

Table 9: Efficiency tests, survey-based quantification

[17] We assume no publication lag for the other variables: Interest rates are financial market variables, and for inflation we showed in section 5.3 that survey respondents are aware of the current rate of inflation

[18] Roberts (1997) and the studies cited there also find no support of the efficiency hypothesis for the US. Adam and Padula (2003) come to the same conclusion. For the Euro zone Forsells and Kenny (2002) who investigated qualitative inflation expectations from the European Commission's Consumer Survey also find that expectation were not efficient during the nineties.

7 Conclusion

This paper presented a new methodology for the quantification of qualitative survey data. Traditional conversion methods, such as the Carlson-Parkin Method (Carlson and Parkin, 1975) or the Time-Varying Parameters Model (Seitz, 1988), require very restrictive assumptions concerning the expectations formation process of survey respondents. Above all, the unbiasedness of expectations, which is a necessary condition for rationality, is imposed. Our approach avoids this assumptions. The novelty lies in the way the boundaries inside of which survey respondents expect the variable under consideration to remain unchanged (the so-called indifference limen) are determined. Instead of deriving these boundaries from the statistical properties of the reference time-series (which necessitates the unbiasedness assumption), we directly queried them from survey respondents by a special question in the *Ifo WES*. This Survey-Based Method was then applied to expectations about the future development of inflation obtained from the *Ifo WES*.

The major advantage of our approach is that we can explicitly test for rationality of expectations in the sense of Muth (1961). We showed that inflation expectations in most of the countries (with the exception of the UK and the US) display a weak form of rationality, meaning they are unbiased but inefficient predictors of future inflation rates. The traditional conversion methods do not reveal these characteristics of the time-series because unbiasedness is imposed a priori even though there is a lot of counter-evidence from quantitative surveys.

Another advantage of our approach is that the *Ifo WES* polls economic experts from all over the world. Thus, the answers to our special question were given for a large spectrum of perceived inflation rates so that we were able to test whether the inflationary environment matters for the width of the indifference band. Our estimates showed that the boundaries vary over time as a function of the actual (perceived) rate of inflation and that, moreover, the boundaries are asymmetric, both of which is in stark contrast to the assumptions underlying the Carlson-Parkin Method. The former finding takes up a proposal which is at the core of the Time-Varying Parameters Model by Seitz (1988) who modeled the boundaries of the indifference limen as a random walk. In contrast to this approach, we showed that the boundaries are a positive function of the actual inflation rate and we delivered an economic rationale for this relationship (the so-called Weber-Fechner Law). While the dependence of the boundaries on the perceived rate of inflation was found to be statistically significant, the asymmetry of the boundaries was not.

Apart from the relaxation of some crucial assumptions underlying the traditional conversion methods, a more practical advantage of the Survey-Based Method is that the resulting time series for inflation expectations are not subject to revisions. While in the traditional methods the boundaries of the indifference limen are recalculated with every additional data point, in our approach the boundaries are exogenous to the qualitative expectations and only vary with the level of the current rate of inflation.

The problems related to the assumption of normally distributed survey responses remain unsolved by our approach. Like the traditional conversion methods, the Survey-Based Method uses the computed boundaries to divide the Gaussian bell curve into three sub-areas: expectations of a lower, a constant and a higher future inflation rate. Problems emerge when there are no survey participants in one of the categories. This situation appears quite often in an expert survey such as the *Ifo WES* with a limited number of participants so that in the present paper we only considered countries for which a critical number of respondents was exceeded.

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