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Ingvild Svendsen

Empirical Tests of the Formation of Expectations

A Survey of Methods and Results

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Tall kan ikke forekomme	Category not applicable	.
Oppgave mangler	Data not available	..
Oppgave mangler foreløpig	Data not yet available	...
Tall kan ikke offentliggjøres	Not for publication	:
Null	Nil	-
Mindre enn 0,5 av den brukte enheten	Less tan 0,5 of unit employed	0
Mindre enn 0,05 av den brukte enheten	Less than 0,05 of unit employed	0,0
Foreløpige tall	Provisional or preliminary figure	*
Brudd i den loddrette serien	Break in the homogenity of a vertical series	—
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Preface

This monograph surveys a wide range of studies confronting different hypotheses of how expectations are formed with empirical findings. The survey covers studies of the rational expectations hypothesis as well as different sorts of extrapolative expectations models. Only studies using data on agents' expectations are considered; the so called direct approach. Different types of agents are represented; firms, consumers and agents engaged in the exchange markets. Some of the studies analyse expectations held by leading economists. The survey covers studies using regression analysis on time series data as well as methods for cross-sectional categorical data. The different approaches found in the literature to the use of categorical data are discussed.

The survey starts out with an overview of different expectations hypotheses. The support to the rational expectations hypothesis is not impressive in the surveyed works. The results are as much in favour of some sort of extrapolative expectations.

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Svein Longva

Contents

1. Introduction and summary[1)]

The aim of this paper is to give an overview of empirical studies that test different hypotheses on how economic agents form their expectations of future events, such as the price level next year and demand towards firms. The survey may serve as a guide when deciding which assumptions should be made on how expectations are formed as well as help those that plan to do empirical work in the area.

In economic theory the question of how expectations are formed has long been seen as crucial to the question of how the economy works. Let us illustrate by a firm taking decisions on real investments which will increase the firm's production capacity. The decision makers have to make up their mind of how the world will look like tomorrow - and not only on how their own increased capacity will influence the total supply and hence the price in the market, but also how the rest of the economy will evolve. Conditions important to the firm's current decisions are the future demand in the market and the part of it directed towards the firm, future prices on own products and on raw materials and energy in addition to labour costs in next periods. They also have to form expectations of other firms' decisions and the government's decisions. The predictions the decision makers in the firm make, will not only influence their investments decisions, but the current and future states of the whole economy and also the effects of policies.

Being unable to look into the decision makers' minds and see what they expect, the economists, in advising the politicians, have to make assumptions on how expectations are formed. Economic theory has during the last decades come up with several competing hypotheses on the formation of expectations. The main distinction can be drawn between rational expectations on the one side and extrapolative expectations on the other side, of which the adaptive expectations are the most known. According to the rational expectations hypothesis agents, in forming their expectations, make use of all available information in an efficiently way while, according to the extrapolative hypoth-

[1)] I would like to thank Ådne Cappelen and Steinar Strøm for useful comments and suggestions.

esis, only the information embodied in the history of the variable to be predicted is used.

Because the choice of hypothesis often is crucial to the implications to be drawn from, for instance an analysis on the impact of a tax reform on firms' investments decisions, the assumptions have to be confronted with "the real world" in empirical tests. This monograph presents results from such tests in addition to some of the methods used.

Only studies which make use of data of economic agents' expectations, the so called direct approach, are surveyed. The data are mostly taken from business tendency and consumer surveys. In addition to the direct approach, a large literature on indirect tests of the formation of expectations exists. The main difference between the two approaches is that while the direct approach makes use of observations of agents' expectations, the indirect approach does not. Instead a joint hypothesis of an expectations hypothesis and a particular economic model is tested jointly by use of time series data. The differences between the two approaches are further discussed in the next section.

Most of the studies presented, test the hypotheses of extrapolative and rational expectations. These hypotheses are presented in section 3 and 4. The studies to be presented in section 5 to 7, differ substantially in methodology, mainly because of a great variation in the kind of data used. The studies also cover a wide range of markets and different types of agents with respect to their assumed access and ability to process information. The different data sources used are summarized in table V, at the end of the paper.

The studies surveyed do differ in their conclusions. In some cases different methodological approaches applied to the same set of data lead to opposite conclusions. So, no clearcut conclusion can be given on how economic agents form their expectations. But, in light of the strong position the hypothesis of rational expectations has achieved during the last decade in both theoretical and empirical works, a warning has to be made. The empirical evidence from testing the rational expectations hypothesis directly on data of expectations, does not give much support to the hypothesis. The results are as much in favour of expectations being formed by some sort of extrapolative mechanism. So, may be a more pragmatic approach should be taken; in some markets the best way to operationalize the expectations is by use of the REH, while in other markets other hypotheses should be chosen.

What seems to be clear, is that a lot of theoretical and methodological work remain before the issue can be settled. When little is said in this survey on expectations combined with learning processes, the reason is not that I do not find this interesting, but unfortunately little have been done to carry out direct, empirically based tests on this issue. But according to what have been done in this field (see for instance Pesaran (1987)), one should expect the way agents form their expectations to be more complicated than both the models of rational and extrapolative expectations assume.

2. Direct versus indirect tests

There are two methods used in the literature to test expectations hypotheses - the direct and the indirect method. The indirect method is the less demanding with regard to the sort of data needed, but the conclusions to be drawn are vague.

Using the indirect method one starts out with an economic model including agents' expectations as variables and makes assumptions on how these expectations are formed. The implication of combining the expectations hypothesis ***and*** a specific economic theory underlying the model, are then tested empirically. This procedure suffers from one main weakness. The hypotheses which are tested, are joint hypotheses. If the tests tell us to reject for instance the rational expectations hypothesis (REH), we can't tell if we have to reject REH in the specific market or if we have to reject it only in combination with the assumed economic model.

The data used in the direct tests are observations of economic agents' expectations. The different expectations hypotheses impose different restrictions on the observed expectations. Those restrictions are tested to see if they are valid for the particular set of expectations data. There is no need to specify any underlying economic model.

There are different ways of obtaining direct observations. Most often the data are taken from an opinion survey where the respondent (a firm, a household, an economist) is asked about his expectations concerning say, the price of a product in a future period. The opinion surveys can be divided into three groups; those giving categorical observations of the form "prices will go up/ remain the same/ go down", those giving quantitative interval estimates as "up 2-5 per cent" and those giving point estimates as "prices will rise by 4.7 per cent".

A serious objection to the use of direct observations of expectations in empirical studies, is the risk for error in variables. There are two sources of such errors. First, the respondent may misunderstand the question. For example, households being asked whether they expect the general price level to rise may answer to whether they expect the inflation to increase. Second, we cannot know for certain whether the respondent tells us those expectations he actually has in mind when he is making his decisions. And these are the expectations we really are looking for.

Another objection can be raised against confronting the hypothesis of rational expectations with direct tests. Referring back to Muth's original definition (see Muth (1961)) of rational expectations as model consistent expectations, one argue that one cannot separate rational expectations from a specific theory or model. This is precisely what is done in the direct tests. An efficient use of information is crucial in the definition of rational expectations and is also the basis in the direct tests. Different theories of the process generating the variables lead to different sets of information. When direct tests of the hypothesis of rational expectations are applied, one has to define an information set in a model-free context.

Others are arguing that it is too strong to impose the restrictions derived from the hypothesis of rational expectations on expectations formed by individual agents. My opinion is that as long as one assumes, in theoretical or empirical analysis, expectations to be formed according to REH one has to confront this hypothesis with micro observations of expectations. If, at the micro-level, the hypothesis is rejected, one has to argue why the assumption of rational expectations is a good approximation to expectations at a more aggregated level. This refer to cases where the choice of how expectations are formed, is crucial to the model's implications.

Using categorical data or interval estimates raise particular problems if one wants to transform the data into point estimates before the tests are carried out. The most used method in the literature of transforming categorical observations into point estimates, is the method used in Carlson and Parkin (1975) (see section 5.2.1). Pesaran (1984) criticize this method for being based upon untestable assumptions. He proposes another method for getting point estimates out of categorical data (see section 5.2.2). The method is more demanding with respect to data needed than the Carlson and Parkin method. A common drawback with both methods is the need for aggregation. The resulting time series are series for average expectations. This rises the important question whether conclusions drawn from tests on an aggregate level imply the same conclusions to hold on a disaggregate level.

Authors critical to the loss of information when going from a disaggregate to an aggregate level, have shown that it is not necessary to transform the data into quantitative estimates; and thus no need for aggregation. Those studies use different measures of association and loglinear probability models on the cross-section treating each time period in the sample separately (see section 5.3), cf. König, Nerlove and Oudiz (1981) and Zimmermann (1986). Unfortunately, some of the testable restrictions implied by the rational expectations hypothesis do not longer apply when going from time-series to cross-sectional data.

Some authors have sought to derive measures of the market's expectations from market prices on the assumption that a particular economic theory is valid. As an example, the forward exchange rate has been used as a proxy for the market's exchange rate expectations. Doing so, one has to assume away the risk premium. Testing expectations hypothesis on such data involves also testing the assumptions made in constructing the data.

3. Extrapolative expectations

Before the appearance of the hypothesis of rational expectations, different forms of extrapolative expectations was the common way of modelling expectations. During the 1980 this way of modelling expectations became less popular.

Let y_t be a variable unknown to agents when a decision, involving y_t as a part of the decision problem, is taken. We assume agents to be able to form their own opinion of future values of y_t. $_{t-f}y_{it}^e$ is agent i's expectation about y_t formed in period t-f. For the moment, we suppress the subscripts t-f and i. In economic theory a lot of different ways of modelling y_t^e have been supposed.

Extrapolative expectations cover different expectations models with one feature in common: The agents' expectations are assumed to depend upon the history of the variable under consideration. The most well-known version of the extrapolative expectations model, is the adaptive expectations.

The general form of an extrapolative expectations model is given in (1).

$$y_t^e = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_n y_{t-n} + v_t, \quad n \leq \infty \tag{1}$$

v_t is a stochastic variable with standard white noise properties. Assuming different kinds of restrictions on the number of lags and on the β-s, a variety of extrapolative models may be derived, such as adaptive and static expectations models. If the data do not reject the general form in (1), different types of extrapolative models may be tested within this general framework with the general form expressed in (1) as the maintained hypothesis.

If we set $\beta_1 = 1$ and $(\beta_2,\ldots,\beta_n) = (0,\ldots,0)$, (1) is simply the static expectations model. Another version shown in (2), is derived by setting n=2 and restricting the sum of β_1 and β_2 to be equal to one.

$$y_t^e = \beta_1 y_{t-1} + (1-\beta_1) y_{t-2} + v_t$$
$$\Rightarrow \quad y_t^e - y_{t-1} = -(1-\beta_1) \Delta y_{t-1} + v_t \qquad (2)$$

If $\beta_1 > 1$, (2) is known as the "bandwagon"-model. This is characterized by agents expecting the rate of change from the current to the next period to be a positive function of the rate of change from the previous to the current. With $\beta_1 \in < 1, 2 >$ the expectations in (2) are expressed as a finite distributed lag in the two past observations. If, however, $\beta_1 > 2$ the rate of change is expected to increase. Such an expectations mechanism may be destabilizing if the expectations are self-fulfilling.

3.1 The adaptive expectations hypothesis

The adaptive expectations hypothesis goes back to Irving Fisher's work in the 1920's (see Fisher (1930)). The more recent developments are based upon Cagan (1956) and Nerlove (1958). It is assumed that agents adjust their previous expectations in accordance to the deviations between expectations and realizations in the current period (here period t-1).

$$y_t^e - y_{t-1}^e = \delta (y_{t-1} - y_{t-1}^e) + \epsilon_t, \quad 0 < \delta < 1 \qquad (3)$$

The model in (3) is often called the error-learning model, because the agents' expectations are revised (y_t^e - y_{t-1}^e) in light of the prediction error made in the most recent period (y_{t-1} - y_{t-1}^e). Rewriting (3) gives us the well known pure adaptive scheme.

$$y_t^e = \delta y_{t-1} + (1-\delta) y_{t-1}^e + \epsilon_t \qquad (4)$$

The pure adaptive scheme shows the expectations as a weighted average of the last observation (y_{t-1}) and the previous held expectations (y_{t-1}^e).

The hypothesis of adaptive expectations is tested directly by estimating (5) and testing the restriction imposed by H_0. This can only be done when direct observations of expectations are available.

$$y_t^e = b_1 y_{t-1} + b_2 y_{t-1}^e + e_t$$
$$H_0 : b_1 + b_2 = 1 \text{ vs. } H_1 : b_1 + b_2 \neq 1 \qquad (5)$$

Here the adaptive expectations model is the maintained hypothesis with H_1 representing "other forms of expectations".

When adaptive expectations are assumed in economic modelling, the so-called Koyck-transformation is used (see Koyck (1954)), giving raise to yet another version of the model. In this version the parallel to the general extrapolative model is obvious.

$$y_t^e = \delta \sum_{j=0}^{\infty} (1-\delta)^j y_{t-j-1} + \sum_{j=0}^{\infty} (1-\delta)^j \epsilon_{t-j} \qquad (6)$$

By using the Koyck-transformation, adaptive expectations can be shown to be equal to an infinite lag-distribution in lagged realizations with geometrical declining weights. The weights are declining with increasing distance in time, in such a way that the latest observation carries the heaviest weight. The weight placed on the latest observation increases with δ.

The adaptive expectations hypothesis have been criticized for several reasons. The most important shortcoming is the fact that the hypothesis allows agents to make systematical errors in their predictions. In periods whith increasing (decreasing) inflation, agents forming their expectations according to the hypothesis of adaptive expectations are systematically underestimating (overestimating) the rate of inflation. Another important weak point is the lack of use of other sources of information. Such additional information is knowledge about policy, state variables and the economic structure.

These two shortcomings are first of all met by the hypothesis of rational expectations, but also by some formulations of the regressive expectations model; see Frankel and Froot (1987). Some authors also make use of what they call an augmented adaptive model; the adaptive scheme augmented with some other variables assumed to influence the forecasted variable.

3.2 Regressive expectations or habitat models

These models originate from Modigliani and Sutch (1966), modelling the term structure of interest rates. Frenkel (1975) has applied the model to expectations of inflation rates.

There are several different regressive expectations models in the literature. What they have in common is the assumption that, agents when forming their expectations, account for the variable's deviation from its normal- or long-run equilibrium level at the time when the expectations are formed. Compared with adaptive expectations, the regressive expectations model is more consistent with dynamic models in which variables converge towards their long-run equilibrium level over time.

The "normal level" has been defined in different ways in the literature; as a time invariant constant, a distributed lag-function of the past history of the variable or as a function of other variables. The different specifications of the "normal level" are grounded on different assumptions conserning agents' understanding of the "normal level". The first of the three specifications mentioned above, assumes some sort of static long-run expectations, while the last of them assumes agents to know the reduced long-run solution for the actual variable.

Frankel and Froot (1987) use a regressive expectations model in modelling exchange rate expectations:

$$s_t^e - s_{t-1} = -\kappa(s_{t-1} - S_{t-1}^*), \quad 0<\kappa<1 \tag{7}$$

where s_t is the logarithm of the current spot rate, s_t^e is the agents prediction of s_t and S_t^* is the logarithm of the "normal" spot rate; not necessary constant over time. The expectations are formed in period t-1. When expectations are formed according to (7) the exchange rate is expected to fall from period t-1 to t if it lies above its assumed "normal" rate at time t-1. Frankel and Froot give two different descriptions of the "normal" rate. The simplest one is that it is constant over time. A more sophisticated one, is that it is given by purchasing power parity (PPP):

$$S_t^* = s_0 + \log\left(\frac{P_t/P_0}{P_t^*/P_0^*}\right) \tag{8}$$

where P_t and P_t^* is the domestic and foreign CPIs, respectively, and P_0 and P_0^* are the averages over time t-k to t.

The regressive expectations models in their simplest form suffer from one of the same short-comings as the adaptive expectations models, in assuming no use of information other then that given by the variable itself. If the modelling of the "normal level" accounts for variables other then lagged values of the variable itself, one is moving one step in the direction of rationality. Still there exists crucial differences between the models defined in (7) and (8) and the rational expectations models; no strong assumptions conserning optimal use of all available information are imposed on the former ones. But most of all, if agents had rational expectations they would have made their expectations of the long-run equilibrium rate next period (in (7)) in the light of expected price levels.

4. The rational expectations hypothesis

4.1 Definition and properties

The hypothesis of rational expectations (REH) was first proposed by Muth (1961), but came into use first during the 1970s by works of among others, Lucas (1971) and Sargent and Wallace (1976).

The rational expectations hypothesis (REH) is grounded on rather strong assumptions concerning the amount of information available to individual agents and their capacity to fully exploit this information. It is assumed that all agents know the "true" and deterministic part of the economic model underlying the realization of those economic variables essential to the agents' actions. A lot of those variables are unknown to agents when decisions have to be taken. Let y_t be such a variable. A set of assumptions implies that rational expectations are equal to the mathematical expectations of y_t up to a stochastic error term, ϵ_{it}, conditional on all relevant information available for agent i at time t-f, Ω_{t-f}:

$$_{t-f}y^{e}_{it} = E(y_t \mid \Omega_{t-f}) + \varepsilon_{it} \tag{9}$$

The individual error terms arise because agents do not know the exact form of mathematical moments in the stochastic process generating y_t. The error terms are assumed to follow a white noise process. When aggregating over an increasing number of agents, the individual error terms will asymptotically disappear. We then get to the more familiar definition of rational expectations: "...rational expectations, that is, expectations equal to the mathematical expectations of y_{t+1} based on the information available at time t" (Blanchard and Fischer (1989)).

Most direct tests of rational expectations are based on the prediction error. The prediction error is defined as the discrepancy between the realization, y_t, and the agent's prediction, y_{it}^e (omitting subscript denoting the time when the expectations are formed). Applying the definition of a rational expectation (see (9)), the rational prediction error will take the following form:

$$\zeta_{it} = y_t - y^e_{it} = y_t - E(y_t \mid \Omega_{t-f}) - \varepsilon_{it} \tag{10}$$

If the expectations are formed rationally the prediction error will not differ systematically from zero over time. At a given point of time, however, it may vary systematically from zero when studying a cross-section if the agents are subjects to a common shock, even if they all have formed their expectations rationally. This is further discussed in Svendsen (1993). Unsystematic variation around zero arise because (a) y_t differs from its mathematical expectation, (b) the discrepancy between the unconditional and conditional expectation, and (c) because of the individual error term.

Four main properties concerning the rational prediction error follow from the main assumption underlying the REH: Orthogonality, efficiency, unbiasedness and no serial correlation.

The property of *orthogonality*: The expected prediction error, conditional on all available information, equals zero. As shown in (11) this property also apply for the expected prediction error conditional on a subset S_{t-f} of Ω_{t-f}.

$$E[\zeta_t \mid \Omega_{t-f}] = 0 \Rightarrow E[\zeta_t \mid S_{t-f}] = 0, \quad S_{t-f} \subseteq \Omega_{t-f} \tag{11}$$

A special case of the property of orthogonality, is the property of *no serial correlation*, stating that the prediction error is uncorrelated with lagged prediction errors which should belong to the information set.

$$E(\zeta_{it}\zeta_{i,t-r}) = 0 \quad \text{and} \quad E(\zeta_{it}\zeta_{i,t+r}) = 0, \quad r \geq 1 \tag{12}$$

The property of *efficiency*: Rationality implies an optimal use of all available information. Efficiency implies an efficient use of the information contained in lagged realizations of y_t. This information is available free of charge. Efficiency follows from the property of orthogonality if $y_{t-1}, y_{t-2}, \ldots$ are a subset of Ω_{t-1}.

$$E[\zeta_{it} \mid y_{t-1}, y_{t-2}, \ldots] = 0, \quad y_{t-1}, y_{t-2}, \ldots \subseteq \Omega_{t-1} \tag{13}$$

The property of *unbiasedness*: The unconditional prediction error has expectation equal to zero. This follows from the property of orthogonality by the use of the rules for double expectations. For the property to hold, the prediction must be an unbiased estimator for $E(y_t)$.

$$E(\zeta_{it}) = 0 \Leftrightarrow E(y_t - y^e_{it}) = 0 \Leftrightarrow E(y^e_{it}) = E(y_t) \tag{14}$$

4.2 Empirical tests of rational expectations

We distinguish between full rationality, partial rationality and completeness. The expectations are fully rational if *all available information* has been used in an *optimal* manner. It is optimal in the sense that no other unbiased predictor has smaller variance. Partial rationality implies that the *information actually used*, which may be less than all available information, has been used efficiently while completeness implies that all available information has been made use of.

The property of orthogonality is a sufficient condition for full rationality. The other properties are only necessary conditions and tests based on these properties are weak tests of rationality. When testing for full rationality we test whether all available, relevant information have been used in an optimal manner to form the prediction. A strong test of full rationality is however impossible, because we can never guarantee that we have got the proper operationalization of the entire information set. There are nevertheless two weak tests frequently used; the orthogonality-test and the efficiency-test. In both these tests, the rational expectations hypothesis form the null hypothesis. The alternative hypothesis is a general statement; "the expectations are not formed according to the rational expectations hypothesis".

The *test for orthogonality*:

$$\zeta_{it} = y_t - y^e_{it} = \tau_0 + \tau_1 X'_{i,t-f} + w_{it} \qquad (15)$$
$$H_0: (\tau_o, \tau_1) = (0,0) \text{ and } w_{it} \text{ is white noise.}$$

where X' is a vector of variables containing free and available information, such as policy and state variables. If the test is conducted to cross-sectional data, the restrictions implied by the REH, formalized in the null-hypothesis in (15), must be revised by omitting the restiction $\tau_0 = 0$.

We derive the *efficiency-test* by setting $X' = (y_{t-1}, y_{t-2},..)$, testing whether all information contained in former observations of y is efficiently used in predicting y_t.

If *testing for no serial correlation*, $X' = (\zeta_{t-1}, \zeta_{t-2},..)$.

The *test for unbiasedness* is a weak test of partial rationality, and is used because of the problem in the defining the information set actually used (S_t is unknown):

$$y_t = \alpha + \beta y^e_{it} + u_{it} \qquad (16)$$
$$H_0: (\alpha, \beta) = (0,1) \text{ and } u_{it} \text{ is white noise.}$$

The unbiasedness-test is no longer valid while run on cross-sectional data. In this case H_0 in (16) may be rejected even if all agents have formed their expectations rationally, but a majority of the agents experience a common shock.

The test for lack of serial correlation can only be conducted if there are no measurement error in the data of expectations. If errors are present, this may give raise to an erroneously correlation between the right-hand side and left-hand side variables.

In some earlier studies a test of the consistency property is run (Pesando (1975), Carlson (1977) and Mullineaux (1978)). This property implies that "the multispan forecasts are obtained recursively, with the rational forecasts being substituted for the as yet unobserved realizations of the series." (Pesando (1975)).

5. Firms' expectations

Firms' decisions on production, labour demand and investment often depend upon their expectations of prices and future demand. In addition to theoretical arguments, several papers report empirical evidence on these relations. In Nerlove (1983) it is shown that anticipated changes in production levels are effected by expectations of future business conditions or demand. Batchelor (1982) find that growth in output is more associated with expectation errors on inflation than with actual inflation.

One possible implication of incorrect expectations is illustrated in the well-known cobweb model. Other illustrations are found in models where the effect on economic policy depends heavily upon the way firms form their expectations.

The empirical studies on how firms form their expectations, includes a great variety of methods, partly depending on the characteristics of the analyzed data. Two main distinctions can be made concerning the methods applied. The first is between categorical and quantitative data and the second is between aggregated and individual expectations measures. The results from the studies to be surveyed in this chapter are summarized in table I. Information on the different data sources are given in table V. Before we present the results, some methodological questions shall be discussed.

5.1 Methodological problems

5.1.1 Measurement errors in quantitative vs. categorical data

A lot of data on firms' expectations are categorical. Typically, firms are asked whether they expect the price on own product[2)] to increase, remain unchanged or decrease from the current to a specified future period. The observed variable, the expected direction of change, is an observation of the underlying latent variable, the exact expected rate of change in quantitative terms.

[2)] One may erroneously interpret the firms' plans concerning own prices as their expectations conserning the same variables. We return to this problem in section 5.1.3.

There are different sources of measurement errors that can be present in observations of expectations. Two of the sources are common for both quantitative and categorical data. First, the firms' reported expectations may be different from the expectations the firms base their behaviour upon, because the firms do not make their decision at the same point of time as they report their expectations. The difference may also be due to some psychological mechanisms, for instance that firms don't like to report an expectation that differ to much from the commonly accepted expectations. Second, the reported expectations may differ from the firms' real expectations because they do not use time to reason before they fill in the form, or that they let someone not in a decision position, fill in the form.

One might argue that because categorical data do not try to measure the exact quantitative expectations - the first two sources of measurement errors are less critical for this sort of data. The chance of capturing the firms' real expectations within a certain category is higher than when the firms are asked about an exact value. But when emphasising this point - categorical data are victim to a third source of measurement errors - the reported expectations are not the same as the expectations the firms base their decisions upon just because they are categorical.

Using categorical data to give the expected direction of change for a certain variable, requires a broader definition of prediction errors. A prediction error will cover only the cases where the expected direction of change differ from the realized direction. The case where a firm expects the prices to increase and they actually do increase, but with a different rate of change then the firm had expected, will not fall into the category "wrong expectations". So, when using this sort of data in testing the REH, the criteria for accepting the hypothesis will be less strong then if we had used a quantitative measure of expectations.

5.1.2 Aggregated measures or individual expectations?

One of the main differences between the papers presenting empirical tests of expectations hypotheses, is whether the tests are carried through on an individual basis or on some aggregate level. Some will argue that for most practical purposes, for instance in macroeconomic modelling, what's matter is whether the average expectations in the market fulfil the requirment imposed by the REH. But, if we think of the REH, or some other expectations mechanisms, as assumptions concerning the agents' behaviour, the test should be performed on microdata.

If we run our tests of REH on an aggregate level, we may falsely accept the hypothesis because the aggregation process levels out the individual prediction errors. So, we may have the situation where none of the individual agents can be said to possess rational expectations, but the average prediction error is close to zero.

There is also a possibility of wrongly rejecting the REH when testing on aggregated data, because we test whether the prediction errors are independent of a too strong information set. For instance, when running the orthogonality test, a lot of authors test whether the errors are independent on former prediction errors. But, what they seem

to forget, is that the prediction error is an artificial variable constructed by themselves. The question to ask, is whether we can assume this variable to be known by the agents involved in the survey and thus part of their information sets. Authors including the aggregated prediction error in the information set, are Batchelor (1981, 1982), Jonung and Laidler (1988), Frankel and Froot (1987) and MacDonald (1990).

One reason for using an aggregated measure, is that the two known methods used to transform the categorical data into some sort of quantitative expectations measure, both involve aggregation. The methods are the Carlson and Parkin method (Carlson and Parkin, (1975)) and the regression-method described in Pesaran (1984, 1987). In addition to the need for aggregation, there is also a need for posing some additional assumptions on the data in order to make the transformation possible. These assumptions are not trivial to the test results, and even grave - they cannot be tested by the use of the data set involved. The Carlson and Parkin method is used by Batchelor (1981, 1982), while Pesaran (1987) uses both methods.

An alternative to derive an aggregated, quantitative expectations measure, and then to use traditional econometric methods on the resulting time series, is to apply methods for categorical data directly on the individual, categorical data. This method is used by König, Nerlove and Oudiz (1981), Nerlove (1981), Zimmermann (1986) and Stålhammar (1987) on cross-sectional data.

5.1.3 Plans or expectations?

When firms' reported anticipations are subject to analyzes, one has to be careful with the interpretations. An important question to ask is whether the anticipations are supposed to be expectations or plans. While demand, business conditions and prices of products purchased by the firm are clearly out of the firm's control, prices of products sold, inventories and production cause some trouble. Production anticipations will often be plans rather than expectations, but conditional upon the firms' expectations concerning future prices, demand and/or business conditions. This is specially true for short term anticipations in industries mainly producing on ordered deliveries. For prices one has to distinguish between price setters and -takers, the formers forming plans and the latters forming expectations. Which description is true will probably differ among industries, firms of different sizes, countries and whether one is concerned about the prices in home or export markets.

If the reported anticipations are plans rather than expectations, the anticipations should in fact satisfy the same properties as rationally formed expectations. Many authors do not seem to be aware of this problem. Batchelor (1982) for instance, analyses whether production expectations are rational without mentioning the problem at all while König, Nerlove and Oudiz (1981) and Nerlove (1981) on the other hand do not even try to test different expectations models on the reported anticipations on changes in production. Instead they try to draw conclusions on whether German and French firms are price setters or price takers. Their tentative conclusion is that the French firms are less competitive then the German firms, because there is less association between demand expectations and price expectations/plans in the French data.

5.2 Empirical evidence based on transformed categorical data

5.2.1 The Carlson and Parkin method

The most often used method in the literature for transforming categorical answers about expectations hold by individual agents into a quantitative measure of expectations hold by the population as a whole, is the Carlson and Parkin method presented in their 1975-paper. They apply their method to households' expectations concerning the inflation. The input in the transformation process is four time-series respectively giving the proportion of the total number of respondents in period t answering "up", "down","stay the same" and "don't know" to the question "in which direction do you expect the prices to move during the next period".

The individuals are assumed to form their expectations on the basis of their own individual probability distribution for the percentage change in the price index for their own consumption bundle. Carlson and Parkin assume that the individuals' probability distributions belong to the same class of probability functions with a finite mean and variance. The distributions can be aggregated across the individuals, giving a probability distribution held by the population as a whole over the rate of inflation. Carlson and Parkin assume a normal distribution, but both the logistic and the uniform distributions have been used in the literature.

Further, Carlson and Parkin assume there exist what they call, a range of imperceptibility, $<-\delta,\delta>$. A rate of change, which lies within this range, cannot be distinguished from zero price change by agents. In the literature δ is called the difference limen or the threshold. Carlson and Parkin assume the threshold to be symmetric, constant across time and the same for all individuals. In principle it can vary both across time and across individuals and it can be non-symmetric. Further they assume that a constant fraction α of the respondents are incapable of developing any view about the inflation. α is used when deriving the aggregated expectations measure. An estimate of α is derived by assuming a stable relationship between the proportion responding "don't know" and the proportion responding "stay the same". When the fraction answering "don't know" is less than the estimated proportion α, the actual fraction replaces α.

Carlson and Parkin end up with two equations defining three unknown parameters, the threshold δ, the expectations p_t^e and the variance in the assumed distribution. Usually the identification problem is solved by estimating the threshold elsewhere.

Carlson and Parkin (1975) estimate the threshold by assuming the expectations across individuals to be unbiased over time; the time-average of the expected inflation equals the same as the time-average of realized inflation. This assumption cannot be said to be advisable when the resulting timeseries shall be used in testing the hypothesis of rational expectations. Batchelor (1981) applies a least squares criterion instead of the unbiasedness criterion. But, according to Pesaran (1987) the property of unbiasedness follows implicit from the method Batchelor choses in order to get an estimate of the threshold. A last method of estimating the threshold is proposed by Bennett (1984). The application of this method depends however upon the respondents providing their

opinion on the realization of the investigated variable (for instance the inflation) in addition to their expectations.

No matter the choice of assumptions concerning the probability distribution, a scaling parameter is involved in the resulting expression defining the aggregated measure for the expectations. When the normal or logistic distribution is assumed, the threshold is used as a scaling parameter. If one instead assume an uniform distribution, the range over which this distribution is defined serve the role as a scaling parameter. This range is assumed constant over time.

The use of a scaling parameter have been pointed out as one of the method's weaknesses. In Pesaran (1987) different values for the scaling parameter is calculated assuming different types of probability distributions (the uniform, normal and logistic distribution) and using four different ways of estimating the threshold (the Carlson and Parkin-estimator and three ways of estimating the Bennett-estimator). For all three distributions, the highest estimate of the threshold is about 20% higher than the lowest estimate. This illustrates how crucial the different assumptions underlying the estimated scaling parameter may be.

The transformation process involves two threshold values, one value below zero and another above, defining an interval around zero. The two threshold values are often assumed to be equal. This is synonymous with assuming that the rate of inflation below and above zero, which the agents can't distinguish from zero inflation, is the same in absolute value. This may not be the case. Depending on the history of inflation, economic agents may be much more aware of increasing prices than decreasing prices or opposite. The use of the uniform distribution allows for the possibility of the thresholds not being symmetric.

Batchelor (1981) discusses the use of symmetric distributions - and propose non-symmetric distributions to be better approximations. He refers to two empirical studies, Carlson (1975) and Vining and Elwertowski (1976), which conclude that the distributions of individual price-expectations are more centrally peaked[3)] than the standarized normal distribution and also asymmetrical with a time-varying skewness parameter. Non-stable parameters implicates that the second order moment in the individual distributions doesn't exist and thus the aggregated distribution cannot be normal. Batchelor consider three different distribution-models, one of them being the normal one. In the two other models he first allows the distribution to be more peaked and then in addition, he also allows for a time-varying skewness parameter. The degree of skewness varies over time according to the deviation of the actual rate of growth from its mean over the whole sample period.

[3)] The measure of peakedness is a function of the second and fourth sample moments about the sample means.

Batchelor utilizes categorical expectations data on firms expectations on own prices and outputs in France and Germany (1965-1977). The criteria the three constructed series are compared according to, is how well they follow the actual series. The series based on the distribution allowing for varying skewness, perform better than the two others. Further, Batchelor shows that these preferred series satisfy two tests for rational expectations.

Batchelor's work is interesting in that it questions the assumptions concerning the probability distribution applied together with the Carlson and Parkin method. The conclusion, that acceptance or rejection of the REH may depend crucially upon the assumed probability distribution, is an important criticism of using this method. But as long as there exists no overwhelming evidence on how expectations actually are formed; comparing the different quantified expectations series with actual inflation cannot be accepted as a device for choosing which of the series that best represents the latent expectations variable. It is even worse when a representation of the underlying expectations, chosen as the one best representing the actual inflation, in the next step is used to test whether the expectations are rational or not!

Batchelor (1982) expands his analysis of firms' expectations by including data from Italy and Belgium. He has to reject the unbiasedness property for all inflation series, when estimating on monthly data. Running the same regression on annual averages, leads to acceptance for both output growth and inflation expectations. This leads him to conclude that the biases are removed within the scope of one year. Batchelor also tests whether the expectations are as accurate as the optimal time series predictor. He finds that his measures are all inferior to the ARIMA predictors, rejecting the REH. The overall conclusion is that the expectations are not formed in accordance with the REH.

Another interesting finding in Batchelor (1982) is the strong positive correlation of both actual and expected values, across countries, and that this correlation are strongest for the expectations. Batchelor proposes two possible explanations. Irrationally, the firms might put to much weight on international events while forming the expectations, or most of the shocks are domestic in character.

A final problem with the Carlson and Parkin method to be mentioned arise if in one of the sampling periods the fraction answering "up" respectively "down" should happen to be equal to zero; none of the respondents belong to the actual group. In that case the method breaks down. In practical use this problem is solved by removing those periods from the sample.

Table I: Firms; Results

	Variabels	Model	Results	Additional explanatory variables/ remarks
De Leeuw and McKelvey (1981)	Sales prices Capital goods prices	REH: (U) (O) AD AD-AG	 **R** **R** **R** **A** sales prices (**) **A** capital goods prices (*)	 Money growth,capacity utilization Lagged changes in the rate of price increases (*), lagged capacity utilization (*) and lagged rate of changes in the money supply (*,**)
König, Nerlove and Oudiz (1981)	Sales prices	AD EX EL	**R** **R** **A**	
Nerlove (1983)	Sales prices Demand	AD EX EL	**R** **R** **A**	
Zimmermann (1986)	Demand	REH (U) (E)	 **R** **R**	 Two different tests
Batchelor (1981)	Inflation Production	REH (U) (E)	 **R** 2 out of 3 **R** 2 out of 3	The tests are conducted to three different constructed series.
Batchelor (1982)	Inflation Production	REH (U)	 **R**	
Pesaran (1987)	Sales prices	REH (O) RG EL EL-AG	 **R** **R** **R** **A**	 Lagged price changes and output, money supply, exchange rate and rate of unemployment. Manufacturing prices, past price-shocks, lagged prices on raw materials and fuels, rate of change in manufacturing output and price policy variables. Time varying parameters
Saunders (1983)	Sales prices	REH (U) (E) (O)	 **R** 9 out of 12 **R** 2 out of 12 **R** 3 out of 12	 Actual and expected cost changes, unanticipated inventory changes, unfilled orders and the level of capacity utilization
Stålhammar (1987)	Sales prices Demand	REH (U) (E) AD EX	 **R** **R** **A**, Prefered **A**	

REH: Rational expectations hypothesis (U) unbiasedness, (O) orthogonality, (E) efficiency
AD: Adaptive expectations, EL: Error-learning, EX: Extrapolative, AG: Augmented
A: Accepted, R: Rejected

5.2.2 The regression method

The regression method, which is presented in Pesaran (1984, 1987), is an alternative way of transforming categorical expectations data into a quantitative measure of expectations. Pesaran uses the method on firms' expectations concerning the direction of change in own prices.

The main idea behind this method is to combine the micro information from the survey indicating the realized direction of change in the prices of the firms' products, with the information of the realized rate of change in the price of the aggregated sector product as reported in official sources; for instance the national account. The method is rather demanding concerning the amount of data needed. Combining the two sources, Pesaran derives a nonlinear relation between the weighted ratio of the firms reporting their prices have gone "up" respectively "down" and the average rate of change in the sector price. He uses the ratios from the survey and the quantitative rate of change for the sector price taken from official statistics and estimates the parameters in the equation by use of maximum-likelihood estimation. He assumes the same relation to hold for the expected rate of change in the prices. A quantitative estimate on the expected rate of change in the sector price is then derived by use of the estimated parameters and the ratios of the firms expecting their prices to increase or decrease.

In deriving the relation three assumptions have to be made:

(i) If a firm reports that the price of its product has increased, the unobserved rate of change is assumed to be a linear function of the rate of change in the price of the aggregated sector product. This function differs among the firms only with a firm specific error term.

(ii) If a firm on the other hand reports that its price has decreased, the unobserved rate of change is assumed to vary around the average rate of change in the prices of the products from those firms reporting a decrease, only with a firm specific error term. This assymetric way of treating reported increases and decreases have been critizied by Tirole (1984) for being too ad hoc.

(iii) The rate of change in the average price level for the sector's products, is assumed to be a weighted average of the unobserved rate of change for those firms reporting an increase and those reporting a decrease. Assumptions (i) and (ii) are used in replacing the unobserved rates of change. Candidates for the weights are the firms' ratio of the total production or use of labour in the sector.

As pointed out in Pesaran (1987) all assumptions being made can be tested for. This is an appealing property with the method. For instance, one does not need any assumptions on probability distributions. But if the two assumptions concerning the relation between the unobserved rates of change and the observed average rate of change shall be tested for, one does need information from the firms on the direction of change in their prices as well as their point estimate on the same variables. This information is seldom available.

This method, as the Carlson and Parkin method, is based only on the aggregated information in the surveys and ends up with an aggregated measure. So, when interpreted as tests of formation of expectations, it can be confronted with some of the same criticism as mentioned in section 5.2.2.

Pesaran constructs two time series both representing a quantified measure of British manufacturing firms' expectations on the average selling price of their own product. The first one follows the Carlson and Parkin-approach, assuming the normal distribution, while the second one is in accordance with the regression method. Both series are used to test whether the expectations are formed rationally. It is likely that both series suffer from measurement error, so the test for unbiasedness and for absence from serial correlation can not be carried out. The orthogonality hypothesis has to be rejected for both series. As one of the few authors, Pesaran warns against the use of individual data or aggregates of such in the information set when testing on aggregated expectations, because such data are not part of the information set available for all agents. The possibility for measurements errors are taken into account when testing.

After having rejected the REH, other models of expectations formations are tried out (see table I). The model that gives the best fit, is an augmented error-learning model with time-varying parameters. Agents update the estimated parameters in the equation every period in the light of new information. The results imply that the rate of which learning takes place is slow. The model is augmented with past values on variables that enter the reduced-form equations for the rate of changes in prices (see table I).

5.3 Empirical evidence by use of methods for categorical data

In accordance with the criticism against the use of aggregated and quantified measures when testing for the formation of expectations, some authors apply the tests on micro data. Those tests are however conducted on the cross-sections, not making use of the entire panel, so we still have an inefficient use of the information available. A problem arises when the unbiasedness property is tested on cross-sectional data. If all, or a majority, of the firms are subject to a common shock, the distribution of the prediction error will differ systematically from the "no error"-category across the cross-section. This case cannot be discriminated from the case of expectations not being formed in accordance with the REH by the test of unbiasedness when conducting the test to cross-sectional data.

Because most surveys on firms' expectations give categorical data, different measures of association for cross-tables and/or measures based upon the parameters from loglinear probability models are used (see König, Nerlove and Oudiz (KNO hereafter) (1981), Nerlove (1983), Kawasaki and Zimmermann (1986), Zimmermann (1986) and Stålhammar (1987)). When using such methods care must be taken in not interpreting the involved relations between variables as causal relations. The conclusions that can be drawn, concern only associations - not causality.

The hypotheses to be tested in the different papers are all formalized as two or more variables in a cross-table being independently distributed. The hypothesis of independence can be tested formally by the use of for instance a Likelihood Ratio test or Pearson's Chi-Square (see Bishop, Fienberg and Holland (1975)). The Likelihood Ratio test and Pearson's Chi-Square are both measures of nominal association. In addition different measures of ordinal association such as the Goodman and Kruskal's gamma (Goodman and Kruskal, (1979)), can be used when the categories represent a meaningful ordering. The above mentioned papers, all use a special variant of the Goodman and Kruskal's gamma, called the Kawasaki's component gamma coefficient (Kawasaki, (1979)), being a more partial measure than Kruskal and Goodman's gamma. KNO (1981) also use score parameters suggested by Haberman (1974) showing association, skewness and "centering in the no-change categories".

KNO (1981), Nerlove (1983), Kawasaki and Zimmermann (1986) and Zimmermann (1986) all analyze data on German firms from the Ifo Business Test. KNO (1981) and Nerlove (1983) also use data on French firms.

In the German data firms' expectations refer to changes in the variables during the next three (six for business conditions) month, while firms' observations of realized values refer to the last month. The authors solve this problem by constructing a proxy-variable for the changes in the variables over the last three (six) month on the basis of the monthly information. The sample size is somewhat reduced by this procedure.

Nerlove's 1983-paper is an extension of the KNO-paper. The KNO-paper concentrates on the prices of firms' own products, while Nerlove in addition examines the demand facing firms. In the German data demand is proxied by expected business conditions and realized incoming orders. It can be questioned whether those two variables refer to the same latent variable; demand facing firms.

None of the two papers run formal and explicit tests of the REH, but some of the results throw some light on this question nevertheless. KNO find that there exists a positive and significant association between price-expectations/-plans and the subsequent realizations. Some of the positive association is due to a tendency to "centering in the no-change category". The authors refer the positive association to the "expectations" being more of the nature of plans rather than expectations - and do not consider whether it is due to the expectations being formed in accordance with the REH.

Nerlove shows that for the German firms, both prices- and demand-expectations seem to be biased - an evidence against the REH. This finding is not repeated for the French firms' expectations. Nerlove is also able of improving the German forecasts by correcting them with the use of the estimated distribution of the realizations given the expectations. This is again an evidence against the rational expectations hypothesis - in showing us that the past history of the data have not been used efficiently in forming the expectations. For the French data the conditional distributions are too unstable to be used.

The expectations models that are more formally tested in the KNO- and the Nerlove-paper, are the adaptive model, the error-learning model and the general extrapolative model; the error-learning model is the preferred one.

There are three main point of criticism against the papers, two of them mentioned by the authors themselves. First, the data cover a very short time period and specifically - do not cover a full business cycle. Second, they implicitly assume the same price formation behaviour of all industries inside a country. Specifically on the distinction between plans and expectations it would be reasonable to assume differences between industries according to their strategic positions. The last point of criticism is the lack of confronting the data with the rational expectations model.

Zimmermann (1986) tests whether the German firms' expectations of business conditions can be said to have been formed rationally. He formulate three different null-hypothesis to be true under REH; two of them are tests for the efficiency property and the third for the property of unbiasedness.

The efficiency property implies both equality between the stochastic processes creating respectively the actual value and the expected value of the business conditions, and efficient use of past information on the variable. When testing for "same stochastic process", Zimmermann tests whether two cross-tables; expected conditions by past conditions and realized conditions by past conditions, can be said to be realizations from two equal probability distributions. In doing this, he looses the link between the three variables for the individual firm. Consequently, this test do not utilize the microinformation as efficient as the other efficiency test, where the hypothesis of independence between the prediction error and the past business conditions is tested.

The results of the three different tests must, with respect to the REH, be said to be negative. The unbiasedness property may however errouneously have been rejected due to the firms being confronted with a common shock as mentioned earlier in this section. In the period 1979/80 there is a bias in the direction of negative shocks and in the direction of positive shocks in 1981/82.

Kawasaki and Zimmermann (1986) test whether the price expectations in the Ifo-Munich survey are formed rationally. The unbiasedness property is tested by use of measures of the degree of overestimation relative to underestimation of total biases. They conclude by rejecting both the unbiasedness and the efficiency properties and find a tendency of firms overpredicting the levels of selling prices, in addition of being conservative in predicting price changes. Their unbiasedness test is victim to the same problem as the test run by Zimmermann (1986).

Stålhammar (1987) applies tests suggested in Kawasaki and Zimmermann (1986) and/or Zimmermann (1986) on Swedish data. He rejects the rational expectations hypothesis for both demand- and price-expectations. In this study, the demand facing firms are proxied by incoming orders. Further he finds that there is a tendency for overestimating the changes in the variables when there is an upward trend, and

underestimating the changes when there is a downward trend. Two other hypothesis are compared, the adaptive and the extrapolative ones, with the general adaptive to fit the data best.

5.4 Empirical evidence from quantitative data

There does not seem to be many databases containing firms' expectations in a quantitative form. In Saunders (1983) such data is applied to analyse Australian producers' expectations of changes in own selling prices. The hypothesis to be tested is the REH. The distinction between plans and expectations is not discussed in the paper. He tests at two level of aggregates, the aggregate manufacturing level and the two-digit industry classification level, with 12 industrial groups. The averages of the actual and expected price changes as reported by firms, are then analyzed. The results are summarized in table I.

The reported expectations are originally six-month ahead forecasts which have been transformed into three-month forecasts in order to match the reported realized values. As shown in Brown and Maital (1981) the residuals will be serial correlated after the data has gone through such a transformation. It may as a result be impossible to reject the REH. In Saunders' work however, this autocorrelation is accounted for in testing the REH.

In presenting the results for the unbiasedness test, Saunders points to the fact that when running separate tests of the constant term being equal to zero and the slope being equal to one, respectively, the REH is rejected for no more than 3 industries. The results mentioned in table I (rejection for 9 industries) are however derived by the means of a joint F-test. One should therefore be careful when interpreting results where only separate tests have been applied. Saunders stresses that the efficiency test is a rather weak test because producers should be expected to make their decisions on a much broader information set then past changes in the prices, as assumed in the efficiency test. For this reason Saunders tests on an information set containing variables that in former studies have been shown to have a significant impact on price determination in Australia (see table I for details). Two of the variables are weighted aggregates of the individual responses. It can then be questioned whether those variables really are free available information to the firms, or constructions made by the author.

The overall conclusion in the paper based on all three tests (see table I), is that for one industry (miscellaneous manufacturing products) the REH can be rejected and for two industries it cannot be rejected (wood, woodproducts and furniture and transport equipment). For the rest of them including total manufacturing, the results are inconclusive. The conclusion of inconclusiveness when you get rejection in one test and non-rejection of others, may be criticized. When the expectations fail on the unbiasedness tests, one of the properties assumed under the REH is violated. The expectations should consequently be viewed as not fully rational even though other properties are not violated.

In DeLeeuw and McKelvey (1981) the rational expectations model, the adaptive model and an augmented adaptive model of firms' expectations of price changes of own products and of capital goods purchased are tested on aggregated figures from firms belonging to the US industry. The authors argue that using aggregates, reduces the problems of errors in variables due to the individual firms over- or understating the rates of changes. It does not seem to bother the authors that the aggregation also serves to hide firms' systematic errors that in fact could have been caused by expectations not being formed in accordance with the REH. Even so, the data do not support the REH (see table I). The augmented adaptive expectations model is the one that fits the data best. For both expectations variables, the data showed a rather strong effect from the most recently observed price changes.

Aiginger (1981) (not included in our tables) tests REH on a broad range of data sources. His sample covers 39 different expectations series from 6 different countries (Austria, USA, Japan, France, Norway, Finland and the entire OECD-area). Series based on both categorical and quantitative data is used. Aiginger does not comment on which method he has used in deriving a quantitative measure from the categorical data. The series cover firms', experts' and consumers' expectations of different variables. Some of the series used, are better described as anticipations or plans, than pure expectations. Testing hypotheses on the formation of expectations on such series, may be misleading when this distinction is not discussed. Aiginger confronts the sample with a number of different tests. I shall not go into detail on the results, but just mention the overall conclusion which is disappointing with respect to the REH. In addition to separate tests of the different properties proposed to be true under REH, he also runs two comprehensive tests of some of the series. Time series analysis like the Box Jenkins Technique and transfer functions are utilized with the aim of testing aspects of efficiency, unbiasedness and orthogonality simultaneously, still leading to a rejection of the REH. The series that give some support to the REH are the experts' expectations and categorical expectations in the manufacturing sector of Norway and Finland.

5.5 Conclusions

We have surveyed different studies of firms' formation of expectations in the preceding sections. The studies apply a great variety of methods on quite different data sources. Some of the methods have been questioned for different reasons. The most important objections are the use of untestable assumptions in deriving quantitative expectations measures from original categorical data, and the inclusion of constructed aggregates in the firms' information sets. It should also be mentioned that when aggregated expectation measures are applied, too much of the information contained in the micro-data are thrown away. When possible, tests of expectations hypothesis should be based on the micro data.

But, despite the variety in the chosen approaches, the results show an overwhelming rejection of the rational expectations hypothesis. The studies show some evidence for some sort of extrapolative expectations, but the fit is improved when other variables are included in the equation modelling the formation of expectations. Candidates should be

variables assumed to influence the realization of the predicted variable. Another interesting path of further research is the inclusion of the process by which the agents learn how the economy functions.

6. Consumers' expectations

How rational are consumers when they form their expectations ? Households, or consumers, form a special group of agents as far as the formation of expectations are concerned, due to the great variability in their access to information and even more in their ability to process the information (abilities in general, education, etc.).

Most of the studies of households' expectations concentrate upon their expectations concerning the general price level. Obvious, the general price level is of significant importance for the consumers in deciding the real value of their income and wealth, but one might question how important the expected price level is in determining the individual consumers behaviour (events of hyperinflation disregarded). When comparing the loss in welfare for individual consumers due to prediction error and, for many of them, the difficult and time-consuming task to improve their estimated expectations, it might be rational for the consumer to allow themselves in making rather big and, in some cases, systematical mistakes.

Some of the first to study the households' inflation expectations were Carlson and Parkin (1975), in the same paper where they proposed their method for transforming categorical data on expectations into a quantitative time-serie measuring the expected inflation. In the paper they employ their method to monthly UK-data. The preliminary results indicate a structural break and they end up with an autoregressive scheme in periods with low inflation and a second order error-learning process while inflation are high, both augmented with a devaluation dummy. Other variables were also tested for (see table II) but showed no significant effect on the expected inflation.

Jonung and Laidler (1988) analyze the rationality in Swedish consumers' ex post perceptions of the changes in the general price level. The authors' argument for not testing the rationality of the consumers' expectations ex ante is the "Peso problem". The "Peso problem" arises when over a sequence of periods there are a positive probability for an event which significantly will affect the path of the variable to be predicted, to occur. This probability will certainly influence the agents' ex ante expectations, and can cause these to differ systematically from the ex post observations as long as the

Table II: Consumers' expectations; Results

	Variabels	Model	Results	Additional explanatory variabels / remarks
Carlson and Parkin (1975)	Inflation	AR-AG	**A** (high infl.)	Devaluation
		EL-AG	**A** (low infl.)	Devaluation
			R	Changes in indirect taxes, wage-price controls, change in the political party in power
Jensen and Jonassen (1988)	Inflation	EX-AG	**A**	Perceived inflation
			A	Macroeconomic situation (actual and expected)
				Microeconomic sitaution:
			R	actual
			A	expected
			A	Age
			R	Position in the labour market, education and sex
Jonung and Laidler (1988)	Inflation	REH:		
		(U)	**R**	
		(O)	**R**	Previous errors
			R	Import price inflation
			A	Unemployment

REH: Rational expectations hypothesis (U) unbiasedness, (O) orthogonality, EL: Error-learning, EX: Extrapolative, AG: Augmented
A: Accepted, R: Rejected

prescribed event fail to occur. The result is serial correlated error terms. So, the existence of the "Peso problem" make it impossible to reject the REH just because the error terms are serially correlated. The contemporaneous perceptions are not subject to the "Peso problem".

The use of the agents' ex post perceptions can also be motivated by the fact that in the Lucas-model (Lucas (1973)), the shocks to private agents stem from the agents wrongly perceiving a change in the general price level as a change in relative prices, because of their limited information. Despite good arguments for economists to take interest in agents' perceptions and not only their expectations, it must be stressed that those two terms are not identical. The distinction between them are well captured in the terms introduced by the authors, forecast and backcast.

The perceptions are collected before the CPI is public. Those respondents answering that the prices have been increasing, are asked to give their point estimate, but are also allowed to give an interval estimate or just answer "don't know". Jonung and Laidler make use of the mean value of the point estimates, and are by then restricting the sample to include the more informed agents. Use of the mean value will in addition, as usual, throw away a lot of information embodied in the original material. Although the perceived inflation rate is an unbiased predictor for the CPI, the results show serial correlation in the error term. Further, the changes in the rate are systematically underestimated, and the perception could have been made more accurate by more efficient use of the information embodied in past errors and previous import price inflation. This result, on the lack of rationality in the forming of ex post perceptions, are rather strong evidence against the proposition of the ex ante expectations being formed rationally.

Several studies analyze how different sets of information influence peoples expectations. One example of this line of research is Lark (1989), giving a somewhat new approach towards the old question "How do people form their expectations ?"; instead of testing formal models as the extrapolative and rational ones, he concentrates upon the differences in the way people receive and evaluate information using cross-sectional data. The conclusion, not surprisingly, is that people make use of information when forming their expectations, but they do differ in the way they use it and in their abilities to process it. Age had no significant impact, and Lark takes this as an indication of none, or very rapid, learning process. The sign of the unemployment expectations-parameters indicates that people do not believe in a Phillips curve relationship, but instead can be grouped into pessimists and optimists. The results and the approach are interesting, but it would maybe have been of greater interest to study how the same dependent variables influence the prediction errors people make.

Another study is Jensen and Jonassen's cross-sectional study (1988) on Norwegian consumers' inflation expectations. They regress expected inflation (given on intervals) on a vector of variables (see table II). Educational level, age and sex are proxies for differences in the agents' information-set. The results (see table II) support some sort of an augmented extrapolative scheme in the formation of expectations. The distinction between optimists and pessimists found in Lark's paper, are also reported in this one. The agents' inflation-estimates decreased with age. One reason for this finding is that old pople have lived through a long period of stable prices. Older people should on the other hand, have better reasons for being concerned about the inflation rate, because more of their income is nominally fixed.

7. Experts' expectations

In this section we will present some results from studies of what could be called experts' expectations. In our connection experts can be defined as agents specially qualified to express opinions concerning the future path of a specified variable, both because of their accessibility to the flow of information and their ability to make use of it. The very candidates for this group are economists; although not everybody will agree with this statement. The Livingston survey, which we will return to below, is an example of experts' expectations containing the forecasts of leading economists. Agents engaged in the exchange market form another group of experts, cf. section 7.2, due to the fact that their success weight so heavily on the accuracy of their own expectations concerning the movements in the exchange rates.

One would suppose the experts' expectations to be closer to rational expectations than those of less informed agents. And, if the experts are not able to form their forecasts rationally - could we then suppose the man in the street to do so? Rejection of the hypothesis that the experts' expectations are formed rationally, is a rather strong evidence against the rational expectations hypothesis.

7.1 The Livingston survey

Most of the earliest studies on the formation of expectations, using direct tests, utilize the Livingston survey data, named after Joseph A. Livingston; an economic columnist in the Philadelphia Bulletin. The data are collected twice a year on a wide range of economic variables from a panel of leading economists in industry, government and universities. The variables the experts are questioned about are the general price level, wages, real and nominal GNP, industrial production, unemployment, industrial stock prices and business fixed investment; both six-month and twelve-month forecasts. The survey has been conducted since midyear, 1946. In most studies aggregated data is used. Most of the studies of this data base have concentrated upon the price expectations. One exception is Brown and Maital (1981).

Gibson (1972) and Turnovsky (1970) both concluded that there is a structural break in the Livingston price expectations around 1959 and they identified the two sample

periods 1959-62 and 1962-69 to be the ones most likely to meet the rationality conditions. They attributed the structural break to increased inflation from 1960 on. When the actual rate of inflation is low the agents don't find it worth the cost to gather information. Instead they resort to naive expectations. The findings of a structural break have been questioned by Figlewski and Wachtel (1981), which I discuss below.

Pesando (1975) utilizes the published time-series in testing whether the inflation expectations are rationally formed. Two requirements imposed by rationality are tested - efficiency and consistent use of one-period forecasts in forming multispan forecasts (consistency). The tests are carried out on the two time intervals defined above. For both periods the rational expectations hypothesis is rejected, mainly because the data fail to meet the consistency requirement. Pesando concludes that the series cannot be the markets expectations *because* they fail to accept the hypothesis of rationality, rather than concluding that the market's expectations are not rational. This conclusion seems somewhat peculiar.

In Carlson (1977) the use of the published data is criticized because Livingston's adjustments have not been done consistently[4]. Series based on the original answers are then constructed. The same tests as Pesando carried out are applied to the new series for the same two periods. Both series fail to meet the two requirements of rationality and lead to a strong rejection of the REH.

Pesando (1975) and Carlson (1977) test the restrictions imposed on the data under the REH by applying a Chow test. This test requires that the error terms in three estimated equations (for more details see Pesando (1975)) are independent and identically distributed. Mullineaux (1978) rejects the hypothesis of homogeneous variances in the error terms on both Pesando's and Carlson's data and suggests an alternative procedure for testing the requirements of efficiency and consistency. The efficiency test is the same as the one presented in chapter 4.2. The tests are applied to Pesando's and Carlson's data. Mullineaux' results support the hypothesis that the Livingston price expectations have been formed rationally contrary to the results in Pesando's and Carlson's works.

While Pesando, Carlson and Mullineaux concentrate on the price expectations, Brown and Maital (1981) test the rationality hypothesis on the whole set of variables the experts are questioned about. They make use of both the 6- and 12-month forecasts. As the other authors mentioned so far in this chapter, they refer to the studies by Gibson and Turnovsky and choose 1961 -1977 as the period for their analysis.

The orthogonality property is rejected for some more series than the unbiasedness property (see table III). The expectation series of wages, industrial stock prices and

[4] Livingston in writing his column, presenting the consensus of the experts' forecasts had access to more recent figures than the experts had when they made their forecasts. If there had been great changes in the levels in the period between, Livingston himself corrected the mean level of the expectations to preserve the expected average rate of change.

Table III: The Livingston Survey; Results

	Variabels	Model	Results	Additional explanatory variables/ remarks
Brown and Maital (1981)	CPI	REH		
	Weekly wages	(U)	**R** 2 series (6 months)	
	Wholesale prices		**R** 3 series (12 months)	
	Industrial stock prices	(O)	**R** 5 series (6 months)	The change in government purchases, money supply, public interest bearing debt, CPI, wholesale prices, wages, production, investment and unemployment rate
	Real GNP		**R** 6 series (12 months)	
	Nom. GNP			
	Industrial production			
	Business fixed inv.			
	Unemployment rate			
Pesando (1975)	Inflation	REH		
		(E)	**R**	
		(C)	**R**	
Carlson (1977)	Inflation	REH		
		(E)	**R**	
		(C)	**R**	
Mullineaux (1978)	Inflation	REH		
		(E)	**R/A**	
		(C)	**A**	
Figlewski and Wachtel (1981)	Inflation	REH		
		(U)	**R**	
		(O)	**R**	
		AD	**A**	Time varying parameters
		REG	**R**	
Keane and Runkle (1990)	Prices	REH		
		(U)	**A**	
		(O)	**A**	Money supply, crude oil prices

REH: Rational expectations hypothesis (U) unbiasedness, (O) orthogonality, (E) efficiency (C) consistency
AD: Adaptive expectations, REG: Regressive, A: Accepted, R: Rejected

industrial production tend to vary more than the corresponding realized series. This finding is in fact the opposite of what should be true given the hypothesis of rational expectations.

An interesting aspect with Brown and Maital's work, is that they include a wide range of variables assumed to belong to the entire information set while running the orthogonality test. The orthogonality property is not rejected (12 month forecasts) for the real GNP, investment, and unemployment rate. The results suggest that there exists a better understanding of the behaviour of the real variables than of nominal or price-related variables. One interesting result concerning the monetarist view is that even though the experts expectations are not fully rational, the consumer price forecasts could have been improved, if the Livingston's experts had taken fully account of monetary growth in forming their expectations.

Brown and Maital conclude with not rejecting that the investment and unemployment rate forecasts have been formed according to the REH. In judging the result the fact that

the tests for rationality have been employed on the series revised by Livingston himself and to the periods assumed to be the most likely to meet the rationality conditions, has to be stressed.

The study by Figlewski and Wachtel (1981) differs from those mentioned above in several aspects. Most important, they examine the full set of individual responses, using pooled cross-section-time-series regression on 1,864 observations and thus utilize all information in the data base. Second, they are not following the widespread opinion that there was a structural break around 1960, but examine the entire time period; 1946-1975. Third, they also examine other models of inflationary expectations, namely the adaptive and the regressive model, after the REH has been rejected at both the aggregate and disaggregate level. The adaptive model is the preferred one.

While estimating the adaptive model, they allow for the adaptive coefficient to vary across individuals and time. They get on average a higher adaptive coefficient than if it is constrained to be time invariant. The data also show an apparent variability around the coefficient due to individual behaviour. Finally Figlewski and Wachtel run regressions of the estimated time series for the adaptive coefficient on among other, the lagged rate of inflation and the variation in this rate. They conclude that the speed of adjustment decreases when inflation decreases; agents believe the decrease in inflation to be due to non-recurring shocks, and increases at higher levels of uncertainty. And further, when one allows the adaptive coefficient to vary across time, there are no reasons to pick 1960 as a turning point when one is studying the formation of expectations using the Livingston survey.

7.2 Exchange Rate Expectations

One of the first to study the formation of exchange rate expectations utilizing survey data, were Frankel and Froot (1987). The paper also gives an excellent overview of the earlier work on exchange rate expectations, both the process behind it and the use of it as a predictor of the future rate. Their results differ in several respects from previous findings and propositions. They base their study on data from three different surveys (see table V). The data cover forecasts on three to twelve months horizons.

Because of the restricted sample sizes, Frankel and Froot pool the cross-section of the different currencies at each survey date and utilize seemingly unrelated regressions or method of moment estimators. They find the expectations to be biased predictors of the future rate. They acknowledge that this findings can be due to the "Peso problem". The way they conduct the efficiency test, is somewhat unusual. They first examine different extrapolative mechanisms used to form expectations, out of which the "distributive lag" model is the one that fits the data best, but none of the stabilizing models are clearly rejected. The next step is to examine whether those ways of forming exchange rate expectations are rational. This is done by testing whether the different models are sufficiently adaptive or the weights put on the last observed rate of change are high enough. This way of running the efficiency test, is somewhat attractive in that it formulates an alternative hypothesis which the rational expectations hypothesis is tested against. But, the disadvantage is that as well the alternative hypothesis could be

Table IV: Exchange Rate Expectations; Results

	Variabels	Model	Results	Additional explanatory variables / remarks
Dominiquez (1986)	Yen, £, DM, SFR vs.$	REH		
		(U)	**R**	
		(O)	**R**	Forward premium
Frankel and Froot (1987)	Yen, £, DM, FFR, SFR vs.$	REH		
		(U)	**R**	
		AD	**R** 3 out of 6	
		EX	**A** Prefered	
		REG	**R** 2 out of 6	
Ito (1990)	Yen vs.$	REH		
		(U)	**R** 2 of 6	One month forecasts
			R 2 of 6	Three months forecasts
			R 4 of 6	Six months forecasts
		(O)	**R** all series	Forward premium, previous errors, actual changes
MacDonald (1990)	Yen, £, DM, SFR vs.$	REH		
		(U)	**R**	
		(E)	**A**	
		(O)	**R**	Forward premium, previous errors

REH: Rational expectations hypothesis (U) unbiasedness, (O) orthogonality, (E) efficiency
AD: Adaptive expectations, EX: Extrapolative, REG: Regressive
A: Accepted, R: Rejected

rejected when tested against other ignored hypotheses. In any case, Frankel and Froot conclude that the rational expectations hypothesis has to be rejected. The rejection is due to different factors over the sample period and suggests a more complicated model behind both actual and expected rate. Frankel and Froot utilize the mean values from the surveys and this is subject to the same criticism as so many others. They mention, however, the possibilities of different expectations models being in use at one time in the market. The REH is also rejected in Dominguez (1986), analyzing data from the US.

MacDonald (1990) tests the REH on data collected from financial institutions situated in Europe. In addition to the ordinary tests for unbiasedness and orthogonality, he tests whether the exchange rate forecasts for the different currencies are cointegrated. If the series are cointegrated, at least the forecasts for one of the currencies could have been improved by more efficient use of the information from the other markets. The null-hypothesis of no cointegration, can not be rejected by the data. But on the basis of the results from the two other tests, the REH is rejected. Like Dominguez (1986), he find that the agents get the wrong direction of exchange rate changes.

While the above mentioned authors all base their studies on the median responses from the surveys, Ito (1990) explores the individual responses, analyzing them as panel data. The respondents are not only Japanese banks and financial institutions, but exporters and importers as well. He find the expectations to be heterogenous with group-specific significant constant-biases. These findings are interpreted as "wishful expectations" in that the exporters have a depreciation bias and the importers and trading companies

have an appreciation bias. The author rejects the view that the heterogeneity can be due to private information and consequently not inconsistent with the rational expectations hypothesis. The results from the different tests are not in favour of agents forming their expectations rationally, but as stressed by the author, must be interpreted with caution as the data could be damaged by the "Peso-problem".

Table V: Data in the surveyed studies

Authors	Data	Country	Period
Batchelor (1981)	The Commission for the European Communities (CEC)- database	France Germany	1965-77
Batchelor (1982)	The (CEC)- database	Belgium France Germany Italy	1965-77
Brown and Maital (1981)	Livingston	US	1961-77
Carlson and Parkin (1975)	The Gallup Poll	UK	1961-67 1967-73
Carlson (1977)	Livingston	US	1959-69 1962-69
De Leeuw and McKelvey (1981)	Bureau of Economic Analysis	US	1971-80
Dominiquez (1986)	The Money Market Services, Inc. (MMS) (US)	US	1983-84 1984-85
Figlewski and Wachtel (1981)	Livingston	US	1947-75
Frankel and Froot (1987)	The American Express Banking Corporations (Amex), Economist Financial Report, MMS (US)	US	1976-85 1981-85 1983-84
Ito (1990)	The Japan Centre for International Finance	Japan	1985-87
Jensen and Jonassen (1988)	The Consumer Survey - CBS	Norway	1983-85
Jonung and Laidler (1988)	National Institute of Economic Research in Stockholm	Sweden	1979-85
Lark (1989)	British Social Attitudes Survey	UK	1983
Keane and Runkle (1990)	Livingston	US	1968-86
König, Nerlove, Oudiz (1981)	The Ifo Business Test, Service de la Conjuncture (INSEE)	Germany France	1977-78 1974-77
MacDonald (1990)	MMS (UK)	Europe	1982/84-87
Mullineaux (1978)	Livingston	US	1959-69 1962-69
Nerlove (1983)	The Ifo Business Test, Service de la Conjuncture (INSEE)	Germany France	1977-78 1974-77
Pesando (1975)	Livingston	US	1959-69 1962-69
Pesaran (1987)	The CBI Industrial Trends Surveys	UK	1959-85
Saunders (1983)	Survey of Manufacturing Activity	Australia	1973-79
Stålhammar (1987)	Konjunkturinstitutets's business test	Sweden	1978-82
Zimmermann (1986)	The Ifo Business Test	Germany	1975-82

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