The information content of survey data on expected price developments for monetary policy

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Abstract

The present paper uses survey data on expected consumer price developments to analyse the role of inflation expectations in the inflation process. The survey measures of price expectations are derived from the European Commission's Consumer Survey and from the surveys of professional experts conducted by the London-based institute Consensus Economics. The estimates of the New Keynesian inflation model presented here underscore the importance of inflation expectations for the short to medium-run development of consumer prices in Germany, France and Italy. Furthermore, the analysis of the process of expectations formation indicates that the expectations of the households and experts surveyed are strongly guided by earlier forecasts and past price developments. The resultant "stickiness" of the inflation process heightens the need for monetary policy makers to adopt a forward-looking approach.

JEL classifications: E 31, E 52
Keywords: inflation expectations, survey data, Phillips curve

Zusammenfassung

Die vorliegende Arbeit verwendet Umfragedaten zur erwarteten Preisentwicklung, um die Rolle der Inflationserwartungen im Inflationsprozess zu analysieren. Dabei konzentriert sich die Analyse auf die im Rahmen der EU-Verbraucherumfrage ermittelten Daten und die von Consensus Economics erhobenen Expertenprognosen für Deutschland, Frankreich und Italien. Die präsentierten Schätzungen des neukeynesianischen Inflationsmodells unterstreichen die Bedeutung der Inflationserwartungen für die kurz- bis mittelfristige Entwicklung der Konsumentenpreise. Ferner deutet die Analyse des Erwartungsbildungsprozesses darauf hin, dass sich die befragten Haushalte und Experten bei der Erwartungsbildung stark von früheren Prognosen und von der vergangenen Preisentwicklung leiten lassen. Die daraus resultierende Persistenz inflationärer Prozesse verstärkt die Notwendigkeit eines vorausschauenden Verhaltens der geldpolitischen Entscheidungsträger.

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The information content of survey data on expected price developments for monetary policy*

I. Introduction

There is a broad consensus among theoreticians and practitioners of central banking alike that inflation expectations play a key role in shorter-term price developments and in the effectiveness of monetary policy. This consensus is born of the realisation that expectations regarding future price developments enter into the decisions taken by economic agents and are thus themselves part of the process of price formation. This connection is especially striking when we look at price formation on the labour markets, where wages are negotiated with future inflation developments in mind.

Central banks, whose main task is to maintain price stability, therefore have a vested interest in observing and analysing private sector inflation expectations. However, empirical studies of the role of expectations in the inflation process are only possible if reliable observations of market players' inflation expectations are available. One way to solve this problem is to ask economic agents directly what they expect. That way, observations may be obtained which are not prejudiced by certain a priori assumptions. The quality of such survey data, however, hinges crucially on the phrasing of the questions, the size of the sample and the motives of the respondents.

In the United States, the use of survey data on price expectations obtained as part of the Michigan, Livingston and ASA-NBER surveys has a long tradition.[1] By contrast, comparable data from surveys conducted in the member states of the European Union have been little used so far. The present paper tries to fill this gap by studying the information content of survey data on expected price developments from the European Commission's Consumer Survey and from the survey of professional experts conducted by the London-based institute Consensus Economics. The group of participants, the exact wording of the questions and the method of transforming the qualitative EU data into quantitative inflation expectations are all described in detail in Chapter 2 of this paper.

In Chapter 3, the time series calculated from the Consensus Forecasts and the EU survey data are used to study the role of inflation expectations in the inflation process. The theo-

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[1] An overview of this literature is given in Thomas (1999).

retical foundation for this analysis is provided by Taylor's (1979, 1980) model of staggered contracts and its extension by Fuhrer/Moore (1995). These models create a link between inflation, inflation expectations and real economic activity known as the "New Keynesian Phillips Curve", which has, over the past few years, become a standard feature of many macro models. Since the time horizon of the survey data matches the time horizon of the New Keynesian inflation model, the data may be used directly for an empirical review of the model without any further critical assumptions being necessary.

The empirical evidence presented in Chapter 3 underscores the important role inflation expectations play in shorter-term price developments. This turns the spotlight on the issue of what determinants economic agents rely on when forming expecations. In Chapter 4, the survey data are therefore used to test alternative models of expectations formation. Owing to its outstanding importance in macroeconomic theory, I first test the validity of the rational expectations hypothesis as defined by Muth. While the survey expectations pass the standard test of unbiasedness, further tests indicate that at least part of the households and experts surveyed did not make efficient use of the information available at the time they formed their expectations. In order to find out how far the survey data deviate from the benchmark of perfectly rational expectations, I then formulate and estimate a model of partly rational, partly adaptive expectations. Chapter 5 summarises the findings and discusses their monetary policy implications.

II. Description of the survey data used

II.1. Survey data as a measure of expected price developments

Anyone wishing to test the importance of inflation expectations for the inflation process empirically faces the underlying problem that economic agents' expectations are non-observable variables; suitable strategies for quantifying these variables must first be found. One approach to solving this problem consists in specifying a model for the inflation process and then solving this model on the basis of a given expectations formation hypothesis. In this case, however, the results are obviously not independent of whatever expectations formation model has been chosen. For its part, an empirical test of alternative models of expectations formation is possible only if direct observations exist for the expectations of the economic agents in question.[2]

Several authors have therefore attempted to derive market players' inflation expectations from financial asset prices (especially the term structure of interest rates and the prices of interest-rate derivatives).[3] However, the derivation is based on certain non-testable assumptions regarding the level and the structure of ex ante real interest rates. This seriously impairs the information content of the expectations calculated in that manner.[4] Alternatively, one can ask market participants directly what their expectations are over a certain time horizon through a survey. The advantage of direct surveys is that they yield observations of inflation expectations which are not prejudiced by certain a priori assumptions. However, the quality of the survey data hinges crucially on the size of the sample, the wording of the questions and the motives of those surveyed.

The European Union member states have a number of surveys at their disposal which also contain information on expected price developments. They include, in particular, the consumer surveys carried out on behalf of the European Commission, the surveys of professional experts conducted by the London-based institute Consensus Economics, and the ECB's Survey of Professional Forecasters.[5] Unlike the ECB survey, the EU and Consensus Economics surveys have been carried out since the beginning and end of the eighties, respectively, which means the number of observations is sufficient for analytical purposes. The following two sections describe how the EU survey data and the Consensus Forecasts

[2] Cf. Pesaran (1989), p. 207.

[3] For more see ECB, Monthly Bulletin, May 2000, pp. 37-55, or also Mylonas/Schich (1999).

[4] Pesaran (1989, p. 210) therefore calls these types of calculations "theory-loaded implicit methods" and notes: "such 'implicit' methods of the measurement of inflation expectations are, however, only as good as the theory and the auxiliary assumptions that underlie them".

[5] There are also a host of country-specific surveys. In Germany, one example is the Centre for European Economic Research (*Zentrum für Europäische Wirtschaftsforschung*, or *ZEW*). The inflation expectations gathered by ZEW cover a forecast horizon of six months and are based on a survey of around 350 financial experts from banks, insurance companies and selected business firms.

may be used to derive measures of expected price developments for a uniform time horizon of twelve months. The forecast horizon of one year is of particular interest in this paper since models of the inflation process which ascribe a prominent role to inflation expectations are usually geared to this time horizon (see Chapter 3).

II.2. The EU Consumer Survey of expected price developments

In the European Union member states, a harmonised consumer survey, which also includes an assessment of past and future price developments, is conducted monthly. The surveys are carried out by national institutions, such as the *Gesellschaft für Konsumforschung (GFK)* in Germany. Each country's sample comprises at least 1,500 persons selected by a special procedure. For the larger countries — France, Italy, Spain and the United Kingdom — the sample size was increased to 2,000, and for Germany to 2,500. Although the survey has been conducted in this form since 1980, results from these surveys have only been available since 1985 owing to database problems at the EU Commission. For those member countries who entered the EU at a later date (Spain, Portugal, Austria, Finland), the sample period shortens accordingly.

The EU survey is not designed to yield exact quantitive forecasts but takes the form of a tendency survey in which the respondents may choose from among several categories of responses. Table 1 shows the exact wording of the questions and the categories of responses available. The terms A', B', etc. denote the percentages of the respondents in each response category. Owing to the large sample size and the selection criteria applied by the polling institutes, it may be assumed that the basket of goods relevant for the surveyed households more or less corresponds to the basket of goods of the average household used by statistical offices to measure consumer price movements. The survey data may thus be interpreted as an assessment of the direction of change of the respective national consumer price index.[6]

An argument in favour of gathering qualitative rather than quantitative data is that the surveyed households are more likely to have an opinion on the expected direction of future price changes than they are to give precise forecasts for a certain time horizon.[7] This advantage is offset somewhat, however, by the fact that the object of the study often requires a quantification of the survey results which, in turn, is only possible under certain assumptions, some of which may not be testable.[8] To convert the qualitative EU data into

[6] Cf. Reckwerth (1997), p. 13f.

[7] For more on this see Pesaran (1989), p. 210.

[8] At the microeconomic level it is also possible to work directly with ordinal responses. Nerlove (1983) may be regarded as a pioneer in this field. However, the use of ordinal measures of expectations in conven-

Table 1: Questions and response categories of the EU Consumer Survey on price developments

How, in your view, have prices moved during the past 12 months?	How, in your view, will prices move in the coming 12 months?
Fallen slightly (A')	*Fall slightly (A)*
Hardly changed (B')	*Stay roughly the same (B)*
Risen slightly (C')	*Rise less sharply than before (C)*
Risen moderately (D')	*Rise by roughly the same amount as before (D)*
Risen sharply (E')	*Rise more sharply than before (E)*
Don't know (F')	*Don't know (F)*

absolute expected values for future price movements, I apply the method described by Reckwerth (1997) which goes back to the distribution function approach developed by Carlson and Parkin (1975) and its extension to the case of five categories by Batchelor and Orr (1988).[9]

Generally speaking, the distribution function approach developed by Carlson and Parkin is based on the assumption that every respondent forms a subjective probability distribution with a density function for the expected change in the price index to which he/she gears his/her response. It is further assumed that an aggregate density function for all respondents can be derived from the subjective density functions. The last step needed in order to convert the response percentiles into the expected rate of inflation is to specify a concrete distribution function. With the central limit theorem in mind, it is usually assumed that the aggregated density function follows a normal distribution or a logistic distribution. Since earlier studies have shown that both alternatives lead to very similar results, I choose a logistic distribution for computational convenience.[10] For a given distribution, corresponding areas under the graph of the aggregated density function (or values of the cumulative density function) can be assigned to the percentage shares of respondents in the individual response categories; these reflect the corresponding probabilities.[11] The expected value of the

tional, aggregated time series models is extremely time-consuming, if not impossible altogether; therefore, qualitative data generally need to be quantified for studies of this type.

[9] See Reckwerth (1997), pp. 11-14. By contrast, the regression approach proposed by Pesaran is better suited to the enterprise survey data he uses. Cf. Pesaran (1989), p. 221 ff. and Batchelor/Orr (1988), p. 322.

[10] Cf. Lahiri/Dasgupta (1992) and Reckwerth (1997), p.15f.

[11] As is common practice, the responses in the category "Don't know" are distributed proportionally among the other categories.

density function calculated in that manner may then be interpreted as the mean rate of inflation expected by the respondents.

However, the quantification of the price expectations from the EU survey is complicated by the fact that the wording of the response categories C, D and E - "rise less sharply than before", "rise by roughly the same amount as before", "rise more sharply than before" - links the respondents' assessment of expected future price developments to their perception of price movements in the more immediate past (presumably during the past 12 months). In terms of the conversion method, this means that the mean expected inflation rate $E_t\pi_{t+12}$ is the product of the (mean) assessment of price developments over the past 12 months, π'_{t-1}, and a factor x_t (calculated using the cumulative density function) which reflects the change in the assessment of future relative to past price developments:[12]

$$\pi^e_{t+12} = \pi'_{t-1} x_t \tag{1}$$

This raises the question as to what variable should be used to measure the perceived past rate of price increases, π'_{t-1}. An obvious solution would be to use the assessment of past price trends which was culled in the first part of the question.[13] However, quantification of these data is further complicated by the fact that the response categories C', D' and E' refer to the assessment of past price trends in relation to a benchmark considered "moderate". Developing equation (1), this link may be expressed as:

$$\pi'_{t-1} = \pi^m_{t-1} x'_{t-1} \tag{2}$$

where x'_{t-1} reflects the assessment of past price trends relative to the rate of price rise considered to be moderate by the average respondent. In order to be able to evaluate the responses to this part of the question, one therefore needs additional information as to what respondents consider a moderate rate of inflation. Since such information is not available and other conceivable methods of determining the "moderate" rate of inflation require additional critical assumptions, this approach will not be pursued further here.[14] Instead, I shall assume that the assessment of past price developments by the households surveyed matches the actual rate of change of the respective national consumer price index over the past twelve months (i.e. $\pi'_{t-1} = \pi_{t-1}$).[15] This assumption appears fairly unproblematical

[12] The precise method of deriving this term is described in Reckwerth (1997), p. 56 ff.
[13] Batchelor/Orr (1988) and Reckwerth (1997) choose this approach.
[14] Batchelor/Orr (1988) use a complicated method to determine the moderate rate of inflation; this method requires, inter alia, quantifying the "natural" rate of inflation. For more see Batchelor/Orr (1988), p. 322f.
[15] Simmons/Weiserbs (1992) and Berk (1997, 2000) use this approach.

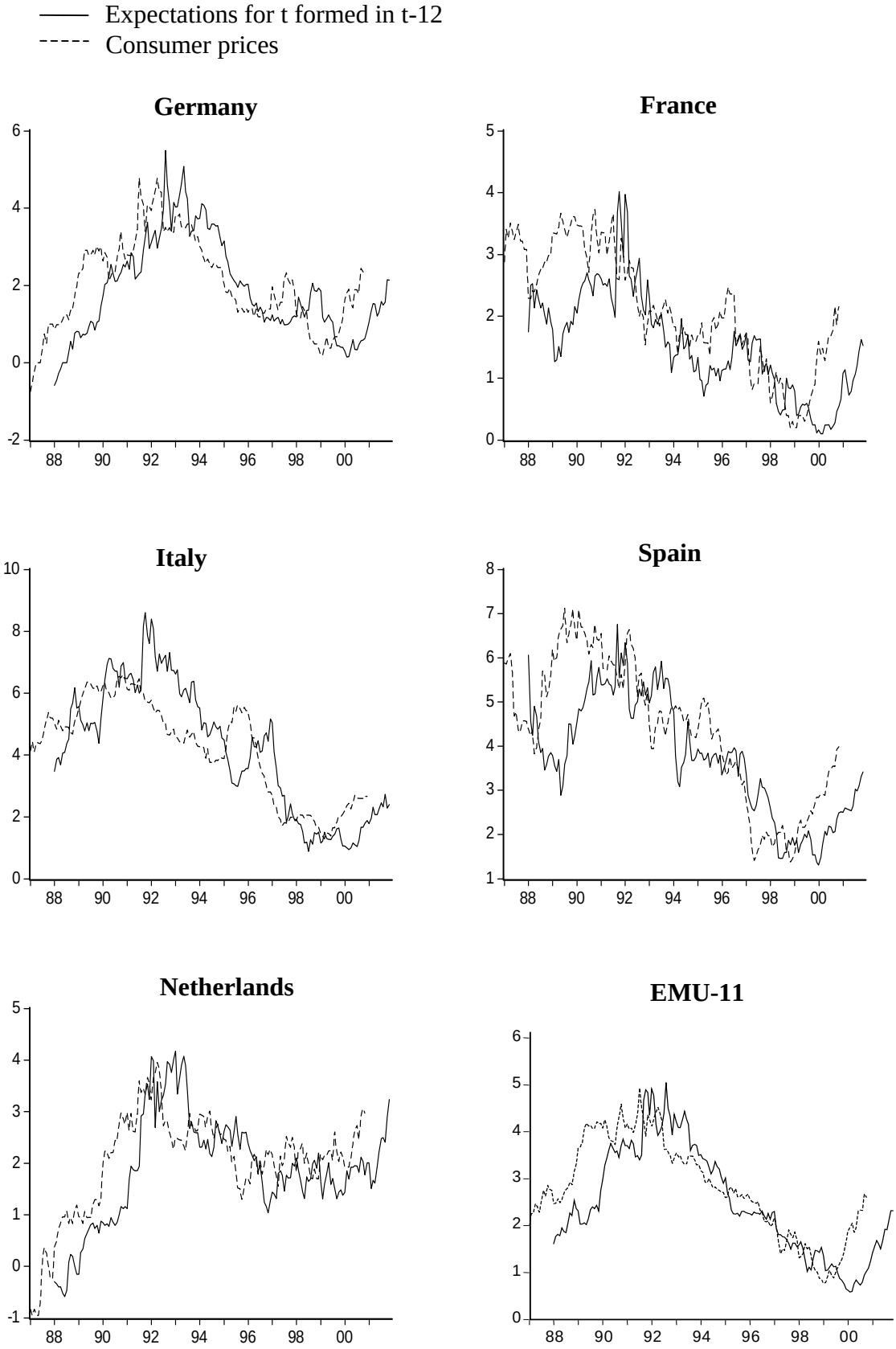
since the rate of change in the consumer price index is a variable which is measured monthly and published on a timely basis in the countries under observation.

Figure 1 shows the pattern of the expected price changes, quantified on the basis of current CPI inflation, for the five largest euro-area members and for the euro area as a whole (EMU-11). To construct the euro-area series, I weighted the contributions of the individual countries with their 1999 percentage shares in overall euro-area consumer expenditure.[16] In the charts, the inflation expectations formed in t-12 are contrasted with the actual (year-on-year) rates of CPI change in t. The difference between the two series at time t accordingly shows the "forecast" error. At first glance, the inflation expectations derived from the survey data seem to distinctly trail behind actual price developments. Thus, the surveyed households systematically underestimated inflation during the period of accelerating price increase up to mid-1991 but then distinctly overestimated it during the period of decelerating price increase between mid-1992 and mid-1993. Since March 1999, inflation expectations have been rising virtually parallel to currently observable price developments. However, it should be noted that the downward trend in the inflation rate between mid-1993 and the beginning of 1999 was anticipated correctly. This would indicate that not only a backward-looking component but also other explanatory factors play a role in the formation of expectations.

Despite the fact that the EU Consumer Survey is supposed to be harmonized across all participating countries, the wording of the questions and the response categories in France and Spain displays some peculiarities which need to be taken into account when quantifying the data gathered there and using them for analytical purposes. For example, the surveyed French households are asked for their assessment of expected price developments "in the coming months" without this time period being specified more precisely (see Table A1 in the Annex). To keep things simple, Figure 1 assumes that French households' responses relate to a time horizon of one year, just like those of the other countries. Since the first part of the question, however, refers to the assessment of price trends in the past six months (again different from the other countries), one cannot rule out the possibility that some of the respondents will likewise relate the question concerning future price developments to that time horizon. The danger that the price expectations calculated from the EU survey are subject to a measurement error is consequently greater for France than for the other countries. In Spain, the response category "rise by roughly the same amount as before" is replaced by "will rise rather sharply"; ergo $\pi^{e}_{t+12} = \pi^{rs}_{t-1} x_t$ (see Table A2 in the Annex). It is not clear (at least to us) what the surveyed households are supposed to

[16] Because they joined the EU at a later stage, Finland and Austria are only included in the aggregate from mid-1997.

Figure 1: Price expectations according to EU Consumer Survey
(Change from previous year in %, monthly values)



understand by "prices rising rather sharply". However, the fact that the category "risen moderately" (D') is likewise replaced by the formulation "risen rather sharply" – ergo, $\pi'_{t-1} = \pi^{rs}_{t-1} x'_{t-1}$ - enables us to derive a proxy for this variable from the responses to this part of the question. If we once again assume that the surveyed households correctly assess past price developments (i.e. $\pi'_{t-1} = \pi_{t-1}$), the price rise considered to be "rather sharp" at that particular point in time can be calculated by dividing the measured inflation rate by the distribution term x´.

II.3. Consensus Forecasts for consumer prices

A potential weakness of consumer and business surveys is that there might be little economic incentive for the respondents to state their expectations correctly. Some critics therefore recommend to restrict attention to surveys of professional forecasters who also sell their forecasts on the market.[17] However, other authors point out that it is precisely the professional forecasters who may have strategic incentives to report forecasts that deviate from their "true" expectations.[18]

Since the autumn of 1989, the London-based firm Consensus Economics has been conducting a survey at the beginning of each month in which renowned experts are asked to give their forecasts for the development of a range of important macroeconomic variables in over 20 countries. For each of the seven largest industrial countries (United States, Japan, Germany, France, United Kingdom, Italy and Canada), a separate panel of professional forecasters is recruited from the major banks, investment firms, economic research institutes and other business services in that country.[19] Since the end of 1994, the group of countries having their own expert panels has been enlarged to include the Netherlands, Spain, Sweden, Switzerland and Norway. For numerous other countries, including all other euro-area countries, Consensus Economics collects forecasts based on information provided by a number of leading economic forecasters.

With regard to the construction of time series, the usefulness of the regular monthly Consensus Forecasts is limited by the fact that the forecasts are made for the current year and the following year and thus do not have a fixed forecast horizon. However, once every quarter Consensus Economics asks the country panellists to provide additional estimates

[17] Cf. Keane/Runkle (1990), p. 715.
[18] Cf. Lamont (1995).
[19] In Germany, 26 institutions are surveyed at present (in France: 17, in Italy:13, in Spain: 10, in the Netherlands: 9): DG Bank, BHF Bank, Deutsche Bank Research, DGZ Deka Bank, JP Morgan, MM Warburg, WGZ Bank, Bank Julius Baer, BfG Bank, Commerzbank, Dresdner Bank, Invesco Bank, RWI Essen, Sal Oppenheim, Bayerische LBank, FAZ Institut, HypoVereinsbank, Bankgesellschaft Berlin, Helaba Frankfurt, IW Cologne, DIW Berlin, HSBC Trinkaus, IFO Munich, IfW Kiel, Merrill Lynch, Westdeutsche LBank.

for each of the following six (or sometimes even seven) quarters. These "quarterly consensus forecasts" include estimates of real growth, real consumption expenditure and industrial output as well as forecasts of the (year-on-year) rates of change in each national consumer price index. The published forecasts are the respective arithmetical means of the panellists' individual forecasts, which are not published separately. Table 2 shows the results of the December 11, 2000 survey regarding the expected development of consumer prices in Germany.

Table 2: Quarterly forecasts of the rate of change in consumer prices for Germany as at December 11, 2000[20]

Quarterly Consensus Forecasts

Percentage Change (year-on-year). From Survey: December 11, 2000

	2000				**2001**				**2002**	
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
Consumer Prices	1.8	1.6	2.0	***2.3***	***2.2***	***2.0***	***1.6***	***1.3***	***1.3***	***1.5***

Consensus Forecasts shown in bold italics

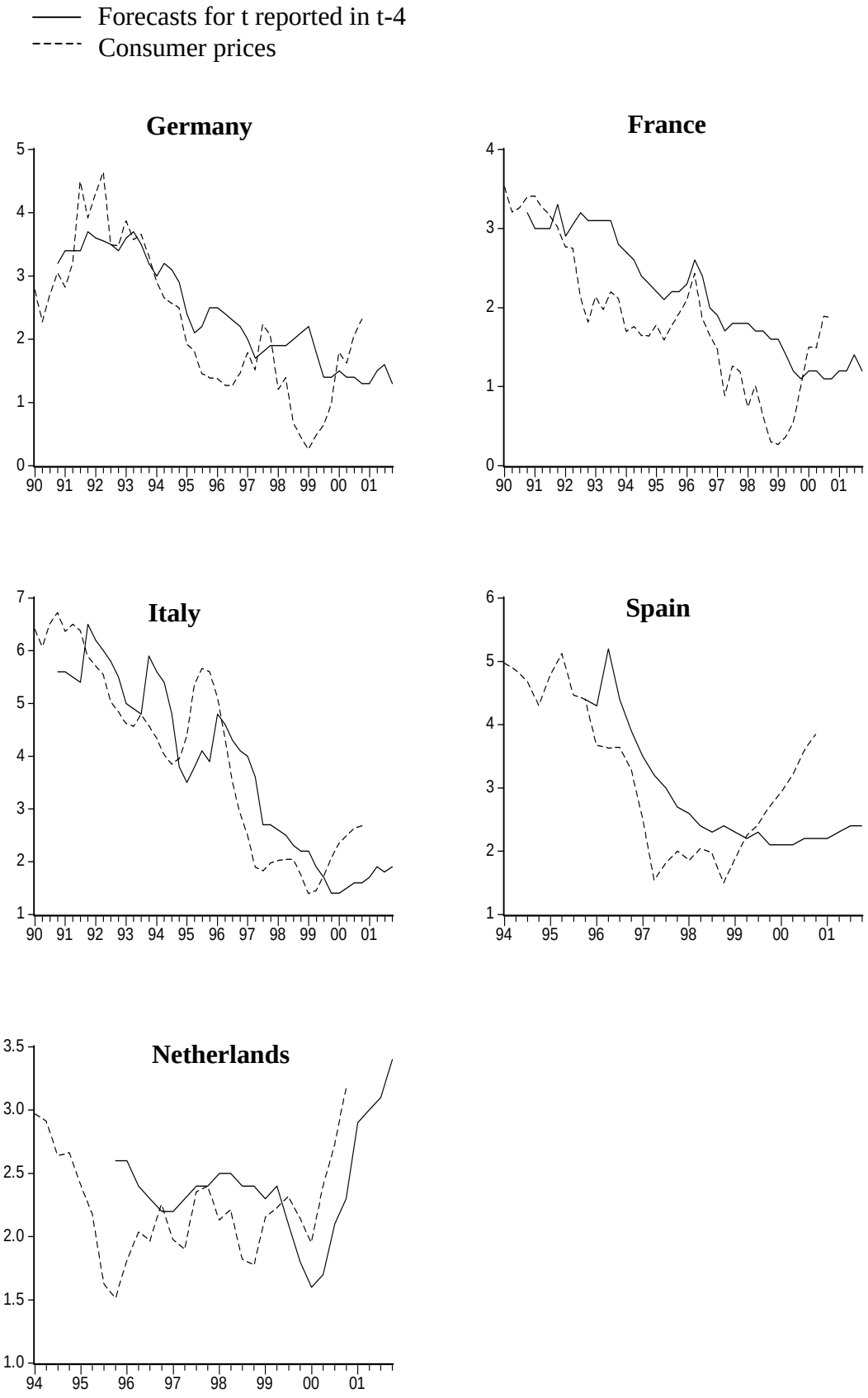
The quarterly Consensus Forecasts are available for Germany, France and Italy from November 1989 and for Spain and the Netherlands from December 1994. These data can be used to construct time series of the price developments expected by the surveyed experts for fixed time horizons of between one and six quarters. Figure 2 shows the pattern of inflation forecasts with a horizon of four quarters relative to actual price developments. In contrast to Figure 1, the rates shown here are quarterly averages, which explains the steadier path of the series.[21] Since the sample period of the forecasts for Spain and the Netherlands, at 25 observations, is too short for an empirical investigation of the issues to be pursued in this paper, the analyses conducted below focus on the survey data for Germany, France and Italy.

One striking feature is that the professional experts polled by Consensus Economics failed to anticipate either the deceleration of inflation in the first half of the nineties or the further sharp slowing of inflation rates in the run-up to European monetary union. The tendency to overestimate the actual rate of price increases was particularly marked in the case of France

[20] See: Consensus Economics, Consensus Forecasts, December 2000, p. 8.

[21] In 1990 (1991) the country panellists were asked to provide additional forecasts for individual quarters as part of the February (March), July and November surveys. In 1992 and 1993, the quarter-by-quarter forecasts were part of the February, May, August and November surveys, and since the beginning of 1994, they have been included in the March, June, September and December surveys. In Figure 2, the two missing observations for the second quarter of 1990 and 1991 were approximated by interpolating the preceding and succeeding "observation".

Figure 2: Consensus Forecasts of consumer prices in four quarters
(Change from previous year in %, quarterly data)



but can also be observed clearly in the forecasts for Germany, especially at the turn of 1998 to 1999. Nor was the most recent turning point in price trends predicted correctly, which was, however, caused by exogenous factors (the oil price shock).

In order to compare the predictive power of the Consensus Forecasts with that of the EU survey data, use may be made of statistical measures such as the mean absolute forecast error, the root mean square error or Theil's inequality coefficient, which gives the forecast error relative to the static forecast ("no change in the inflation rate"). Table 3 summarises the values of these measures for the survey data considered here. It indicates that the mean absolute forecast error of the Consensus Forecasts for Germany and Italy was smaller than the corresponding figure for the consumer price expectations polled in Germany and Italy. By contrast, in the case of France the expert forecasts show a larger absolute forecast error than the price expectations calculated from the consumer survey. This is confirmed by the values of the other two measures. As indicated by the values of Theil's inequality coefficient, the Consensus Forecasts for Germany and Italy outperform the naive extrapolative forecast, whereas the forecast error of the French experts corresponds exactly to that of the "no change" forecast. Of all forecasts considered here, only the price expectations of the Italian households surveyed, whose forecast error even exceeds that of the naive extrapolative forecasts, perform worse than the Consensus Forecasts for France.

Table 3: Comparison of predictive power

Estimation period: 4th qtr of 1990 to 4th qtr of 2000

Price expectations according to	Germany	France	Italy
	Mean absolute forecast error		
Consensus Forecasts	0.61	0.63	0.82
EU Consumer Survey	0.77	0.53	1.06
	Root mean square forecast error		
Consensus Forecasts	0.76	0.72	0.93
EU Consumer Survey	0.91	0.68	1.29
	Theil's inequality coefficient[1)]		
Consensus Forecasts	0.72	1.00	0.73
EU Consumer Survey	0.88	0.94	1.06

1) Forecast error of the survey data relative to the naive extrapolative forecast ($E_t\pi_{t+4}=\pi_{t-1}$). Values smaller than unity imply that the forecasts of the surveyed households and experts outperform the naive extrapolative forecast.

III. Inflation expectations as a determinant of inflation

III.1. The New Keynesian model of the Phillips curve

There is a broad consensus among economic scholars and monetary policy makers alike that private-sector inflation expectations play a key role in the monetary transmission process.[22] However, there is still no agreement on the exact nature of that process. Consensus exists only insofar as most economists and central bankers share the view that, in the long run, inflation is a monetary phenomenon whereas the influence of monetary policy on the real economy is limited to the short to medium term.

Most approaches to explaining the short to medium-run dynamics of inflation are based on the trade-off between (wage) inflation and unemployment described by Phillips (1958).[23] The realisation that wage bargainers negotiate expected real wages led Friedman (1968) and Phelps (1967) to add an expectational component to the original Phillips curve. The core argument of the Friedman-Phelps model is that there is a trade-off between inflation and unemployment only as long as private-sector inflation expectations deviate from the actual rate of inflation. Newer models stress the importance of temporary wage and price rigidities and try to come up with an explicit microfoundation of the Phillips-curve relationship. Among these, the groundbreaking models of staggered wage/price contracts proposed by Taylor (1979, 1980) and Calvo (1983) as well as Rotemberg's (1982) model of quadratic price adjustment costs deserve special mention.

Whereas Calvo's and Rotemberg's models describe enterprises' price-setting behaviour in a situation of monopolistic competition, Taylor derives the influence of expected price developments on the current price level from the existence of staggered wage contracts which run for two or more periods. Since the data from the EU survey and the Consensus Forecasts are primarily suited to test the Taylor model, I will review the salient features of this model before presenting empirical results.[24] In the most simple two-period version of the Taylor model, it is assumed that all wage contracts have a duration of two periods and that one-half of all contracts are renewed each period. Under these assumptions, the wage level w prevailing in period t is the average of the contract wages x negotiated in t and t-1:

(3a) $$w_t = (x_t + x_{t-1}) / 2$$

[22] See e.g. ECB (2000), p. 49.
[23] Under the assumption that prices are set as a constant markup on wages, output prices will grow in proportion to nominal wages.
[24] The description of the model follows Roberts (1997), p. 175f..

Furthermore, it is assumed that the contract wage negotiated in t depends on the price level expected for the duration of the contract, on the expected unemployment rate u, on a constant b_0 and on a random shock ε_t:

(3b) $$x_t = (p_t + E_t p_{t+1})/2 - \gamma(u_t + E_t u_{t+1}) + b_o + \varepsilon_t$$

Equation (3b) may be interpreted as a "quasi" labour supply function. The model is closed by the assumption that enterprises react to changes in nominal wages by adjusting prices accordingly (mark-up pricing):

(3c) $$p_t = w_t + h(s_t) + \nu_t$$

The variable s is a proxy for all other factors relevant to enterprises' pricing policies, such as the price of crude oil and other commodity prices. Inserting (3a) and (3b) into (3c), and solving for the rate of change in prices, Δp, gives the following price equation:

(4) $$\Delta p_t = \frac{1}{2}\left(E_t \Delta p_{t+1} + E_{t-1}\Delta p_t\right) - \gamma \hat{u}_t + 2h(s_t) + 2b_0 + (\varepsilon_t + \varepsilon_{t-1}) + 2\nu_t$$

where $\hat{u}_t = u_{t-1} + u_t + E_{t-1}u_t + E_t u_{t+1}$. The lagged value of the expected rate of price change is often subsumed into an expectational error term:

(4a) $$\Delta p_t = E_t \Delta p_{t+1} - 2\gamma \hat{u}_t + 4h(s_t) + 4b_0 + 2(\varepsilon_t + \varepsilon_{t-1}) + 4\nu_t + \eta_t$$

where η_t stands for the expectational error $(E_{t-1}\Delta p_t - \Delta p_t) = (E_{t-1}p_t - p_t)$. It should be noted, however, that the term η_t has an expected value of zero only if expectations are unbiased. Since this cannot be taken for granted, care must be taken when empirically testing equation (4a) that a constant is included in the estimation.

Because the rate of unemployment, u_t, is strongly serially correlated, it can be argued that current unemployment is an adequate proxy for $\hat{u}_t$. Owing to measurement problems and to doubts regarding the constancy of the "natural" rate of unemployment, many more recent studies replace the unemployment rate by the gap between actual and potential output. This may be justified by appealing to Okun's law, which postulates a fixed relationship between the output gap and the deviation of the unemployment rate from its natural level. However, even if Okun's law is considered to have only limited validity, one may argue that wage settlements in many cases depend more on the cyclical situation than on the level of the unemployment rate. If one replaces the unemployment rate with the output gap, z=(y-

y*)/y*, and summarises the "wage" shock ε, the "price" shock ν and the expectational error η into a joint error term ε^{π}, one ends up with the prototype of the New Keynesian Phillips curve:

$$\Delta p_t = E_t \Delta p_{t+1} + c_1 z_t + c_2(s_t) + c_0 + \varepsilon_t^{\pi} \tag{5}$$

In the past few years, this type of Phillips curve has become a standard feature of the dynamic microfounded IS-LM models which are widely used to evaluate alternative monetary policy strategies.[25] However, under the assumption of rational expectations, equation (5) implies that a - credibly announced - disinflation can be achieved at no real cost (or even, that a gradual disinflation would actually be accompanied by an economic boom!).[26] This flies in the face of the empirical observation that reducing high rates of inflation generally involves sizable output losses, even in countries like Germany where the central bank traditionally enjoyed a high degree of credibility.[27] In empirically oriented studies the right-hand side of equation (5) is therefore often augmented by one or more lags of the endogenous variable:

$$\Delta p_t = \delta E_t \Delta p_{t+1} + (1-\delta)\Delta p_{t-1} + c_1 z_t + c_2(s_t) + c_0 + \varepsilon_t^{\pi} \tag{5a}$$

where $0 \leq \delta \leq 1$.

One possible explanation of the influence of past inflation on current price developments is the existence of a backward-looking element in the formation of expectations. Thus, Gali/Gertler (2000), using a Calvo model, assume that only a certain fraction of the entrepreneurs form rational expectations, whereas the others set their prices based on simple, purely backward-looking rules of thumb.[28] If one follows this interpretation, the expectations term in equation (5a) represents the forward-looking "rational" component of expectations formation. Alternatively, some authors justify adding the lagged inflation rate to equation (5) by the hypothesis that wage demands in period t are geared to real wages negotiated in period t-1 as well as the (real) wage agreements expected for t+1. The assumption that relative wages - the wage structure - play a key role in wage negotiations goes back as far as Keynes (1936) and has been taken up more recently by Buiter/Jewitt (1981) and Fuhrer/Moore (1995).[29]

[25] See e.g. Clarida/Gali/Gertler (1999), McCallum/Nelson (1999a/b), Rotemberg/Woodford (1999) and various other contributions published in Taylor (1999).
[26] Cf. Mankiw (2000), p. 13.
[27] For more see Ball (1994).
[28] Cf. Gali/Gertler (2000), p. 12f.
[29] Cf. Keynes (1936), p. 14. Ascari/Garcia (1999) try to derive this idea from first principles.

Using survey data on market players' inflation expectations, one may test directly whether past inflation plays a role in the inflation process independently of inflation expectations. Roberts (1995, 1997) and Rudebusch (2000) use survey data on price expectations of US households as well as forecasts by professional experts to estimate the Phillips curve model described by equation (5a) for the US economy. Whereas the evidence presented by Roberts does not suggest that inflation is "intrinsically" sticky, Rudebusch comes up with a point estimate of only 0.29 (and a 90 percent confidence interval of between 0.16 and 0.42) for the parameter δ.[30] In the following, the survey data described above are used to estimate the inflation model described by equation (5a) for Germany, France, and Italy.

III.2. Formulating the estimation equation

Since the average duration of wage agreements in the United States and Europe is between one and two years, equation (5a) is usually interpreted as a model for price developments over a time horizon of one year.[31] On the one hand, this means that we don't have to "break down" the price expectations calculated from the EU and the Consensus surveys into 6-month or 3-month expectations but can use them directly to estimate equation (5a). On the other hand, the discrepancy between the time horizon of the price variable and the sampling interval of the data means that we have to find a way to deal with the problems caused by overlapping observations. Some authors circumvent these problems by adapting the data frequency to the time horizon of the variables in question.[32] However, since I cannot afford to sacrifice three quarters of the available observations, this approach is out of the question here. I therefore choose to estimate equation (5a) with quarterly data, which means that the time horizon of the price variables amounts to four sampling intervals:

$$(6) \qquad \Delta_4 p_t = \delta E_t \Delta_4 p_{t+4} + (1-\delta)\Delta_4 p_{t-4} + c_1 \tilde{z}_t + c_2(\tilde{s}_t) + c_0 + \varepsilon_t^{\pi}$$

$\tilde{z}_t$ and $\tilde{s}_t$ denote four-quarter averages of the variables in question (so that $\tilde{z}_t = 0.25 \cdot (z_t + z_{t-1} + z_{t-2} + z_{t-3})$ etc.). To overcome the problems caused by the overlapping nature of the observations, I apply the method proposed by Newey and West to calculate heteroskedasticity and autocorrelation (HAC-)consistent standard errors.[33]

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[30] One reason for the difference in results may be that Roberts estimates equation (5a) for the annual and the semiannual rate of change in the CPI, whereas Rudebusch estimates the model for quarterly inflation in the GDP chain-weighted price index (although he uses survey data on inflation expectations which refer to the rate of change in the CPI).

[31] Cf. Rudebusch (2000), p. 4, and Svensson (1999) and Smets (2000). By contrast, an equation for the rate of change in prices against the previous quarter can be better derived from a model of staggered wage contracts with a contractual length of four or more periods. For more see Fuhrer/Moore (1995).

[32] Roberts (1995) and Smets (2000) choose this route.

[33] For an earlier attempt to deal with this problem, see Hansen and Hodrick (1980).

To achieve consistency with the survey data, the rate of price changes in equation (6) is measured by the respective national consumer price indices. The fact that the employees (or their representatives) mainly have their eye on the expected development of consumer prices when negotiating wages is another argument in favour of this choice. One must note, though, that the price variable on the left-hand side of the mark-up equation (3c) is the price level of domestically produced goods which, in an open economy, may evolve differently than the consumer price level.[34] When interpreting equation (6) as a model for consumer price inflation, we therefore have to add the (relative) prices of imported consumer goods to the list of exogenous variables that need to be included in s_t. In the following, I use the rate of change of import prices relative to the rate of change of consumer prices (Δpim^r) as a summary statistic for the combined influence of the prices of imported raw materials, intermediate products and consumer goods: [35]

$$\text{(6a)} \qquad \Delta_4 p_t = \delta_1 E_t^s \Delta_4 p_{t+4} + \delta_2 \Delta_4 p_{t-4} + c_1 \tilde{z}_t + c_2 \Delta_4 pim_t^r + c_0 + \varepsilon_t^\pi$$

The output gap in quarter t, $z_t=y_t-y_t^*$, is measured as the difference between (the log of) real GDP and its long-term trend.[36] In order to estimate the trend, (the log of) real GDP is regressed on time and time squared. The inclusion of a quadratic trend is one way of giving the estimation an additional degree of freedom without having to specify a particular point in time for the structural break.[37] In Figure 3 the results of these estimations are contrasted with the output gaps estimated for Germany, France and Italy by the OECD, which, however, are only available on a biannual basis. As the comparison shows, the two series generally display a relatively similar pattern, despite some differences in the details.

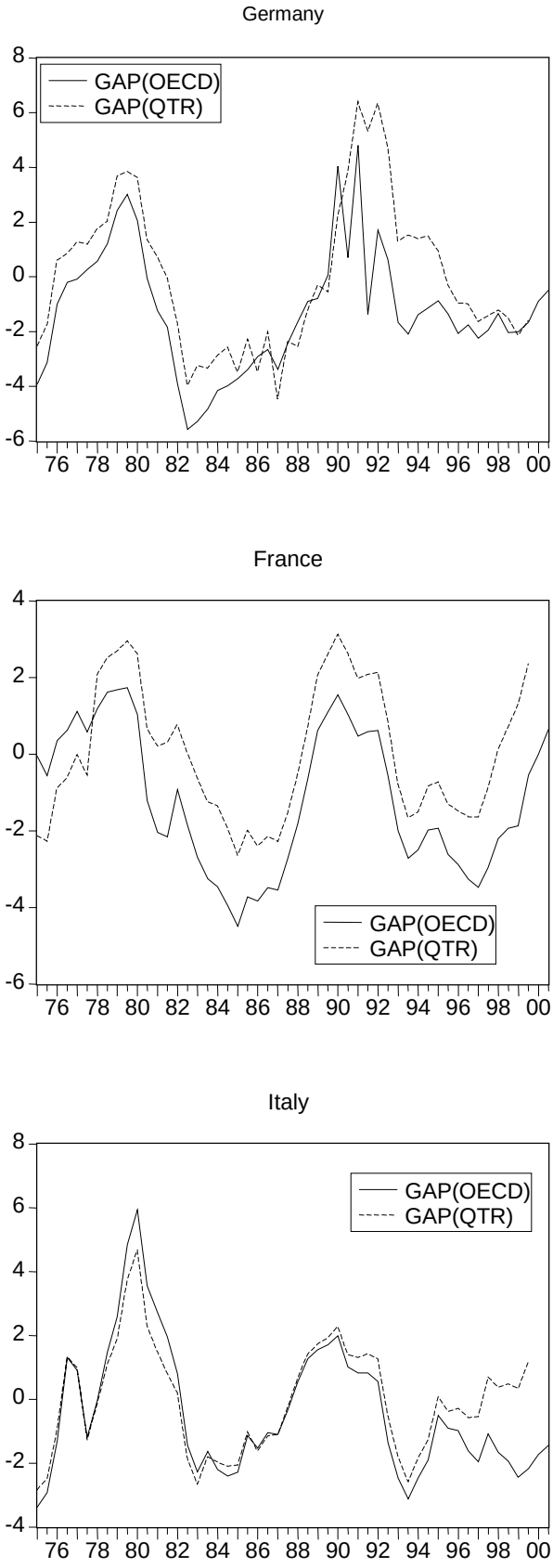
[34] The consumer price index (P^c) is composed of the prices of domestically manufactured and consumed consumer goods (P^d) and the prices of imported consumer goods ($E \cdot P^f$), weighted by their respective shares in consumer expenditure, (1-a) and (a). Consequently, the relationship between those variables' rates of change is: $\Delta p^c = (1-a)\Delta p^d + a(\Delta p^f + \Delta e)$ and. $\Delta p^d = \Delta p^c - a(\Delta p^f + \Delta e - \Delta p^c)/(1-a)$.

[35] See Rich/Rissmiller (2000) for the significance of import prices for a relatively closed economy like the United States.

[36] See ECB, Potential output growth and output gaps: concept, uses and estimates, Monthly Bulletin, October 2000.

[37] The question as to the appropriate trend specification for real output is still the subject of heated debate in the literature. Assenmacher (1998) studies this question for GDP in the Federal Republic of Germany and comes to the conclusion that German GDP did not display a stochastic trend since the Second World War but was trend-stationary in the 1950-1995 estimation period, with structural breaks in 1961 and 1973.

Figure 3: A comparison of OECD output gaps and the author's own estimates



III.3. Interpreting the estimation results

III.3.1. Estimation results based on Consensus Forecasts

One reason for using the expert forecasts collected by Consensus Economics to empirically test the inflation model described by equation (6a) is that those forecasts are published, media attention is devoted to them, and they are consequently an important source of information for wage bargainers. A decisive advantage of this source of information over the forecasts of individual institutes or organisations is that the forecasts published by Consensus Economics already represent the average values of a sizable number of individual forecasts which are based on different forecasting approaches and divergent assumptions regarding the development of key exogenous factors.

Table 4a summarises the results of the estimations conducted on the basis of the one-year-ahead Consensus Forecasts of consumer price inflation. In order to allow for some delay in the reaction of consumer prices to changes in the output gap and changes in import prices, a nonoverlapping lag of both variables (dated t-4) was included in the estimation. In addition to the results for the individual countries, table 4a presents the results of an estimation performed for an EMU-3-aggregate consisting of all three countries. For this purpose, the national time series were aggregated on the basis of GDP shares for 1995 (calculated at purchasing power parities), which are 0.425 for Germany, 0.292 for France and 0.283 for Italy.[38] The estimates given in columns 2 to 5 are the results of OLS estimations. Since one cannot rule out the existence of a simultaneity problem with regard to the contemporaneous expectations, output gap and import price variables, I conducted additional instrumental variables estimations, in which the variables in question were instrumented by their own lagged values. The IV estimates (columms 6 to 9) barely differ from the OLS estimates, however. The last line of the table contains the results of a test of overidentifying restrictions proposed by Davidson and MacKinnon, which confirms the validity of the instruments used.[39]

With adjusted coefficients of determination of between 82% and 95%, the explanatory content of the approach is highly satisfactory. The coefficient of the expectations variable, δ_1, is highly significant and is in all cases close to unity. By contrast, the coefficient of the lagged inflation rate, δ_2, is in no case significantly different from zero and was therefore restricted to zero. The P-values of this restriction are listed in the next-to-last line of the table. Secondly, there are considerable country-specific differences in the transmission of

[38] In 1995 the share of the three "major" countries in euro-area GDP, in terms of purchasing power parities, was over 70 %.
[39] See Davidson/McKinnon (1993), p. 235f.

Table 4a: Estimation results based on Consensus Forecasts

Estimation equation:

$$\pi_t = \delta_1 E_t^s \pi_{t+4} + \delta_2 \pi_{t-4} + c_1 \tilde{z}_t + c_2 \tilde{z}_{t-4} + c_3 \Delta_4 pim_t + c_4 \Delta_4 pim_{t-4} + c_0 + \varepsilon_t^{\pi}$$

Estimation period: Q1 1990 to Q4 1999, estimation method: OLS/TSLS, Newey-West correction of standard errors[1)]

	OLS				TSLS[2)]			
	GE	FR	IT	EMU-3	GE	FR	IT	EMU-3
δ_1	0.84*** (0.17)	0.97*** (0.11)	0.99*** (0.06)	0.92*** (0.07)	0.86*** (0.25)	1.05*** (0.12)	1.02*** (0.06)	0.94*** (0.10)
δ_2	-	-	-	-	-	-	-	-
c_1	0.10 (0.07)	-0.07 (0.08)	0.30** (0.15)	0.11* (0.06)	0.12 (0.09)	-0.09 (0.08)	0.47*** (0.16)	0.16 (0.11)
c_2	0.16*** (0.04)	0.29*** (0.09)	-0.08 (0.16)	0.17** (0.08)	0.14** (0.05)	0.33*** (0.11)	-0.08 (0.14)	0.18** (0.07)
c_3	0.06* (0.03)	0.10*** (0.03)	0.02 (0.03)	0.08** (0.03)	0.09** (0.04)	0.14*** (0.05)	0.07* (0.03)	0.13*** (0.05)
c_4	0.01 (0.04)	0.09** (0.04)	0.05** (0.02)	0.08** (0.03)	-0.03 (0.04)	0.11** (0.04)	0.06** (0.02)	0.11*** (0.03)
c_0	-0.02 (0.47)	0.08 (0.34)	0.27 (0.21)	0.20 (0.23)	-0.06 (0.62)	0.05 (0.35)	0.21 (0.20)	0.26 (0.31)
R2bar[3)]	0.89	0.83	0.90	0.95	0.87	0.82	0.88	0.94
AC(1)[4)]	0.39	0.47	0.56	0.45	0.41	0.43	0.60	0.50
AC(5)[4)]	-0.16	-0.12	-0.38	-0.52	-0.11	-0.18	-0.40	-0.58
Restrict., P-values	0.64	0.83	0.05	0.60	0.29	0.48	0.58	0.50
Overid., P-values[5)]					0.26	0.45	0.79	0.35

***(**/*) denotes significance at the 1%(5%/10%) level; values in brackets denote the HAC-consistent standard errors.

1) Carried out because the discrepancy between the data frequency and the time horizon of the endogenous variables may cause autocorrelation of the first to (at most) the fourth order. 2) The instruments used are lagged values of the explanatory variables. 3) Adjusted coefficient of determination. 4) Autocorrelation coefficient of the first and fifth orders (standard error according to Bartlett: $1/\sqrt{T}$, i.e. 0.16 for T = 40). 5) Test of orthogonality of the residuals against the instruments used; see Davidson/MacKinnon (1993), p. 235 f.

Table 4b: Estimation results for the relationship between inflation and inflation expectations based on Consensus Forecasts

Estimation equation

$$\Delta_4 p_t = E_t^s(\Delta_4 p_{t+4}) + c_1\tilde{z}_t + c_2\tilde{z}_{t-4} + c_3\Delta_4 pim_t + c_4\Delta_4 pim_{t-4} + c_0 + \varepsilon_t^{\pi}$$

Quarterly data, estimation period: Q1 1990 to Q4 1999, estimation method: Two Stage Least Squares[1)], Newey-West correction of standard errors[2)]

	Germany	France	Italy
c_1	-	-	0.46*** (0.15)
c_2	0.21*** (0.02)	0.25*** (0.04)	-
c_3	0.06*** (0.02)	0.12*** (0.04)	0.07** (0.03)
c_4	-	0.09*** (0.03)	0.07** (0.03)
c_0	-0.36*** (0.10)	0.06 (0.15)	0.28** (0.13)
R2bar[3)]	0.89	0.83	0.88
AC(1)[4)]	0.45	0.48	0.60
AC(5)[4)]	-0.09	-0.16	-0.32
Validity of coefficient restriction, P-values	0.28	0.31	0.74
Test of overidentifying restrictions, P-values[5)]	0.55	0.63	0.90

***(**/*) denotes significance at the 1%(5%/10%) level; values in brackets denote the HAC-consistent standard errors.

1) The instruments used are lagged values of the explanatory values. 2) Carried out because the discrepancy between the frequency of data and the time horizon of the endogenous variables may cause autocorrelation of the first to (at most) the fourth order. 3) Adjusted coefficient of determination. 4) Autocorrelation coefficient of the first and fifth orders (standard error according to Bartlett: $1/\sqrt{T}$, i.e. 0.16 for T = 40). 5) Test of orthogonality of the residuals against the instruments used.

output shocks to prices. Aggregation thus entails a loss of information, which may give rise to a bias in the coefficient estimates of the aggregated equation (the so called aggregation bias).[40] In the case at hand, though, the estimation results for the aggregated time series

[40] As was shown by Theil (1954), an aggregation bias can only be avoided if either the parameters of the disaggregated equations are identical or the countries' shares in the aggregated variables remain constant

generally seem to match the weighted average values of the country-specific coefficients. Still, it would seem that caution is warranted with regard to the use of an aggregated inflation model for Germany, France and Italy, at least until there are clear signs of a greater convergence of national inflation processes.

To illustrate the extent of country-specific differences, for each country an additional version of equation (6a) was estimated, in which the coefficient δ_1 was restricted to unity and all non-significant coefficients with the exception of the constants were restricted to zero (see Table 4b). The results indicate that consumer prices in Germany and France react to changes in the output gap with a lag of one year, whereas a corresponding rise or fall in capacity utilisation in Italy has its main impact on consumer prices before the year is out. In addition, the point estimate of the coefficient c_1 is considerably larger for Italy than the corresponding values of the coefficient c_2 for Germany and France. The rate of change of import prices has the expected positive impact on inflation everywhere. The strength and the timing of this effect likewise show certain national differences.

III.3.2. Estimation results based on EU survey data

In order to check the sensitivity of the results to the survey data used, the estimations were repeated using the price expectations calculated from the EU survey. Bearing in mind the wage contract model, an argument in favour of using these data is that they reflect the expectations of those economic agents who ultimately make the decisions on labour supply.

Table 5 summarises the estimation results for the inflation expectations calculated from the EU survey data. With adjusted coefficients of determination of over 90%, the explanatory power of the estimated equations is once again very high. However, this result is based almost exclusively on the close relationship between current and expected price developments. While the coefficient of lagged inflation, δ_2, proves to be significantly positive in the OLS estimation for Italy, it can be restricted to zero without any difficulty in the corresponding IV estimation. The differences between the OLS and the IV estimates point to the existence of an endogeneity problem. One possible reason for this problem could be that the surveyed households' assessment of future price developments is itself heavily dependent on current price developments (for more on this see Chapter IV). The close correlation between these two variables could also be the reason why the coefficients of the other explanatory variables are in many cases non-significant. According to the results of the IV estimations, the influence of the output gap variables on the current rate of inflation is only significant in the estimations for Italy, but with a negative sign instead of the expected

over the entire period. In the present example apparently neither condition is met. See Wesche (1998), p. 59ff.

Table 5: Estimation results based on EU survey data

Estimation equation:

$$\pi_t = \delta_1 E_t^s \pi_{t+4} + \delta_2 \pi_{t-4} + c_1 \tilde{z}_t + c_2 \tilde{z}_{t-4} + c_3 \Delta_4 pim_t + c_4 \Delta_4 pim_{t-4} + c_0 + \varepsilon_t^{\pi}$$

Estimation period: Q1 1990 to Q4 1999, estimation method: OLS/TSLS, Newey-West correction of standard errors[1)]

	OLS				TSLS[2)]			
	DE	FR	IT	EMU-3	DE	FR	IT	EMU-3
δ_1	0.88*** (0.05)	0.92*** (0.11)	0.66*** (0.05)	0.86*** (0.07)	0.88*** (0.08)	1.08*** (0.09)	0.82*** (0.03)	0.97*** (0.06)
δ_2	-	-	0.21*** (0.07)	-	-	-	-	-
c_1	0.00 (0.02)	-0.11*** (0.04)	0.28*** (0.09)	0.01 (0.04)	0.00 (0.04)	-0.07 (0.04)	0.15 (0.11)	-0.08 (0.05)
c_2	0.05** (0.02)	0.17** (0.07)	-0.28*** (0.07)	0.09* (0.05)	0.03 (0.02)	0.06 (0.06)	-0.27*** (0.07)	0.03 (0.05)
c_3	0.04*** (0.01)	0.01 (0.02)	0.04*** (0.02)	0.07*** (0.01)	0.03** (0.01)	0.01 (0.02)	0.02 (0.02)	0.05** (0.02)
c_4	0.01 (0.01)	0.03 (0.03)	0.04*** (0.01)	0.08*** (0.02)	-0.01 (0.01)	-0.02 (0.02)	0.04** (0.02)	0.05* (0.03)
c_0	0.41*** (0.09)	0.62*** (0.16)	0.58*** (0.10)	0.78*** (0.17)	0.36*** (0.12)	0.34*** (0.10)	0.89*** (0.13)	0.48*** (0.17)
R2bar[3)]	0.98	0.92	0.96	0.98	0.98	0.91	0.96	0.97
AC(1)[4)]	0.24	0.15	0.49	0.15	0.28	0.20	0.52	0.18
AC(5)[4)]	-0.00	0.01	-0.42	-0.22	-0.04	-0.09	-0.16	-0.27
Restrict., P-values	0.68	0.55	-	0.65	0.47	0.14	0.18	0.94
Overid., P values[5)]					0.42	0.35	0.33	0.98

***(**/*) denotes significance at the 1%(5%/10%) level; values in brackets denote the HAC consistent standard errors.

1) Carried out because the discrepancy between the frequency of data and the time horizon of the endogenous variables may cause autocorrelation of the first to (at most) the fourth order. 2) The instruments used are lagged values of the explanatory values. 3) Adjusted coefficient of determination. 4) Autocorrelation coefficient of the first and fifth orders (standard error according to Bartlett: $1/\sqrt{T}$, i.e. 0.16 for T = 40). 5) Test of orthogonality of the residuals against the instruments used; see Davidson/MacKinnon (1993), p. 235 f.

positive sign. Moreover, only in the case of Germany and Italy can a significant influence of (relative) import prices on consumer prices be demonstrated.

To sum up, it may be said that the estimation results presented here underscore the importance of expected price developments for current inflation. By contrast, I find no evidence for a significant influence of last year's inflation rate on current price developments. The evidence presented here thus does not back the "sticky-inflation" model empasized by Fuhrer and Moore (1992, 1995) which claims that lagged inflation plays an autonomous role in the inflation process independently of the formation of expectations. Rather, the results suggest that if we want to explain the high degree of inflation persistence to be observed in the real world, we have to take a closer look at the way wage-setters form expectations. This may be done by using the survey expectations to test alternative models of expectations formation.

IV. Determinants of inflation expectations

IV.1. Alternative models of expectations formation

The estimations presented in Chapter 3 support the hypothesis that private sector inflation expectations constitute an important determinant of current inflation. However, we cannot rule out the possibility that inflation expectations are for their part influenced by past price developments. In order to understand the short-run dynamics of inflation, we therefore need to know more about the process of expectations formation. This knowledge is not only of theoretical interest but also has important practical implications for monetary policy. If the central bank does not succeed in anchoring inflation expectations at the desired low level, it must combat the "excessive" expectations by pursuing a restrictive monetary policy course. The attendant real costs in the form of output and employment losses would then jeopardise the public acceptability of a monetary policy geared to price stability.[41]

The spectrum of expectations formation models discussed in the literature ranges from simple, purely backward-looking "rules of thumb" to explicitly modelling learning processes to the hypothesis of perfectly rational expectations.[42] Simple backward-looking models assume that agents use only past price developments and earlier forecast errors to form expectations while other influences and relationships are disregarded. In his definition of "rational expectations", by contrast, Muth assumes that the subjective expectations of economic agents match the predictions of the relevant economic theory.[43] Consequently, an essential feature of Muth's definition of rational expectations is that economic agents do not make systematic errors.

The hypothesis that economic agents possess full knowledge of the relevant structural relationships is doubtless an extreme assumption that cannot be maintained outside the tranquillity of a prolonged steady state.[44] Many critics have pointed to the importance of information problems and have stressed the need to take into account the costs of making optimal forecasts and also to explicitly model learning processes.[45] However, since its adoption by Lucas (1972, 1973, 1975), Sargent (1973), Barro (1977) and others, the rational expectations hypothesis has become one of the broadly accepted paradigms of macroeconomic analysis.

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[41] This is also called the "expectations trap". For details see Christiano/Gust (2000).
[42] For more see Pesaran (1989), chapters 2 and 3.
[43] In Muth's own words: "Expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory." Muth (1961), p. 316.
[44] Cf. Pesaran (1989), p. 2.
[45] Among these critics are Akerlof/Yellen (1985a/b, 1987), Pesaran (1989), Ball (1991) and Evans/Honkapohja (2000).

IV.2. Tests of unbiasedness and informational efficiency

The popularity of the rational expectations hypothesis has motivated numerous authors to test it on survey data.[46] The tests conducted draw on certain properties of the expectations errors, $\eta_t = \pi_t - E_{t-j}\pi_t$, which must be met in a rational expectations scenario. Most importantly, the expectations errors must have a mean value of zero and they must not be correlated with variables which were included in the agents' information set Ω_{t-j} at the time the expectations were formed:

(7a) $E(\eta_t) = 0$ (Criterion of unbiasedness)

(7b) $E(\eta_t \mid \Omega_{t-j}) = 0$ (Criterion of orthogonality)

The property of unbiasedness may be tested by regressing the forecast error on a constant:[47]

(8a) $$\pi_t - E_{t-4}\pi_t = c_0 + \varepsilon_t$$

If the constant c_0 is significantly different from zero, the null hypothesis of unbiasedness must be rejected. Table 6 summarises the results of this test for the Consensus Forecasts of consumer prices and the price expectations calculated from the EU survey. Accordingly, the null hypothesis of unbiasedness can only be rejected with a high level of confidence in one case, namely for the Consensus forecasts of consumer price inflation in France. The Consensus forecasts for Germany also display a certain bias; however, it is only significant at the 10 % level. Unlike the mean forecast error of the experts for France, the average expectations error of the polled French households during the period under review was greater than zero, which indicates that the surveyed consumers tended to underestimate rather than overestimate the measured price rise. However, this bias could be due to a measurement error resulting from the fact that French consumers were asked about their expectations for the "coming months" without a more precise definition of the forecast horizon.

Unbiasedness is merely one necessary condition for the Muth-rationality of expectations. The second, stricter criterion requires the expectations errors to be orthogonal to the information commonly available at the time expectations are formed. The orthogonality or informational efficiency of the survey data can be tested by regressing the forecast error on a

[46] Many of these studies make use of the Michigan and Livingston surveys of inflation expectations. See Roberts (1997), Croushore (1998), Grant/Thomas (1999) and the older studies quoted there.
[47] For more see Holden/Peel (1990), p. 124.

Table 6: Are the forecast errors unbiased?

Estimation equation: $\pi_t - E^s_{t-4}\pi_t = c_0 + \varepsilon_t$

Quarterly data, estimation period: Q1 1991 to Q4 2000

Estimation method: OLS, Newey-West correction of standard errors[1)]

	Germany	France	Italy
	Consensus Forecasts		
c_0	-0.32* (0.18)	-0.51*** (0.14)	-0.21 (0.24)
c_0=0, P-values	0.09	0.00	0.39
	Price expectations according to EU consumer survey		
c_0	0.00 (0.24)	0.30* (0.15)	-0.30 (0.36)
c_0=0, P-values	0.997	0.05	0.41

***(**/*) denotes significance at the 1%(5%/10%) level; values in brackets denote the HAC consistent standard errors.

1) Carried out because the overlapping forecast errors cause autocorrelation of the residuals of (at most) the fourth order.

range of variables which may have been of help in forecasting inflation at the time the forecast was made:

(8b) $$\pi_t - E_{t-4}\pi_t = ßx_{t-5} + \varepsilon_t$$

If ß is significantly different from zero, the null hypothesis of informational efficiency must be rejected. However, it must be ensured that the vector x only contains variables which were actually available to those polled at the time expectations were formed ("real-time data"). Time series which are subject to major revisions after initial publication, such as industrial output or gross domestic product, are therefore not admissible (unless real-time data are still available). Here, I use the (unrevised) unemployment rates (national definitions), the three-month national money market rates and the rates of change in the national consumer price indices as elements of the vector x. All three variables are formulated as year-on-year changes/rates of change. To allow for the possibility that lagged values of the selected variables still contain information which is relevant to future price developments, I included the most up-to-date values of these variables (dated t-5) as well as their respective previous year's values (dated t-9) in the estimation.

Table 7: Are the forecast errors orthogonal to selected information variables?

Estimation equation:

$$\pi_t - E^s_{t-4}\pi_t = c_0 + ß_1\pi_{t-5} + ß_2\pi_{t-9} + ß_3\Delta_4 RU_{t-5} + ß_4\Delta_4 RU_{t-9} + ß_5\Delta_4 i_{t-5} + ß_6\Delta_4 i_{t-9} + \varepsilon_t$$

Quarterly Data, estimation period: Q1 1999 to Q4 2000

Estimation method: OLS, Newey-West correction of standard errors

	Germany	France	Italy
	Consensus Forecasts		
ß=0, P-values	0.00	0.00	0.00
	Price expectations according to the EU consumer survey		
ß=0, P-values	0.00	0.046	0.00

***(**/*) denotes significance at the 1%(5%/10%) level; values in brackets denote the HAC-consistent standard errors.

1) Carried out because overlapping forecast errors cause autocorrelation of the residuals of (at most) the fourth order.

As the results summarised in table 7 show, the null hypothesis of orthogonality must be rejected for all of the survey data considered here. This evidence suggests that neither the polled experts nor the surveyed households made efficient use of all the information available to them at the time the forecasts were made. Taken together, the results of the tests conducted here are consistent with those for other survey data, namely that direct observations on expectations do not possess the properties implied by Muth's definition of rational expectations.[48]

IV.3. Formulating a model of partly rational and partly adaptive expectations

This raises the question as to how the expectations formation process of the polled experts and households differs from the benchmark of perfectly rational expectations. In the context of the inflation model examined in chapter 3, some authors have recently worked with the assumption that only a certain fraction of agents make forecasts which are optimal in a statistical sense, whereas the others rely on simple, purely backward-looking rules of thumb.[49] To motivate this assumption, one can draw on earlier work by Akerlof and Yellen (1985a,b) who make the point that the additional utility of optimal forecasts compared with an adaptive adjustment of expectations is likely to be small for many market participants. If that is the case, adaptive expectations could be "near-rational" or even perfectly rational for

[48] Examples include Baghestani (1992), Batchelor/Dua (1989) und Roberts (1997).
[49] Roberts (1997, 1998) and Gali/Gertler (2000).

those agents for whom the costs of obtaining and processing information exceed the additional utility of optimal forecasts.[50]

Heterogeneity of this type can be represented by an expectations formation model which contains both a forward-looking "rational" element and a backward-looking element which captures the idea that agents update their expectations in the light of past forecast errors:

$$(9) \qquad E_t\pi_{t+4} = c_1 E_t^m \pi_{t+4} + (1-c_1)(E_{t-4}\pi_t + c_2(\pi_t - E_{t-4}\pi_t))$$

$E_t^m \pi_{t+4}$ is the purely rational or "mathematical" expectation of future inflation, and the coefficient c_2 measures the speed at which agents revise their expectations. If c_2 equals one, the backward-looking element of equation (9) corresponds to the simplest form of an extrapolative model of expectations formation (also known as the "naive" expectations formation model). The empirical relevance of this model and the relative weight of the individual elements can be tested using the available survey data. If one realistically assumes that the rate of price change over the current period ($p_t - p_{t-1}$) is not known at the time expectations are formed, the lagged endogenous variable and the forecast error must be backdated by one period for the empirical test:

$$(9a) \qquad E_t^s\pi_{t+4} = c_1 E_t^m \pi_{t+4} + (1-c_1)(E_{t-5}^s\pi_{t-1} + c_2(\pi_{t-1} - E_{t-5}^s\pi_{t-1})) + \varepsilon_t^s$$

Following McCallum (1976), the "rational" expectation $E_t^m \pi_{t+4}$ can be replaced by the actual inflation rate in t+4 less an expectations error ν_{t+4}:

$$(9b) \qquad E_t^s\pi_{t+4} = c_1\pi_{t+4} + (1-c_1)(E_{t-5}^s\pi_{t-1} + c_2(\pi_{t-1} - E_{t-5}^s\pi_{t-1})) + \varepsilon_t^s - c_1\nu_{t+4}$$

The drawback of the McCallum method is that it introduces an additional source of error, ν_{t+4}, which can have a negative impact on the accuracy of the estimation. To avoid the bias which would result from the correlation between actual inflation in t+4 and the error term, we must find suitable instruments for the future inflation rate. Since the expectations error ν_{t+4} is, by definition, uncorrelated with information already known in t or prior to t, a consistent estimate of the parameters c_1 and c_2 can in principle be obtained by using lagged values of the endogenous variable ($E_{t-5}\pi_{t-1}$, $E_{t-6}\pi_{t-2}$,..) and the inflation rate (π_{t-1}, π_{t-2},..) as instruments. However, the estimation of equation (9b) is further complicated by the potential presence of measurement error in the survey data which would introduce correlation between the lagged endogenous variable and the disturbances. I therefore restrict the set of

[50] Cf. Akerlof/Yellen (1985a). For the probable magnitude of losses see Haltiwanger/Waldman (1989) and the article by Naish (1993), which also contains numerical examples.

instruments to several lagged values of the inflation rate. Again, the P-values of the test of overidentifying restrictions proposed by Davidson and McKinnon (1993) are shown separately in the tables of results.

IV.4. Interpreting the estimation results

Table 8 summarises the estimation results for the Consensus Forecasts. With adjusted coefficients of determination of between 0.80 and 0.89, the explanatory content of the approach is again highly satisfactory. The estimates of the coefficient c_1 are significantly positive in all cases, with estimated values of between 0.13 and 0.47. The hypothesis of purely backward-looking expectations (c_1=0) must consequently be rejected (in the case of the forecasts for France, though, only at the 90% level of confidence). On the other hand, the estimated share of the backward-looking element in the formation of expectations is greater than 0.5 in all cases, so that the hypothesis of purely forward-looking expectations (c_1=1) must likewise be rejected at an even higher level of confidence. The evidence presented here thus suggests that the polled experts draw on past price developments and earlier forecasts when forming their expectations but also incorporate other information into their calculations.

The estimated values for the speed-of-adjustment coefficient c_2 exhibit the expected positive sign. As regards the expectations formation of the experts for Italy, we cannot reject the hypothesis that the backward-looking element of expectations formation corresponds to the "naive" extrapolative model (c_2=1). By contrast, the experts on the panel for Germany displayed much less sensitivity to past forecast errors. In their case, the hypothesis that c_2 equals zero can only be rejected at the 90 % level of confidence. If we set c_2 equal to zero, the model of partly rational, partly adaptive expectations considered here reduces to the "stubborn" expectations model investigated by Roberts (1998):

$$(9c) \qquad E_t^s \pi_{t+4} = c_1 E_t^m \pi_{t+4} + (1-c_1) E_{t-5}^s \pi_{t-1} + \varepsilon_t^s$$

This specification suggests that economic agents only gradually adjust their forecasts in response to new information. A "rational" reason for this kind of "forecast smoothing" could lie in the considerable degree of uncertainty which generally surrounds the reliability of newly released data and of the forecasting models used.[51]

[51] See Deutsche Bundesbank (1998), Financial market prices as monetary policy indicators, Monthly Report, July 1998, p. 57. Sill and Wrase (1999) formulate a model in which the lagged adjustment of expectations occurs endogenously as the result of Bayesian learning about the prevailing monetary policy regime.

Table 8: Estimation results based on Consensus Forecasts

Estimation equation

$$E_t^s \Delta_4 p_{t+4} = c_1 \Delta_4 p_{t+4} + (1-c_1)[E_{t-5}^s \Delta_4 p_{t-1} + c_2(\Delta_4 p_{t-1} - E_{t-5}^s \Delta_4 p_{t-1})] + \varepsilon_t^s$$

Quarterly data, estimation period: Q1 1990 to Q4 1999

Estimation method: two-stage least squares[1)], Newey-West correction of standard errors[2)]

	GE	FR	IT	EMU-3
Share of the forward-looking element (c_1)	0.32*** (0.11)	0.13* (0.08)	0.47*** (0.08)	0.40*** (0.13)
Share of the backward-looking element ($1-c_1$)	0.68*** (0.11)	0.87*** (0.08)	0.53*** (0.08)	0.60*** (0.13)
Magnitude of error correction (c_2)	0.24* (0.13)	0.30*** (0.07)	0.88*** (0.28)	0.41** (0.20)
R2bar	0.80	0.86	0.87	0.89
AC(1)[3)]	0.77	0.64	0.66	0.72
AC(5)[3)]	-0.38	-0.71	-0.51	-0.62
AC(9)[3)]	0.24	0.29	0.19	0.37
Test of overidentifying restrictions, P-values[4)]	0.42	0.22	0.30	0.88

***(**/*) denotes significance at the 1 % (5 %/10 %) level; values in brackets denote the HAC-consistent standard errors (Newey-West method).

1) The instruments used are lagged values (up to 12 lags) of the explanatory variables. 2) The Newey-West correction is carried out because the data structure may cause autocorrelation of the first to (at most) the eighth order. 3) The standard error according to Bartlett is $1/\sqrt{T}$, i.e. 0.17. for T equal to 36. 4) Test of orthogonality of the residuals against the instruments used; cf. Davidson/McKinnon (1993), p. 235f.

As a look at Table 9 shows, the results for the EU survey data tend to be even more heterogeneous than those for the forecasts gathered by Consensus Economics. In the equations estimated for the polled German and French households, the coefficient of the forward-looking element c_1 assumes a significantly positive value, with estimated values of 0.22 and 0.30, respectively. By contrast, the null hypothesis of purely backward-looking expectations cannot be rejected for the households polled in Italy. Furthermore, in the equation estimated for the French households, a constant proves to be highly significant, indicating that either a measurement error has occurred with respect to the level of the expectations variable (which could have its roots in the conversion method, for instance) or that the formulated model does not entirely capture the expectation formation process of the polled households.

Table 9: Estimation results based on consumer price expectations

Estimation equation

$$E_t^s \Delta_4 p_{t+4} = c_1 \Delta_4 p_{t+4} + (1-c_1)[E_{t-5}^s \Delta_4 p_{t-1} + c_2(\Delta_4 p_{t-1} - E_{t-5}^s \Delta_4 p_{t-1})] + \varepsilon_t^s$$

Quarterly data, estimation period: Q1 1991 to Q4 1999

Estimation method: two-stage least squares[1)], Newey-West correction of standard errors[2)]

	GE	FR	IT	EMU-3
Share of the forward-looking element (c_1)	0.22** (0.08)	0.30*** (0.10)	-	-
Share of the backward-looking element (1-c_1)	0.78*** (0.08)	0.70*** (0.10)	1.00	1.00
Magnitude of error correction (c_2)	1.18*** (0.14)	1.01*** (0.16)	0.93*** (0.18)	0.90*** (0.19)
Constant c_0	-	-0.45*** (0.05)	-	-0.31** (0.12)
R2bar	0.90	0.86	0.83	0.91
AC(1)[4)]	-0.14	0.15	0.81	0.55
AC(5)[4)]	0.14	0.01	0.29	0.15
AC(9)[4)]	-0.00	0.17	0.16	0.12
Test of overidentifying restrictions, P-values[3)]	0.24	0.25	0.28	0.21

***(**/*) denotes significance at the 1 % (5 /10 %) level; values in brackets denote the HAC-consistent standard errors (Newey-West method).

1) The instruments used are lagged values (up to 12 lags) of the explanatory variables. 2) The Newey-West correction is carried out because the data structure may cause autocorrelation of the first to (at most) the eighth order. 3) Test of orthogonality of the residuals against the instruments used; cf. Davidson/McKinnon (1993), p. 235f. 4) The standard error according to Bartlett is $1/\sqrt{T}$, i.e. 0.17 for T equal to 36.

From a monetary policy perspective, the demonstration of a significant backward-looking component in the formation of expectations is important because backward-looking expectations retard the speed at which monetary impulses are transmitted from aggregate demand to prices. This point can be illustrated by drawing together the results of chapter 3 and the previous section. If we take for instance the inflation model estimated for Germany (table 4b):

(10a) $$\Delta_4 p_t = E_t^s(\Delta_4 p_{t+4}) + 0.21 \cdot \tilde{z}_{t-4} + 0.06 \cdot \Delta_4 pim_t^r + c_0 + \varepsilon_t^\pi$$

lag it five periods, multiply the resulting expression by a factor α and substract it from equation (10a), we get an equation which expresses the rate of change in consumer prices as a function of its own lagged value as well as the contemporary and lagged values of the survey expecations:

$$\begin{aligned}\Delta_4 p_t = {} & \alpha \cdot \Delta_4 p_{t-5} + E_t^s(\Delta_4 p_{t+4}) - \alpha \cdot E_{t-5}^s(\Delta_4 p_{t-1}) + 0.21 \cdot \tilde{z}_{t-4} - \alpha \cdot 0.21 \cdot \tilde{z}_{t-9} \\ & + 0.06 \cdot \Delta_4 pim_t^r - \alpha \cdot 0.06 \cdot \Delta_4 pim_{t-5}^r + (1-\alpha)c_0 + \varepsilon_t^\pi - \alpha \cdot \varepsilon_{t-5}^\pi\end{aligned} \tag{10b}$$

Now, the expectations variable $E_t^s(\Delta_4 p_{t+4})$ can be replaced by the expectations formation model estimated with the help of the survey data. For Germany, table 8 yields:

$$E_t^s(\Delta_4 p_{t+4}) = 0.32 \cdot E_t^m(\Delta_4 p_{t+4}) + 0.52 \cdot E_{t-5}^s(\Delta_4 p_{t-1}) + 0.16 \cdot \Delta_4 p_{t-1} + \varepsilon_t^s \tag{10c}$$

By inserting equation (10c) into equation (10b), setting α equal to 0.52 and rearranging terms, one arrives at an inflation equation of the form:

$$\begin{aligned}\Delta_4 p_t = {} & 0.32 \cdot E_t^m(\Delta_4 p_{t+4}) + 0.16 \cdot \Delta_4 p_{t-1} + 0.52 \cdot \Delta_4 p_{t-5} + 0.10 \cdot \tilde{z}_{t-4} \\ & + 0.11 \cdot (\tilde{z}_{t-4} - \tilde{z}_{t-9}) + 0.03 \cdot \Delta_4 pim_t^r + 0.03 \cdot (\Delta_4 pim_t^r - \Delta_4 pim_{t-5}^r) \\ & + c_0^{'} + (\varepsilon_t^\pi - 0.52 \cdot \varepsilon_{t-5}^\pi) + \varepsilon_t^s\end{aligned} \tag{11}$$

The rather awkward lag structure is a consequence of the discrepancy between the data frequency and the time horizon of the inflation rate and need not concern us here. Rather, the derivation of equation (11) is meant to illustrate how a backward-looking, adaptive element in expectations formation introduces persistence into the inflation process. The point estimate of 0.68 for the sum of the coefficients on lagged inflation is very much in line with the results presented by Roberts (2001) who estimates the partly forward-looking, partly backward-looking version of the Phillips curve directly and finds that the weight on lagged inflation is in the range of 0.5 to 0.7, with limited sensitivity to specification choice.[52]

[52] See Roberts (2001), S. 3.

V. Summary and outlook

In summary, it may be said that the survey data used here, especially the forecasts collected by Consensus Economics, have proved to be a promising instrument for analysing the inflation process and for testing alternative expectations formation hypotheses. While it cannot be ruled out altogether that the price expectations reported by the surveyed households and experts diverge from their "true" expectations, the tests performed during the instrumental variable estimations did not reveal any notable measurement problem. One limitation of the analysis is certainly that it is based on a comparatively short time span. This is especially true of the estimations based on the Consensus Forecasts, which have only been gathered since autumn 1989. The results obtained can nevertheless be interpreted as useful initial findings regarding the link between inflation and inflation expectations and the structure of expectations formation in the countries under review.

The estimations of the New Keynesian inflation model presented here underline the importance of inflation expectations for the short to medium-run development of consumer prices. If the Consensus Forecasts are used as a measure of expected price developments, the output gap and import prices likewise prove to be important determinants of the current inflation rate. By contrast, the coefficient of the lagged inflation rate is not significantly different from zero no matter which survey data are used. An important implication of this finding is that backward-looking elements in expectations formation seem to be a more promising explanation for inflation inertia than wage setters' concern for relative real wages.

In the last section of this paper, therefore, a model of partly rational and partly adaptive expectations is formulated and estimated using the available survey data. We find that expctations are neither purely forward-looking nor as unsophisticated as the simple adaptive expectations model would suggest, though the relative weight of the adaptive element is in all cases greater than one half. This result backs the supposition of Akerlof/Yellen (1985a/b) and others that many market participants rely on simple, purely backwards-looking rules of thumb when forming their expectations. If the costs of acquiring information and the uncertainty surrounding the reliability of available information are taken into account, such behaviour, even by professional forecasters, may well be considered "rational".

From a monetary policy perspective, the demonstration of backward-looking elements in the formation of expectations is important because the associated persistence of inflationary processes, once they have set in, reinforces the need for monetary policy makers to adopt a forward-looking approach. This line of reasoning has recently been backed by a

number of empirical studies which show that the optimal time horizon of monetary policy decisions increases with the sluggishness of the inflation process.[53] Simulation studies based on models with purely forward-looking expectations are therefore likely to underestimate the need for the central bank to act in a forward-looking manner and to overestimate the stabilisation features of simple, purely backward-looking policy rules.

Conversely, evidence of a forward-looking component in the formation of expectations also has important monetary policy implications. If at least a fraction of market participants behave in a forward-looking manner, the efficacy of monetary policy measures depends on those participants' expectations regarding the goals and future course of central bank policy. In such an environment the central bank must do its utmost to convince market participants of its determination to adhere to a stability-oriented course. The tasks of clearly defining the ultimate objective and announcing a comprehensible and transparent monetary policy strategy play a key role in this context.

[53] See, for instance, Batini/Haldane (1998) and Smets (2000).

Annex

Tab. A1: Questions and response categories of the EU Consumer Survey on price developments in France

Do you think that over the past six months prices have ...	**Compared with current developments, do you think that prices will ...**
risen sharply	*rise more sharply*
risen moderately	*rise by the same amount as before*
risen slightly	*rise less sharply than before*
hardly changed	*remain stable*
fallen slightly	*fall slightly*
don't know	*don't know*

Tab. A2: Questions and response categories of the EU Consumer Survey on price developments in Spain

Would you say that, over the past 12 months, prices have ...	**Do you thank that in the next twelve months prices will ...**
risen very sharply	*rise more sharply*
risen rather sharply	*rise rather sharply*
risen slightly	*rise more slowly*
remained stable	*remain stable*
fallen slightly	*fall slightly*
don't know	*don't know*

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