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Testing the Rational Expectations Hypothesis

Using Norwegian Microeconomic Data

by

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Abstract

The rational expectations hypothesis (REH) is tested directly using Norwegian microeconomic data on firms' expectations of the prices of own products in domestic and export markets and expectations of demand for own products in domestic and export markets. The data are taken from a survey of firms in manufacturing and mining. The data are qualitative and the tests have been carried out by the use of loglinear probability models and various measures of association. Three different tests are run, with differing results on behalf of the REH; the general conclusion is, however, a rejection of the REH.

Keywords: Rational Expectations, Microeconomic Data, Tendency Surveys

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Contents

1. Introduction

This paper presents results from testing the rational expectations hypothesis (REH) on cross-sectional data of Norwegian firms' expectations of prices of, and demand for, own products. Some of the restrictions imposed by the REH, do not apply to cross-sectional data. This seems to have been disregarded in earlier cross-sectional studies.

The hypothesis of rational expectations was first proposed by Muth (1961), but only after works by, among others, Lucas, Sargent and Wallace in the early 1970s did it come into practical use. The hypothesis has gradually been accepted by most theoretically oriented economists. Although it is just one of several competing theories of how expectations are formed, it is for many economists the most appealing because it appears to be a logical consequence of the rational agent paradigm. However, because this logical sequence can be disputed, and because of the importance of the assumption of rational expectations for the results of models and theories to which it is applied, a broad literature confronting the REH with data has developed.

Two methods are used to test the expectations hypothesis - the direct and the indirect method. The indirect method demands the least data. It combines an economic model which includes expected values as variables and a hypothesis regarding how expectations are formed. The implications of combining the expectations hypothesis <u>and</u> the specific economic theory underlying the model are then tested empirically. The hypothesis which is tested is joint; if it is rejected we cannot tell whether we in general should reject the assumed expectations hypothesis or if we have to reject it only in combination with this particular economic model. The direct method, which I have used, does not require a specified economic model, but does require direct observations of expectations.

The most serious objection to the use of direct observations of expectations in empirical studies is the risk of errors in variables. There are two sources of such errors. First, the respondent may misunderstand the question. For example, firms being asked whether they expect their prices to rise may instead answer whether they expect the rate of increase to rise. Second, we cannot know for certain that the respondent reports the expectations which the executives of the firm actually had in their mind when they made their decisions.

The data analyzed in the paper are taken from a quarterly survey of firms in manufacturing and mining, the "Konjunkturbarometeret", conducted by the Statistics Norway.

Among other things, the firms are asked about their expectations regarding the price of the firms' own products and new orders. The data are qualitative and indicate only the expected and realized direction of change: "Prices (orders) will go up/ remain the same/ go down". This paper is the first attempt to make use of the micro information in the survey.

Using qualitative data raises particular methodological problems. Two different methodological approaches are applied in the literature. The most common begins by transforming the qualitative observations into point estimates either using the method proposed by Carlson & Parkin (1975) or the method proposed by Pesaran (1987). The assumptions required by both approaches, but particular the first, are restrictive. A common drawback in both Carlson and Parkin's, and Pesaran's, methods is the need for aggregating the data into time series for the average expectations held by the firms, throwing away micro-information. This raises the important question of whether conclusions drawn from tests at an aggregate level are valid at a disaggregate level.

The other main approach applies loglinear probability models and measures of association directly to the cross-sectional data, treating each time period in the sample separately. See König, Nerlove & Oudiz (1981) and Zimmermann (1986). This is the approach chosen in this paper.

Many empirical studies of the REH use the direct method. The studies mentioned in this paper are all surveyed in Svendsen (1993), while Aiginger (1981) gives a survey of early studies. While some of the studies get inconclusive results, the overwhelming part of them reject the REH. Studies of firms' expectations are found in Saunders (1983), DeLeeuw and McKelvey (1981), Pesaran (1987), König, Nerlove and Oudiz (1981), Nerlove (1983), Zimmermann (1986), Kawasaki and Zimmermann (1986) and Stålhammar (1987).

A broad literature has arisen based on the Livingston survey, a survey covering American expert economists' expectations (see Pesando (1975), Carlson (1977), Mullineaux (1978), Brown and Maital (1981) and Figlewski and Wachtel (1981)). The most recent paper on the Livingston data, is Rich (1990). Most of the studies on the Livingston data concentrate upon the price expectations, while Brown and Maital analyze a wider range of expectations variables covered by the survey.

Studies of direct observations of exchange rate expectations are found in Dominguez (1986), Frankel and Froot (1987), Ito (1990) and MacDonald (1990). All papers reject the REH. A recent survey of exchange rate expectations is given in Takagi (1991).

In sum, despite a wide range of data sources and methods, the empirical support for the

REH is very weak. Of special importance is the result that the hypothesis is rejected even when confronted with the expectations formed by experts, i.e. agents qualified to express their opinions concerning the future development of an economic variable both because of their accessibility to the flow of information and their ability to make use of it. If those agents are unable to form rational expectations, can we believe less qualified agents are ?

The paper begins in section 2 - 4 by establishing a framework in which tests of the hypothesis can be conducted at a microlevel. The data is presented and discussed in section 5, while the applied method is discussed in section 6. Section 7 presents a discussion of the results and conclusions are drawn in section 8.

2. The hypothesis of rational expectations

The aim of this chapter is to define the REH such that it is possible to conduct tests of the hypothesis at the microlevel. The testable restrictions that follow from the definition are presented in the next section.

2.1 Definition of rational expectations

The REH is grounded on rather strong assumptions concerning the amount of information available to individual agents and their capacity to fully exploit this information. As a starting point, it is assumed that agents know the "true" and deterministic past of the economic model underlying the realization of those economic variables essential to the agents' actions.

The formal definition to be presented in this chapter is based on Muth's well known definition of rational expectations. Following Muth (1961) the REH is defined as: "..the expectations of firms (or, more generally, the subjective probability distribution of outcomes) tend to be distributed, for the same information set, about the prediction of the theory (or the objective probability distributions of outcomes)" and, "...expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory."

A digression is needed before we return to the different concepts in this definition. While Muth defines rational expectations in connection to a relevant economic theory, there is disagreement in the literature about whether one may disconnect rational expectations from a specified theory or model. My opinion is that as long as one assumes in a theoretical or modelling framework, that expectations are formed according to REH, one may allow this assumption to be confronted with micro observations of expectations. Moreover, this can be done without jointly testing a specified economic theory. If, at a microlevel, the hypothesis is rejected, one must argue that the assumption is a good approximation to expectations at a more aggregate level if one wants to use REH at a macro level. This is particularly important for models in which the choice of expectations is crucial to the model's implications.

We can now continue by stating a formal definition of REH based on Muth. Let y_t^i be defined as a stochastic variable (or a vector of stochastic variables) with a conditional probability function, $f^i(y_t^i \mid \Omega_{t-f}^i)$. The f-functions represent the objective probability distributions of outcomes referred to in Muth's definition. Ω_{t-f}^{i} is the information set available to agent i in period t-f. ${}_{t-f}y^{e}_{it}$ is the agent i's prediction of y_t^i (his expectation) made in period t-f. This is the variable we are interested in for empirical or theoretical purposes and REH is only one of several hypotheses conserning the formation of these expectations.

Some will find it surprising that I here operate with agent specific stochastic variables and information sets. In most cases the REH is used in connection with the assumption that (i) agents form their predictions about the same variable, for instance the general price-level, and that they have access to the same set of information. This approach is however too narrow when testing the REH on micro-data. One may introduce two other relevant cases in addition to the one mentioned; (ii) agents form their predictions about the same variable, but have access to different sets of information and (iii) agents form their predictions about different variables, and have access to different sets of information. Given our data in which the firms are posed question about prices on - and demand towards - own products, case (iii) is the one of relevance.

The information set includes information relevant to the realization of the variable the agents want to predict. It may include both quantitative and qualitative information, information on former realizations of the variable or other variables of interest, and the agents' interpretation of how the economy works. It may also be a set of processed information including only the possibility set for the variable and possible associated probabilities.

In the survey from the Statistics Norway the agents make predictions of firm-specific variables. One may then assume a firm's information set to include, in addition to more general information, specific information about the markets in which it participates, firm specific technological information and knowledge of the firm's previous predictions, its prediction errors and corrections made when confronted with new information. Thus most firms have access to some information that is not shared by other firms. This information structure is formalized in (1), where Ω_t^{max} is the information set that encompasses all individual sets and Ω_t^{min} is their intersection.

$$\begin{aligned} \exists\, i,j \quad & \Omega_t^{min} \subset \Omega_t^{i} \subset \Omega_t^{max}, \quad \Omega_t^{i} \not\subset \Omega_t^{j}, \; i \neq j \\ & \Omega_t^{max} = \Omega_t^{1} \cup \Omega_t^{2} \cup \ldots \cup \Omega_t^{N} \\ & \Omega_t^{min} = \Omega_t^{1} \cap \Omega_t^{2} \cap \ldots \cap \Omega_t^{N} \end{aligned} \tag{1}$$

It is essential to distinguish between the information agents have access to and the information they actually use. Under the REH all freely accessible information is assumed to be efficiently used. It is a departure from the REH if agents making predictions about the same variables and having access to the same information set, make systematically different predictions because some do not utilize the full set of information. If, on the other hand, the discrepancy between their predictions is due to different access to information, we can not conclude that the assumption of rational expectations is broken.

We continue with the definition of a rational expectation.

A1: Agent i does not know the exact or objective form of the conditional distribution $f^i(y_t^i|\Omega_{t-f}^i)$. Instead he uses an approximation, $g^i(y_t^i|\Omega_{t-f}^i)$ - the i'th agent's subjective probability function - when making his prediction. We have a set of subjective probability functions, $g^1(y_t^1|\Omega_{t-f}^1)$, $g^2(y_t^2|\Omega_{t-f}^2)$,..., $g^N(y_t^N|\Omega_{t-f}^N)$. N is the number of agents. We abstract here from the possibility of learning.

A2: The subjective function , $g^i(y_t^i|\Omega_{t-f}^i)$, and the objective function, $f^i(y_t^i|\Omega_{t-f}^i)$, belong to the same class of probability functions.

A3: The moments of the subjective distributions differ from their respective moments of the objective distribution function. This deviation is captured by a stochastic variable (denoted ε_{it} for the first order moment in equation (2) below). The distribution of this variable, conditional on the information set, is assumed to follow standard white noise properties (see (3)).

As in the literature, I concentrate on the first order central moment - the mathematical expectation. A1-A3 are summarized for this moment in equation (2).

$$\begin{aligned}\int_R y_t^i g^i(y_t^i \mid \Omega_{t-f}^i) dy_t^i &= E_g(y_t^i \mid \Omega_{t-f}^i) \\ = \int_R y_t^i f^i(y_t^i \mid \Omega_{t-f}^i) dy_t^i + \varepsilon_{it} &= E_f(y_t^i \mid \Omega_{t-f}^i) + \varepsilon_{it}\end{aligned} \tag{2}$$

The difference between the moments of the subjective and the objective distributions is due to the fact that agents have imperfect knowledge of the parameters of the objective distributions;

in addition they may make "small errors" in calculating the moments. The deviations from the objective moments vary in a non-systematic way over time and across agents[2) 3)]:

$$
\begin{aligned}
&(i) \quad E_{\Omega}(\varepsilon_{it} \mid \Omega^{i}_{t-f}) = 0 \\
&(ii) \quad Var_{\Omega}(\varepsilon_{it} \mid \Omega^{i}_{t-f}) = \sigma^{2}_{\varepsilon} \\
&(iii) \quad Covar_{\Omega}(\varepsilon_{it}, \varepsilon_{i,t-s} \mid \Omega^{i}_{t-f}) = 0, \quad when\ s \neq 0 \\
&(iv) \quad Covar_{\Omega}(\varepsilon_{it}, \varepsilon_{jt} \mid \Omega^{max}_{t-f}) = 0, \quad when\ j \neq i
\end{aligned} \tag{3}
$$

A final assumption is needed to define a rational expectation.

A4: In period t-f agent i applies the conditional expectation of y_t^i, as given by his subjective probability distribution, as an estimate of the value of y_t^i. This estimate is agent i's rational expectation of y_t^i in period t-f; ${}_{t-f}y_{it}^e$.

Following A1-A4, a rational expectation can be defined as follows

$$ {}_{t-f}y_{it}^{e} = E_g(y_t^i \mid \Omega^{i}_{t-f}) = E_f(y_t^i \mid \Omega^{i}_{t-f}) + \varepsilon_{it} \tag{4} $$

Equation (4) accords with the definition of Sargent and Wallace (1976): "...(People's expectations) equal conditional mathematical expectations plus what may be a very large random term (random with respect to the conditioning information)".

The error term ε_{it} is included because we are interested in the expectations held by an individual agent; it represents dispersion of the individual expectations around the mathematical expectation. When we aggregate over an increasing number of agents, the sum of the individual error terms goes towards zero as the number of agents approach infinity. We then approach the more familiar definition of rational expectations: "... rational expectations, that is, expectations equal to the mathematical expectation of y_{t+1} based on the information available at time t" (Blanchard and Fischer (1989)).

2) The probability function of ε_{it} is defined over all possible outcomes of the information sets; Ω

3) From (3) it can be shown that the unconditional expectations of ε_{it} and ω_{it} also equal zero.

2.2 The rational prediction error

The discrepancy between the realized value of y_t^i and the expectation ${}_{t-f}y_{it}^e$ is called the prediction error, ξ_{it}^f. It is defined by:

$$\xi_{it}^f = y_t^i - {}_{t-f}y_{it}^e \tag{5}$$

This definition is general and independent of our choice of expectations-hypothesis. Given the REH the prediction error is called a rational prediction error, ζ_{it}^f and has the following form:

$$\zeta_{it}^f = y_t^i - E_g(y_t^i \mid \Omega_{t-f}^i) = y_t^i - E_f(y_t^i \mid \Omega_{t-f}^i) - \varepsilon_{it} \tag{6}$$

We will take more closer look at ζ_{it}^f because most of the empirical tests of the REH are based upon this variable.

There are four partial sources of the discrepancy (ζ_{it}^f) between realized y_t^i and the expectation held by agent i, ${}_{t-f}y_{it}^e$. The most obvious source is the fact that the agent may not form his expectations in accordance with the REH. This will result in a systematic discrepancy from zero and the prediction error will not fulfil the requirements of a rational prediction error. There are however three other sources which result in the prediction error differing from zero in a way that are consistent with the REH. These three sources are defined as F_1^i, F_2^i, F_3^i in equation (7), which is an obvious extension of equation (6). While discussing F_1^i, F_2^i, F_3^i in relation to equation (7), we are interested in whether they lead to a systematic or non-systematic discrepancy from zero and whether these features are the same when analyzed over time or over agents. The conclusions are essential to the validity of the different empirical tests to be discussed later on.

$$\zeta_{it}^f = \underbrace{[y_t^i - E_f(y_t^i)]}_{F_1^i} + \underbrace{[E_f(y_t^i) - E_f(y_t^i \mid \Omega_{t-f}^i)]}_{F_2^i} - \underbrace{\varepsilon_{it}}_{F_3^i} \tag{7}$$

The realization of y_t^i will vary around its mathematical expectation. So even in the special case where the subjective and the objective expectations are equal, the prediction will seldom equal the realization of y_t^i. This variation is represented by F_1^i, which is non-systematic over time but can be systematic across the cross-section, i.e. over agents in any period. At a given point of time, F_1^i will be the same and consequently systematic over the individuals if the agents make predictions about the same variable ($y_t^i = y_t^j = y_t$, $i \neq j$). When the agents make predictions about agent- specific variables ($y_t^i \neq y_t^j$) , for instance the demand towards own firm, both the sign and size of F_1^i may vary across the cross-section at a given point of time. But if the variables $y^1,...,y^N$ are correlated, their variation around their expectations will give rise to an aggregate error different from zero (if the variables are negatively correlated the aggregated error may by chance equal zero).

The second partial error, F_2^i, is the difference between the unconditional and the conditional objective expectation. This difference is due to factors important for the realization of y_t^i that are totally unpredictable (i.e. shocks) to the agent at time t-f. REH restricts this error (F_2^i) to be non-systematic over time, but it may be systematic across the individuals at a given point of time. If the agents make predictions about the same variable ($y_t^i = y_t^j = y_t$, $i \neq j$) and their information sets overlap ($\Omega_{t-f}^i = \Omega_{t-f}^j$, $i \neq j$), this error will be identical for all agents. If the agents make predictions about agent-specific variables and/or have access to different information sets, F_2^i may vary across agents. It can however still be the same for all agents, and hence systematic across the cross-section[4)]. An error of type F_2^i, made by agent i, may be a result of an event not predictable given Ω_{t-f}^{max} (defined in (1)). Consequently all agents have been struck by the shock , and even under REH, this give rise to an error which differs systematically from zero across the cross-section.

The last source, F_3^i, of a prediction error that can differ from zero even under REH, is the individual error term, ε_{it}. This has already been assumed to be neither systematic over time for an individual agent, nor systematic across the cross-section at a given point of time (see (3)).

In sum, the rational prediction error includes elements which differ systematically from zero at a given point of time (F_1^i and F_2^i). This is independent of whether the agents are concerned about the same variable or not, and of whether their information is agent-specific or not.

[4)] This is seen by referring to the information set Ω_{t-f}^{max}, encompassing the individual sets .

2.3 Optimality properties of rational expectations

A rational expectation can be shown to be the optimal prediction of y_t^i conditional on the information set, in the sense that it leads to the minimal quadratic prediction error. In other words, rational expectations are formed by efficient use of all available information.

The definition of rational expectations as conditional expectations implies the following two properties[5]:

(i) A rational expectation is an unbiased estimate of y_t^i's unconditional mathematical expectation (**the orthogonality property**):[6]

$$E_\Omega({}_{t-f}y_{it}^e) = E_f(y_t^i) \tag{8}$$

(ii) The distributions of the agents' expectations are more centred than the distribution of y_t^i, so the variance of ${}_{t-f}y_{it}^e$ is no larger than the variance of y_t^i:

$$Var_\Omega({}_{t-f}y_{it}^e) = Var_\Omega(E_f(y_t^i \mid \Omega_{t-f}^i)) \leq Var_f(y_t^i) \tag{9}$$

[5] ${}_{t-f}y_{it}^e$ is a stochastic variable, with probability function defined over Ω.

[6] Proof of the orthogonality proposition:

$$E_\Omega({}_{t-f}y_{it}^e) = E_\Omega(E_f(y_t^i \mid \Omega_{t-f}^i) + \varepsilon_{it}) = E_f(y_t^i) + E_\Omega(\varepsilon_{it}) = E_f(y_t^i)$$

3. Properties of rational prediction-errors

The optimality properties that follow from the REH and general properties for conditional expectations impose four restrictions on the rational prediction error. These are the orthogonality property, lack of serial correlation, unbiasedness and efficiency. From that we deduce hypotheses that can be tested empirically when data on expectations are available. These tests are presented in the next section.

The orthogonality property requires the expectation of the prediction error[7], conditional on the information set, to be equal to zero[8] [9].

$$E_{\Omega}[\zeta_{it} \mid \Omega^{i}_{t-f}] = 0 \tag{10}$$

The orthogonality property must hold even when we condition only on a subset of the information set, because all elements of information should be used efficiently.

$$E_{\Omega}[\zeta_{it} \mid S^{i}_{t-f}] = 0, \quad S^{i}_{t-f} \subseteq \Omega^{i}_{t-f} \tag{11}$$

While the orthogonality property is a sufficient condition for the REH to hold, the three other properties are only necessary conditions. Tests of these three properties are then tests for partial rationality. A full test of the orthogonality property conditional on the entire information set is, however, impossible because we can never guarantee that we have included all relevant elements of information in the set.

The efficiency property requires that the information embodied in previous observations of the variable y is used efficiently. This is in general readily available information to the agents. The property follows from the orthogonality property when $y_{t-1}, y_{t-2},\ldots$ is a subset of Ω_{t-1} (f=1).

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[7] The probability distribution of ζ_{it} is defined over Ω.

[8] Proof for the orthogonality property of the prediction error:

$$\begin{aligned} &E_{\Omega}(\zeta_t \mid \Omega_{t-f}) = E_{\Omega}\{(y_t - E_f(y_t \mid \Omega_{t-f}) - \varepsilon_{it}) \mid \Omega_{t-f}\} \\ &= E_{\Omega}(y_t \mid \Omega_{t-f}) - E_{\Omega}\{E_f(y_t \mid \Omega_{t-f}) \mid \Omega_{t-f}\} - E_{\Omega}(\varepsilon_{it} \mid \Omega_{t-f}) \\ &= E_{\Omega}(y_t \mid \Omega_{t-f}) - E_{\Omega}(y_t \mid \Omega_{t-f}) = 0 \end{aligned}$$

[9] The supscript f on the prediction error is suppressed in the following.

$$E_\Omega[\zeta_{it} \mid y^i_{t-1}, y^i_{t-2}, ...] = 0, \quad y^i_{t-1}, y^i_{t-2}, ... \subseteq \Omega^i_{t-1} \tag{12}$$

Even if we know that the information embodied in previous observations of the variable y is used efficiently, we cannot say that the information embodied in all relevant information is used efficiently. So, the efficiency property is weaker than the orthogonality property[10].

Past prediction errors must also be looked upon as freely available information. If this information is used efficiently, the prediction error will exhibit the property of lack of serial correlation.

$$\begin{aligned} E_\Omega(\zeta_{it}\zeta_{it-s}) &= 0, \quad s \geq 1 \\ E_\Omega(\zeta_{it}\zeta_{it+s}) &= 0, \quad s \geq 1 \end{aligned} \tag{13}$$

The unbiasedness property follows from the property of orthogonality (i) and implies that the unconditional expectations of the prediction error should be equal to zero[11].

$$E_\Omega(\zeta_{it}) = 0 \tag{14}$$

[10] If $\Omega_0 \subset \Omega_1$ the following equality holds:

$$E_\Omega(X \mid \Omega_0) = E_\Omega\{E_\Omega(X \mid \Omega_1) \mid \Omega_0\}$$

And so

$$E_\Omega(X \mid \Omega_1) = 0 \Rightarrow E_\Omega(X \mid \Omega_0) = 0$$

The opposite implications is not true in general.

[11] Proof for the unbiasedness property:

$$E_\Omega(\zeta_{it}) = E_\Omega(y_t - {}_{t-f}y^e_{it}) = E_\Omega(y_t) - E_\Omega({}_{t-f}y^e_{it}) = E_\Omega(y_t) - E_\Omega(y_t) = 0$$

4. Empirical tests for rational prediction-errors

The tests presented in this section are all deduced from the restricions imposed on rational prediction-errors. The tests will differ depending on whether they use times series or cross-sectional data. Attention has not been given in other works using cross-sectional data (Zimmermann (1986), Stålhammar (1987)). The two different null hypotheses are named H_0^T (using time series) and H_0^C (using cross-sectional data). In all our tests, the REH is the maintained hypothesis. Accepting H_0^T and H_0^C does not prove the REH. Other expectations mechanisms, such as the extrapolative ones, may lead to the same process "by accident" in our data.

$\hat{y}_t^i$ is the observation of agent i's perception[12)] of the realization of y_t^i, while ${}_{t-f}\hat{y}_{it}^e$ is an observation of the agent's expectations regarding the same variable. The subscript denoting the period in which the expectations are formed is suppressed. $\hat{y}_t^i$ may vary among agents because their perceptions may differ, because the variables are agent-specific, or because of measurements errors. X' is a vector that includes those freely available variables that can be supposed to affect the realization of y_t^i , for instance policy- and state variables or firm-specific variables. z_{it} is the observed prediction error and is defined by:

$$z_{it} = \hat{y}_t^i - \hat{y}_{it}^e \tag{15}$$

As was mentioned, a full test of the orthogonality property is impossible. The orthogonality-test gives us however a weak test of the property based upon equation (11):

$$z_{it} = \tau_0 + \tau_1 X_{t-f}^{\prime} + w_{it} \tag{16}$$

$H_0^T:(\tau_o,\tau_1) = (0,0)$ *and* w_{it} *is white noise.*

$H_0^C:(\tau_1) = (0)$ *and* w_{it} *is white noise.*

Rejecting H_0^T or H_0^C implies that the information embodied in X can improve the prediction error. Hence the orthogonality property is violated and the REH is rejected. The difference between the two null hypotheses arise from that, when testing on time series, both the constant and the slope parameters must be zero for the REH to be accepted. This joint

12) We distinguish between the realization of y_t^i as reported by official statistcs and the agents' perception of this realization as reported in the survey.

hypothesis constrains the observed prediction error to be independent of the specified variables, and not to differ significantly from zero over time.

The requirement on the constant term cannot be imposed on cross-sectional data. If a shock strikes at least some agents in the same direction we may find the average prediction error at a given point of time to differ significantly from zero even if the agents in question all form their expectations in accordance with the REH (discussed in section 2.2).

In H_0^C we assume that, at a given point of time, an individual correlation between prediction error and the information set X should not be systematic across agents. Since we do not consider the panel-information, we lose information on whether correlation between prediction error and the information set X is systematic over time for each agent. This is a serious objection against conducting the test using only cross-sectional data. We may reject H_0^C at each point in time, without knowing if the same agents make systematic errors given their information set each period. But, if we reject H_0^C for most periods it may be reviewed as evidence that many firms underutilize their information in more than one period. This argues for using the test on cross-sectional data. A test using the whole panel would of course be superior to testing on either time series or cross-sectional data. This is left for further research.

<u>The efficiency-test</u>, derived from equation (12), is run by estimating the model in equation (17) and testing whether the restriction imposed by the REH (expressed in H_0^T and H_0^C) is supported by the data. If we restrict the vector X discussed above to include only the previous observations of the variable to be predicted, the efficiency-test follows from the orthogonality-test.

$$z_{it} = \delta_0 + \sum_{k=1}^{n} \delta_k \hat{y}_{t-k}^{i} + v_{it} \tag{17}$$

$H_0^T: (\delta_0, \delta_1, ..., \delta_n) = (0,0,..,0)$ *and* v_{it} *is white noise.*

$H_0^C: (\delta_1, ..., \delta_n) = (0,..,0)$ *and* v_{it} *is white noise.*

If H_0^T or H_0^C cannot be rejected the efficiency property is accepted and further use of the information in previous observations cannot reduce the prediction error. The difference between H_0^T and H_0^C is analogous to the difference between hypotheses for the orthogonality-test; the reservations about the use of cross-sectional data still apply.

We <u>test for lack of serial correlation</u> (see (13)) by setting

$$X' = [z_{i,t-1},...,z_{i,t-n}] \tag{18}$$

in equation (16).

<u>The test for unbiasedness</u> is given in equation (19).

$$\hat{y}_t^i = \alpha + \beta \hat{y}_{it}^e + u_{it} \tag{19}$$

$$H_0^T: (\alpha, \beta) = (0,1) \quad \textit{and} \quad u_{it} \textit{ is white noise.}$$

The test can only be applied to time series. At a given point of time (α,ß) may differ from (0,1), when tested on a cross section, because the agents fall victim to a common shock. When we test for unbiasedness on a cross-section we then test a joint hypothesis; the expectations to be formed in accordance with the REH and lack of a common shock. The information from rejecting this hypothesis is limited.

An often used variant of the unbiasedness-test is the following:

$$z_{it} = \alpha + \gamma \hat{y}_{it}^e + u_{it}, \qquad \gamma = (\beta - 1) \tag{20}$$

$$H_0^T: (\alpha, \gamma) = (0,0) \quad \textit{and} \quad u_{it} \textit{ is white noise.}$$

The test for unbiasedness is a weak test for partial rationality, in the sense that we test whether the information actually used is used efficiently.

5. The data used

5.1 The"Konjunkturbarometeret"

We test the REH using Norwegian microeconomic data on firms' expectations. The data are taken from a quarterly survey conducted by the Statistics Norway; the "Konjunkturbarometeret". The data have previously been used as exogenous information in explaining changes in production (Husevåg and Sollie (1988)) and in order and deliveries (Stensrud (1981)). Biørn (1982) examines the data in order to construct quantitative time series for optimal stock and wanted order reserves. None of the studies take advantage of the micro information. This paper is the first attempt to confront these data with hypotheses of how the expectations are formed.

The survey started in 1973.4 and covers firms in mining and manufacturing with more than 100 employees. The number of firms surveyed has varied throughout the period. Initially 470 firms were surveyed, increasing to nearly 700 in 1978, and falling to around 450 firms by the end of 1990, primarily because of structural changes in the economy. The micro data from the period 1982.2 - 1987.2 has been lost.

The firms are asked questions concerning the expected direction of change from the current to the next quarter, and the observed change from the previous to the current quarter, for ten economic variables, including total production, received orders from domestic- and export markets, and prices of the firms' own products in domestic- and export markets. It must be emphasized that observed changes from the previous to the current quarter are the firms' own perceptions of actual changes and may differ from the corresponding values in official statistics. In this paper we analyze the prices of firms' own products sold on domestic- and export markets and orders received from domestic- and export markets. Received orders are used as a proxy for demand towards the firms' products.

When we test whether the firms' expectations are formed rationally, we must be aware of the distinction between price-setters and price-takers. A price-setting firm's estimates of price changes from the current to the next period must be interpreted more as plans than expectations. If firms have sufficient market power and do not revise their estimates of variables outside their control during the period, their plans will be fulfilled. So, we may erronously accept the REH when firms are price-setters. In the econometric macro-models in Statistics Norway, Norwegian producers are assumed to be price-setters. The results from estimating the equations indicate their market power to be less on export markets than on domestic markets[13]. The probability for erronously accepting the REH is then larger for domestic markets than for export markets. Rejecting the REH for export prices but not for domestic prices should be taken as a warning of such problems being present. But such results may also be due to the domestic prices being more easy to predict.

As was mentioned, the data are qualitative; the firms report changes in the form: "prices are expected to go (have gone) up / remain(ed) unchanged / go (went) down".

5.2 Definition of variables

In this section we define the variables we use in the subsequent tests. Let Y be prices in domestic or export market or demand from domestic or export markets. We define three variables, EY, PY, LPY, with indices p,j,k = 1,2,3 indicating the categories. The category "up" is assigned the value 1, "no change" the value 2 and "down" the value 3 on the indices.

EY: Firms' expectations regarding the direction of change in Y from period t-1 to t, reported in period t-1. The variable is defined over the index p, p=1,2,3.

PY: Firms' perceptions regarding the direction of change in Y from period t-1 to t, reported in period t. The variable is defined over the index j, j=1,2,3.

LPY: Firms' perceptions regarding the direction of change in Y from period t-2 to t-1, reported in period t-1. The variable is defined over the index k, k=1,2,3.

The three variables are observable functions of the latent variables y_t^e , y_t and y_{t-1} .

The variable PY represents firms' own perceptions of changes in prices and demand. This perception may differ from the actual changes in those variables that are shown in official statistics, both because the two measures do not include the same disaggregated goods and because firms' perceptions may be wrong. One reason for firms' perceptions to be wrong is

[13] It has to be mentioned that the econometric results refereed to, are based on price-aggregates while the results to be presented in this paper are based on micro-information.

because they do not have full information at the time they report.

The data is collected at the end of March, June, September and December; the reporting deadline for the firms occurs five days before the end of each quarter of the year. When firms are asked about changes from the previous to the current quarter (PY), they are asked how they perceive the changes, based on the information they have at that time. Thus, the survey actually gives us two expectations variables; ${}_{t-1}y_t^e$ and ${}_t y_t^e$. Both concern the changes to occur from time t-1 to t, but they are formed in two different time periods, t-1 and t. The former is the expectations of what are going to happen, while the latter is the perception of what has happened. The actual rate of change is first known in period t+1, thus after the end of period t [14].

We introduce a new stochastic variable, the correction term, $\gamma_{it}^{t-1,t}$, defined in (21).

$$\gamma_{it}^{t-1,t} = {}_t y_{it}^e - {}_{t-1}y_{it}^e \tag{21}$$

$\gamma_{it}^{t-1,t}$ is the correction the agent i makes in his prediction of y_t^i as new information becomes available to him in the time between t-1 and t. It can be shown that the same properties that must hold for a rational prediction error (see section 3) must also hold for a rational correction term. It must, for instance, be orthogonal to the information available at the time when the first of the two predictions is made (here t-1). The properties can be tested in the same way as the properties of a rational prediction error (see section 4). In the efficiency-test (see (17)) we now get the observation of ${}_{t-1}y_{i,t-1}^e$ on the right hand-side variable. At the time when the prediction ${}_{t-1}y_{it}^e$ is made, ${}_{t-1}y_{i,t-1}^e$ is the agent's best estimate of y_{t-1}^i, based upon all the agent's information up to that moment. Remarks analogue to those made in section 4 on the difference between tests run with time-series or cross-sectional data, must be made for the rational correction term.

C is the categorical parallel to the latent correction term $\gamma_{it}^{t-1,t}$, and is calculated from PY and EY. This categorical correction term indicates in which direction the firms revise their opinion of the state of the world.

[14] It is possible to derive a categorical measure of the actual changes in price and demand for different production sectors by using the quarterly National Accounts. There are, however, some problems related to such a measure. First of all, the periods in the two sources do not perfectly overlap. In addition, the National Account gives aggregate measures, while "Konjunkturbarometeret" is concerned about the direction of change in prices and demand for individual firms' products.

C: The correction term, defined in equation (22). See also table I. It is defined over the index s, s=1,2,3. A positive (negative) revision (PY <(>) EY) is assigned s=1 (s=3), wereas the same prediction of direction of change in both periods (no revision; PY = EY) is assigned s=2.

$$C = PY - EY \begin{cases} < 0 \Rightarrow s = 1 & \textit{positive revision} \\ = 0 \Rightarrow s = 2 & \textit{no revision} \\ > 0 \Rightarrow s = 3 & \textit{negative revision} \end{cases} \tag{22}$$

Table I: Categories of C (s) for different combinations of EY and PY (p,j). Directions of revisions indicated in ( ).

		PY		
		j = 1	j = 2	j = 3
EY	p = 1	s = 2 (=)	s = 3 (-)	s = 3 (-)
	p = 2	s = 1 (+)	s = 2 (=)	s = 3 (-)
	p = 3	s = 1 (+)	s = 1 (+)	s = 2 (=)

One has to be careful when interpreting the categorical variables; C, EY, PY and LPY. First of all, one can only make qualitative statements on the basis of their values. For instance, s=1 tells us nothing about the size of the revision, just that it's positive. This is due to the fact that EY and PY say nothing about the size of the changes. While the combination (3,1) may seem qualitatively stronger than the combinations (2,1) and (3,2), the latent, quantitative revision underlying may in fact be less (all three combinations give rise to the value s = 1).

A second warning concerns the value s=2, which represents negative, positive and zero values of the latent variable $\gamma_{it}^{t-1,t}$. If, for instance, a firm expects an increase in prices when seen from t-1 and subsequently at time t perceives the prices to actually have increased, the increment perceived at time t may be much more or less than expected at time t-1. Consequently it may be misleading to interpret s = 2 as an absence of revisions.

Another question which arises when dealing with categorical variable is of what firms mean by a "no-change"-response. The amount of change interpreted as "no change" may vary both between firms and between periods and may also depend upon the recent experience of price changes.

5.3 The distribution of the variables

Table II gives the frequencies of the variables PY, EY, and C, calculated over the entire observation-period; Y is defined as prices on and then as demand from domestic and export markets. The data strongly tend to be concentrated in the "no change"-category, for both perceived (PY) and expected (EY) values; this tendency is particularly strong for the two prices. This may throw some doubt on the quality of the data, because prices have been generally increasing over the entire period.

The concentration in the "no change"-category may be reasonable. Firms report perceived and expected changes in Y over a period of three months. Even in a period of increasing (decreasing) prices and demand, changes may be small over this short time period. Firms may have a benchmark over which they report varying prices/demand as changes. So, the change observed over three months may lie inside the interval of "no change" given this benchmark, even if the rate of change over the year clearly lies outside the interval. The higher the benchmark for reporting varying prices as changed prices, the more concentration in the "no-change"-category will be observed. "Menu-costs" may also explain the observed distribution, by creating a tendency to change prices more seldom than in their absence.

A potential explanation of the observed frequencies is the possibilities that respondents may confuse changes in levels with changes in rates of increase, especially when asked about the movements in prices.

Seasonal factors create another source of measurement error. Firms are asked to abstract from changes caused by seasonal variations, but previous studies using the data show them to be subject to seasonal variations.

Table II: Relative frequencies calculated over all periods. Total number of observations in parenthesis.

Variables	Categories			Sum
	1	2	3	
Domestic prices:				
Perceived changes	26.5	66.7	6.8	100 (21,935)
Expected changes	26.7	68.3	5.0	100 (21,580)
Correction term	13.0	72.2	14.8	100 (21,221)
Export prices:				
Perceived changes	25.3	63.2	11.5	100 (17,531)
Expected changes	25.5	66.1	8.4	100 (17,562)
Correction term	14.0	69.0	17.0	100 (17,026)
Domestic demand:				
Perceived changes	25.2	48.9	25.9	100 (22,042)
Expected changes	21.3	58.4	20.3	100 (21,657)
Correction term	20.7	57.2	22.1	100 (21,356)
Demand from export markets:				
Perceived changes	23.0	47.7	29.3	100 (17,651)
Expected changes	19.8	59.9	20.3	100 (17,649)
Correction term	19.9	55.7	24.4	100 (17,166)

6. Testing the REH on categorical data

As mentioned in the introduction, there are two main approaches to the use of categorical data in direct empirical tests of the REH:
(i) The micro data are transformed into a quantitative estimate regarding the average expected or realized changes in price. The restrictions are then tested by use of traditional time-series regressions.
(ii) The tests are carried out by the use of measures of association for categorical data and loglinear probability models estimated on categorical micro data for each cross section.

We have chosen the second of these methods for several reasons. First, we want to test at a disaggregate level because (a) we are interested in the validity of the REH as a description of individual behaviour, (b) if the hypothesis are confronted with aggregated data one may erroneously (i) accept the hypothesis because individual prediction errors cancel with aggregation or (ii) reject the hypothesis because we test the rationality of the expectations based on an information set that includes information to wich the agents do not have access. The second reason for preferring the second method lies in the somewhat arbitrary assumptions which are necessary to transform categorical observations into quantitative estimates.

In this section we present the tests used in this paper. The results from conducting the tests for separate periods are reported in section 7.

While, in sections 3 and 4 related the properties and tests to the rational prediction error, we will from now one relate the tests to the correction term. This is in accordance with the remarks made in section 5.2.

6.1 The efficiency test

In section 4 the efficiency test was presented for quantitative data, with the null-hypothesis requiring there to be a zero relationship between the prediction error (or the correction term) and former observations of the predicted variable. This null-hypothesis can be formulated for categorical variables as absence of association (see (23)) between the variables C and LPY (defined in section 5.2).

We define a simultaneous event {s,k} as C=s and LPY=k. The event is assumed to be a realization from a probability distribution and $\pi_{sk}^{C,\,LPY}$ is the simultaneous probability that the event occurs. From the null-hypothesis of no association between the correction made at time t and the information the firm had at time t-1 about the movements in the variable up to then, it follows that the distributions of C and LPY are independent of each other and the simultaneous probabilities hence are:

$$H_0\colon\ \pi_{sk}^{C,LPY} = \pi_{s.}^{C}\pi_{.k}^{LPY} \tag{23}$$

where $\pi_{s.}^{C}$ and $\pi_{.k}^{LPY}$ are the probabilities in the two marginal distributions.

Table III: C by LPY. Observed and expected frequencies. Percent. Predicted frequencies (H_0: no association) in parantheses.

Domestic prices	1	2	3	Sum	Domestic demand	1	2	3	Sum
1	4.94 (3.50)	6.56 (8.62)	1.49 (0.86)	12.99	1	7.84 (5.30)	8.29 (10.10)	4.52 (5.25)	20.65
2	18.30 (19.48)	50.34 (47.96)	3.60 (4.80)	72.24	2	13.21 (14.67)	31.32 (27.99)	12.68 (14.54)	57.21
3	3.73 (3.98)	9.49 (9.81)	1.55 (0.98)	14.77	3	4.60 (5.67)	9.31 (10.82)	8.21 (5.62)	22.12
Sum	26.97	66.39	6.64	100.00	Sum	25.65	48.92	25.41	99.98
Export prices	**1**	**2**	**3**	**Sum**	**Export demand**	**1**	**2**	**3**	**Sum**
1	5.02 (3.63)	6.49 (8.81)	2.50 (1.57)	14.01	1	6.99 (4.64)	7.69 (9.47)	5.17 (5.73)	19.85
2	16.73 (17.87)	46.34 (43.43)	5.97 (7.75)	69.04	2	11.60 (13.03)	29.86 (26.59)	14.24 (16.08)	55.70
3	4.13 (4.39)	10.07 (10.67)	2.76 (1.90)	16.96	3	4.81 (5.72)	10.18 (11.67)	9.46 (7.06)	24.45
Sum	25.88	62.90	11.23	100.01	Sum	23.40	47.73	28.87	100.00

Table III reports the observed relative frequencies of C by LPY calculated over the entire period (1974.1 - 1982.1 and 1987.3 - 1990.4) and the associated predicted frequencies under H_0 (in parantheses). The absolute distance between what we observe and what is predicted under the null may not seem large, but a more formal criteria is needed; particularly if all 46 periods are to be studied separately.

a. The Likelihood Ratio test

More formal tests of H_0 can be conducted using measures of association, such as the Likelihood ratio test and Pearsons Chi-Square (see Bishop, Fienberg and Holland (1975)). Both are based upon the differences between observed and predicted frequencies and follow an asymptotic $\chi^2(4)$-distribution. Asymptotically, the measures equal eachother. When presenting the results in chapter 7, only the Likelihood ratio (LR) statistic is reported.

The LR statistic is given by (24).

$$LR = 2\sum_s^3 \sum_k^3 m_{sk} \log(m_{sk} / n_{sk}) \tag{24}$$

m_{sk} is the observed absolute frequency for the event {s,k} while n_{sk} is the expected frequency under the null (see (25)). $m_{.k}$ and $m_{s.}$ are the marginal frequencies over C and LPY respectively, and $m_{..}$ is the total number of observations in the frequency table. The LR statistic equals zero if observed and expected frequencies are equal for all events. This is the case under the REH.

$$n_{sk} = \frac{m_{s.}\, m_{.k}}{m_{..}} \tag{25}$$

The LR-statistic, with associated levels of significance calculated over the entire period, are shown in table IV. The test rejects H_0 for all four variables.

Table IV: Likelihood ratio test for the efficiency property		
	LR (4)[15]	Sign. prob.
Domestic prices	479.71	0.000
Export prices	460.80	0.000
Domestic demand	807.05	0.000
Export demand	566.37	0.000

In section 5.1 we discussed the possibility of erroneously not rejecting the REH when confronted with price-setting firms. This may explain why the departure from the null is less for prices than for demand in table IV. One would also expect firms to make bigger mistakes predicting the state of export markets than of the domestic market. This is not found in our data as reported in table IV. The departure from the null is in fact largest for domestic demand.

For a given set of relative frequencies, the observed LR-statistics increase with the number of observations, while the critical value for rejecting H_0 is unchanged. This makes it nearly impossible to not reject H_0 for even the smallest departure from the null when the number of observations goes beyond a certain limit. The LR-statistics reported in table IV are calculated for samples with 18 000-23 000 observations, so one should not draw too strong conclusions from the results.

The LR-test has also been conducted for each of the 46 periods, with the number of observations lying between 300 and 600 in each period. In these subsamples one is not confronted with the problem of large numbers of observations. The results are reported in section 7.

[15] With s=1,...,S and k=1,...,K the degrees of freedom follow from d.f.= (S-1)(K-1).

b. The loglinear probability model

In section 7 the results from four different tests of the efficiency property are presented; two tests for nominal association (including the LR-test) and two tests for ordinal association. All four tests can be discussed in the framework of a loglinear probability model[16] :

$$MODEL\ I\text{:}\quad \log(\pi_{sk}^{C,LPY}) = \mu_I + u_s^C + u_k^{LPY} + u_{sk}^{C,LPY} \tag{26}$$

The parameter μ_I is a constant term equal to the average of the log-probabilities. u_s and u_k are the main effects of C and LPY respectively. Each represents the departure of the log-probability from the average μ_I that is due to its respective variable. $u_{sk}^{C,LPY}$ are the bivariate interaction parameters; for our purposes they are the parameters of most interest. They represent the departure from the sum of the average μ_I and the main effects u_s and u_k, due to the observed association between C and LPY.

A positive value of one of the effect parameters will increase the probability the event occurs, while a negative value reduces the probability. In the case of no association, the bivariate interaction parameters will equal zero.

The LR-test given in (24) and (25) is identical to test a joint null-restriction on all bivariate interaction parameters in (26).

c. A loglinear probabilty model for an ordinal-ordinal table

The categorical variables used in this paper are all ordinal; the orderings of the categories can be given a meaningful interpretation in the form "higher than, less than or equal to". It is then relevant to ask if the association goes in any specific direction when there is association between the correction term (C) and former observations of Y (LPY). If high/low values of C are associated with high/low (low/high) values of LPY the data show a positive (negative) association.

In our case negative association implies a tendency that firms overpredict (underpredict) the direction of change, resulting in a negative (positive) revision, after having reported

[16] For a general reference to loglinear probability models and measures of association, see Bishop, Fienberg and Holland (1975) or Fienberg (1980).

increasing (decreasing) prices in the period before making their expectations. This would be the case of adaptive expectations.

In estimating the general loglinear model in (26), we do not utilize the information embodied in the ordinal nature of our data, which can be used to restrict the number of parameters describing the bivariate association. By testing the null of no association within the framework of a more restrictive model, the power of the test is increased compared to the traditional approach, since one tests over a more restricted parameter space. Another advantage with more restrictive models is that one can derive parameters that indicate the direction of an eventual association.

One such restricted model is the uniform association model (see Agresti (1984)), presented in equation (27). The model restricts the patterns of the bivariate association. The association is now captured in one single parameter, $\beta^{C,LPY,}$, while in four parameters in the general loglinear model.

$$MODEL\ U: \log(\pi_{sk}^{C,LPY}) = \mu_I + u_s^{C} + u_k^{LPY} + \beta^{C,LPY}(s-\bar{s})(k-\bar{k})$$

$$where\ \bar{s} = \frac{1}{3}\sum_{s=1}^{s=3} s \quad and \quad \bar{k} = \frac{1}{3}\sum_{k=1}^{k=3} k \qquad (27)$$

When $\beta^{C,LPY} = 0$ one gets the model of no association /independence[17]. If $\beta^{C,LPY} > 0$, the association is positive and opposite, if $\beta^{C,LPY} < 0$, the association is negative. We first test whether the uniform association model is a good approximation to the process by which the m_{sk} are generated, using a traditional LR-test with 3 d.f. Secondly, if the uniform association model is not rejected, the null hypothesis of no association given uniform association is tested. If this null hypothesis is rejected, the sign of $\beta^{C,LPY}$ gives the direction of association. The test results are presented in section 7.

The uniform association model is rather restrictive. Less restrictive models that also use the ordinal nature of our data can be derived. Some of those models were tried during estimation, but the results did not differ significantly from those obtained by use of the one discussed above.

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[17] If $\beta^{C,LPY} \neq 0$, one can see that the deviation in log m_{sk} from the independent model is linear in LPY for fixed C and linear in C for fixed LPY. Thus the model in (27) is known as the linear-by-linear association model.

d. The component gamma

A well-known measure of ordinal association is Goodman-Kruskal's gamma (GKG) (see Goodman and Kruskal (1979)), defined over the observed frequencies. Suppose two drawings from the total sample with outcomes {s,k} and {s',k'}. In the case of positive (negative) association the probability for the two drawings being equally (unequally) ordered[18] is greater than the probability for they being unequally (equally) ordered. GKG measures the degree and direction of association by the difference between the conditional probabilities for the observations being equally and unequally ordered [19].

One disadvantage of measures of association that are based on observed frequencies is that they are not invariant to changes in the marginal distributions even if the bivariate interaction between the two variables is unchanged. In this paper our main interest is the bivariate interaction, not the marginals. In Kawasaki and Zimmermann (1981), several partial measures of ordinal association are proposed, from which we choose to apply the component-gamma, γ. This is a variant of Goodman-Kruskal's gamma. Kawasaki and Zimmermann (1981) use the bivariate interaction parameters of the loglinear probability model (see (26)) in their measures. As an intermediate step, they introduce the concept of component probabilities. The component probabilities, being functions of the parameters in the loglinear probabilty model[20], represent a partitioning[21] of the probability π_{sk} into the contribution from the marginal probability distributions (π(s) and π(k)) and the bivariate distribution (π(s,k)). Each of the three sets of component probabilities (π(s), π(k) and π(s,k)) satisfies the definition of a probability.

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[18] The outcomes are said to be equally ordered if $\{s>s'$ and $k>k'\}$ or $\{s<s'$ and $k<k'\}$. The variables are said to be unequally ordered if $\{s>s'$ and $k<k'\}$ or $\{s<s'$ and $k>k'\}$.

[19] The conditional probabilities for equally and unequally ordered, are respectively PS/(1-PT) and PD/(1-PT). PS, PD and PT are defined below. Notice that PS+PD+PT=1.

$$PS = Prob[s>s' \text{ and } k>k', \text{ or } s<s' \text{ and } k<k']$$
$$PD = Prob[s>s' \text{ and } k<k', \text{ or } s<s' \text{ and } k>k']$$
$$PT = Prob[s=s' \text{ or } k=k']$$

[20] The definition of component probabilities:

$$\pi(s) = \frac{exp(u_s^{C})}{\sum_{s=1}^{3} exp(u_s^{C})}, \quad \pi(k) = \frac{exp(u_k^{LPY})}{\sum_{k=1}^{3} exp(u_k^{LPY})}, \quad \pi(s,k) = \frac{exp(u_{sk}^{C,LPY})}{\sum_{s=1}^{3}\sum_{k=1}^{3} exp(u_{sk}^{C,LPY})}$$

[21] $\pi_{sk} = \pi(s)\pi(k)\pi(s,k)$

γ is defined as

$$\gamma = \frac{PS^c - PD^c}{PS^c + PD^c} \tag{28}$$

where

$$\begin{aligned} PS^c &= 2\Sigma_s \Sigma_k \pi(s,k) [\Sigma_{s'>s} \Sigma_{k'>k} \pi(s',k')] \\ PD^c &= 2\Sigma_s \Sigma_k \pi(s,k) [\Sigma_{s'>s} \Sigma_{k'<k} \pi(s',k')] \end{aligned} \tag{29}$$

γ measures the partial bivariate association between the two ordinal variables C and LPY. It varies between -1 and 1, and equals -1 if there is perfect negative association, 1 if there is perfect positive association and 0 if there is no ordinal association. γ is asymptotically normally distributed[22]. we test for no ordinal association with a t-statistic. If the null is rejected the sign of γ gives the direction of association. In section 7, γ is calculated for each period.

The measures of ordinal association (here represented by $ß^{C,LPY}$ and γ) can only reveal monotonic association - that is, the same direction of association in all subgroups of cells in the cross-table. If the association is non-monotonic, test-observatores such as the LR-test and the Pearsons Chi-Square are preferable.

e. The component chi-square; ϕ^2

In section 7, a fourth measure of association is calculated, ϕ^2. This is a measure of nominal association that differs from the well known Pearsons Chi-Square in that it requires component

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[22] γ is a function of the estimators for the parameters u_{sk}, which are MLE and asymptotically normal-distributed with covariance matrix Σ. If $\gamma(\underline{u})$ is a differentiable function of $\underline{u}$, γ is asymptotical normal distributed with an asymptotical variance, $\gamma \;\; (1/n)(\delta\gamma/\delta\underline{u})' \Sigma (\delta\gamma/\delta\underline{u})$. This follows by the usual δ-method argument.

probabilities instead of frequencies when calculated. The measure is invariant to changes in the marginal distributions. ϕ^2 is defined by (30).

$$\phi^2 = \sum_s^S \sum_k^K \left[\frac{[\pi(s,k) - \hat{\pi}(s,k)]^2}{\hat{\pi}(s,k)} \right] \tag{30}$$

π(s,k) is the estimated component probability (see (29)) while $\hat{\pi}$(s,k) is the expected component probability given H_0. Under H_0 the bivariate interaction parameters $u_{sk}^{C,LPY}$ will equal zero, giving $\hat{\pi}$(s,k) as shown in (31).

$$\hat{\pi}(s,k) = \frac{exp(u_{sk}^{C,LPY})}{\sum_{s=1}^{3} \sum_{k=1}^{3} exp(u_{sk}^{C,LPY})} = \frac{1}{9} \tag{31}$$

ϕ^2 is asymptotically normally distributed and a t-test can be applied to test whether ϕ^2 is significantly different from zero.

6.2 Testing for "cross-restrictions on equations"

The efficiency property gives rise to a second test. If the information included in previous observations of price changes is efficiently used, both the expectations and realizations regarding the price, EY and PY, should be explained by the same stochastic process in LPY[23)].

This hypothesis can be tested with a pooled variable X and a dummy variable D.

X: A pooled variable, combining PY and EY, defined over the index m = 1,2,3. The number of observations of X in a single period t is $2N_t$, where N_t is the number of observations of PY and EY, respectively. m equals the value of p or j.

D: D is a dummy variable, defined over the index d = 1,2, indicating whether the value on X is taken from an observation of PY (d = 1) or EY (d = 2).

[23)] Under REH: Cov(C,LPY) = 0 <=> Cov(PY-EY,LPY) = 0 <=> Cov(PY,LPY) = Cov(EY,LPY)

The loglinear model to be estimated and the null-hypothesis is given by

$$MODEL\ II\text{: } \log(\pi_{m,k,d}^{X,LPY,D}) = \mu_{II} + u_m^{X} + u_k^{LPY} + u_d^{D} + u_{mk}^{X,LPY} + u_{md}^{X,D} + u_{kd}^{LPY,D} + u_{m,k,d}^{X,LPY,D} \tag{32}$$

$$H_0\text{: } u_{m,k,d}^{X,LPY,D} = 0$$

The probability $\pi_{m,k,d}$ is interpreted as the probability that a firm reports an increase in prices (m=1) given that in the previous period, it perceived a price decline (k=3); if d=1 the former is report of actual prices, if (d=2) it is of expected prices.

Rejecting H_0 implies that the information about whether X reflects actual or expected price-changes, is essential to the association between X and LPY, and thus EY and PY are not the result of the same stochastic process.

This alternative test of the efficiency-property is weaker than the efficiency-test already discussed, because it does not make efficient use of the micro-information. The estimation of (32) is based on two cross-tables, both two-dimensional; PY by LPY and C by LPY. The role of the dummy-variable D in (32) is to identify the cross-tables from which the value of the pooled variable, X, is taken. In (32) we then test whether the bivariate-effect parameter in the two cross-tables is identical. There is an infinite number of combinations of reports given by firms on LPY, EY and PY that can give rise to cross-tables that do not reject H_0. If for instance all pairs of corresponding cells from the two tables have the same relative frequencies, we cannot reject H_0 but we cannot without further information tell whether a pair of corresponding cells represents answers from the same firms. All firms take part in two independent drawings, in period t-1 (d=2) reporting their expectations and in period t (d=1) reporting their perceptions of actual price changes.

The restriction in (32) is tested with a LR-test and a ϕ^2-test. The LR-test is run by estimating the loglinear model with and without the restriction on the trivariate interaction parameter imposed by H_0. The test-statistic is given in (33), where LR(II) equals "-2*log likelihood for MODEL II" and LR(IIB) is the same for MODEL IIB. MODEL IIB is the constrained model and is nested in MODEL II. Z is $\chi(4)$-distributed.

$$Z = LR(IIB) - LR(II) \tag{33}$$

The test-statistic ϕ^2 is nearly identical to the one presented in section 6.1 but is here based on the trivariate component probabilities[24)]. Again a t-test based on the asymptotic variance is used. The results are reported in section 7.

6.3 The test for unbiasedness

In section 4 we presented a test for the unbiasedness-property appropriate for quantitative data. It was emphasized that, if conducted on cross-sectional data, the null is a joint hypothesis; the expectations are formed according to the REH and there are none common shocks. This warning still remains. The categorical correspondent to the hypothesis in equation (20) is the hypothesis of no association between the variables C and EY. In section 7 we test this hypothesis by use of a LR-test. The cross-table of C by EY includes two structural zeros. This is accounted for when calculating the LR-statistics. Because EY is included in C an association may erroneously arise if there are measurement errors in EY.

Further, (20) implies the correction term to be centred around the "no revision"-category with no systematic bias in either positive or negative direction. The absence of systematic bias can be tested for by estimating the following one-dimensional loglinear model:

$$\textit{MODEL III:}\ \log(\pi_s^C) = \mu_{III} + u_s^C \tag{34}$$

The hypothesis to be tested is:

$$H_0:\quad u_2^C > 0 \ \ \textit{and} \ \ u_1^C = u_3^C \tag{35}$$

The hypothesis is accepted if u_2 is positive and differs significantly from zero and the second restriction is accepted. It follows from the restrictions on the sum of parameters (Σu_s=0) and H_0, that u_1 and u_3 should be negative under H_0. The restrictions are tested by use of a Wald-test. The actual Wald-statistics are $\chi(1)$-distributed[25)].

The results are reported in section 7.

[24)] $\hat{\pi}$(m,k,d) =1/18 (follows from (29) and (32)).

[25)] The Wald-statistic is computed by use of the estimated parameters and the information matrix.

7. Results

The results of the empirical tests which have been calculated using the software-package SAS are shown in tables VI-XIII in the appendix; table V summarize the results. Unless stated otherwise the critical level for rejecting H_0 is 5 percent. All tests are conducted to 46 periods.

Table V: Number of periods in which the REH are rejected

	Test	Price		Demand	
		Domestic	Export	Domestic	Export
Efficiency-test	ϕ^2 (Nominal ass.)	15	14	23	14
	LR(4) (Nom.ass.)	37	34	42	35
	LR(3)[26] (Ord ass.)/ ß	14 / 5	14 / 3	16 / 10	18 / 9
	γ[27] (Ordinal ass.)	6 (5)	5 (5)	34 (34)	28 (28)
Test on cross-restrictions	ϕ^2	1	3	6	2
	LR(4)	5	7	18	12
Test of unbiasedness	LR(4)	46	46	46	46
	H_0: $u_2=0$ vs H_1: $u_2>0$	0	0	0	0
	H_0: $u_1=u_3$ vs H_1: $u_1 \neq u_2$	17	17	24	24

7.1 Prices on firms' product

Tables VI and VIII contain the results of the efficiency test (see section 6.1, especially (23)) for the two price-variables. The LR-test (nominal association) shows that there exists an association in the data between the qualitative correction term (C) and the last perceived direction of change (LY). The hypothesis of no association is rejected in 37 periods for prices in domestic markets and in 34 periods for prices in export markets. Thus, more efficient use of the information

[26] The first figure indicate the number of periods not rejecting the uniform association model, while the second figure gives the number of periods out of the first ones, rejecting the REH (ß significantly different from zero).

[27] Number of periods with $\gamma > 0$ (positive association) given in parantheses.

gathered in the firms' previous observations would have reduced the need for correcting the predictions in more than 3/4 of the periods. The results from the ϕ^2-test do not so strongly weigh against the REH; in more than half of the periods the hypothesis of no association (supporting the REH) is not rejected. The LR- and the ϕ^2-statistics represent two ways of testing the null of no association. The "ϕ^2 " tests whether a specific configuration, the bivariate effect parameters in the estimated model, are different from zero; the LR-test, which is calculated directly from the observed frequencies, tests the more general hypothesis of no association. The uniform association model (see (27)) restricts an eventual association to be monotonic. The LR-test (ordinal association) in tables VI and VIII shows that the restrictions imposed by the uniform association model are rejected by the data in more than 2/3 of the periods for price expectations; when the model is not rejected, the association between the correction term and perception of previous price changes is seldom significant. These findings indicate that any possible association is non-monotonic. The gamma test leads to the same conclusions. Less restrictive model of ordinal association were estimated, but did not improve the results.

Tables VII and IX contain the values on LR and ϕ^2 used to test whether the expected and perceived directions of change are generated from the same stochastic process (see section 6.2), the alternative test of the efficiency property. The null-hypothesis is seldom rejected; while the LR-test rejects the hypothesis in only 5 (domestic prices) / 7 (export prices) out of 46 periods, the ϕ^2-test leads to rejection in 1, respectively 3 periods. Thus we cannot reject that price expectations made in period t-1, and the subsequent observations of prices in period t, are generated from the same stochastic process. But, as mentioned in section 6.2, testing the validity of cross-restrictions is a weaker test of the efficiency-property than the efficiency-test described in section 6.1.

The final property to be tested is the unbiasedness property (tables VII and IX). The significance-level for rejecting the null-hypothesis is high in all periods according to the LR-statistics (see section 6.3). But, as stressed before, this result may be due to common shocks and not to expectations not being formed in accordance with the REH. Wald-tests have been run to the parameters in a one-dimensional loglinear probability model (see (34) and (35)). In accordance with the REH, requesting prediction-errors to be concentrated in the "no correction"-category, u_2 is significantly different from zero and positive in all periods both when domestic and export prices are considered, while u_1 (significant in all periods) and u_3 (calculated from the cross-restrictions on the parameter-values) are negative in all periods. The correction term is symmetrically distributed around the "no revision"-category ($u_1=u_3$) in more than half of the periods; the results do not indicate a revision in any specific direction in the remaining periods.

If the firms in fact are price-setters one may errouneously accept the REH; we cannot discriminate between these two hypotheses. The problem of firms being price-setters may be reduced when testing on prices in export markets because one may reasonably expect the firms to have more market power in domestic markets than in export markets.

The results from the three different tests presented in this section do differ in their conclusions with respect to the REH. The efficiency test rejects the REH, while the test on cross-restrictions does not reject the REH. This last test is however a weaker test of the efficiency property than the efficiency test. The unbiasedness test are inconclusive in addition to not being a good test when conducted on cross-sectional data. One may argue that if only one of the restrictions the REH imposes on the correction term is violated, the REH has to be rejected. The hypothesis that firms' expectations regarding prices on own products are formed in accordance with the REH, may be rejected according to this argument.

7.2 Demand from domestic and export markets

When analyzing the firms expectations concerning the demand towards the firms' products we use the firms' reports on orders from domestic and export markets as proxies for the demand from those markets.

The results from the efficiency-test conducted on demand from domestic and export markets are reported in tables X and XII. We find that the property is rejected in most periods by the LR-test (nominal ass.) (42 (domestic) / 35 (export) out of 46 periods), indicating an association between the correction term and perceived previous changes in demand. So, in about 3/4 of the periods we can conclude that there is an association between the correction term and lagged observations, indicating an inefficient use of information when forming expectations. As for the price-variables, the ϕ^2-test leads to rejection in fewer periods, respectively 23 and 14 periods for demand from domestic and export markets.

Again the restrictions implied by the uniform association model are rejected in about 2/3 of the periods; in about half of the remaining periods ß is estimated to be significantly positive. The sign of the γ also shows the association, when present, to be positive. γ is positive in all periods and significantly different from zero in 34 periods for domestic demand, while it is positive in all but 2 periods and significantly different from zero in 28 periods for export demand. A positive association indicates a tendency that firms underpredict (overpredict) the future change in demand if the demand most resently increased (decreased). This is in fact the opposite of what one would have expected to find if the alternative hypothesis was the adaptive expectations scheme. The findings are more in accordance with the regressive-expectations model (see for instance Frenkel (1975)); agents always expect the level or the rate of change to return to a "normal" level.

Tables XI and XIII contain results from the alternative test of the efficiency property (see section 6.2). According to the ϕ^2-statistics the hypothesis is rejected for 6 periods for domestic demand and for 2 periods for export demand, while the LR-test leads to rejection for 18, respectively 12, periods. As for the price variables these results are stronger in favour of the efficiency-property to hold than the results from the efficiency-test reported in tables X and XII.

The second property to be tested is the unbiasedness property (tables XI and XIII). The hypothesis of no association between the correction term and perceived changes in demand is rejected for all periods at a 1 percent level of significance for demand from both markets according to the LR-test (see section 6.3). This results may however be due to common shocks. As for the price variables, the Wald-tests (see (34) and (35)) indicate a concentration in the "no revision"-category, with u_2 being significantly positive in all periods and u_1 and u_3 being negative for most periods for both variables. The equality-restriction on u_1 and u_3 is rejected in about half of the periods for the two demand variables. For these periods we may conclude that either the unbiasedness property is violated or firms are subjects to common shocks.

The overall conclusion is, as for the price variables, not clear-cut but goes in direction of rejecting that expectations, concerning demand from domestic and export markets, are formed in accordance with the REH. The basis for this conclusion is stronger than for the price-expectations.

8. Conclusions

As mentioned in section 5 the quality of the data analyzed can be discussed. The reader should also bear in mind that the unbiasedness property may errouneously be rejected due to firms being confronted with a common shock. The findings presented in this paper must therefore be treated with some caution.

However, the results (summarized in table V) do not give a strong support to the REH. A first glance at table I, which reveals a strong tendency for the data to concentrate in the "no revision"-category, could give the opposite conclusion. But as shown by formal tests, for those firms who give an incorrect prediction there is a tendency in half of the periods for this error to be systematic. This error appears in some fewer periods for the two price variables than for the demand variables. The reason for this difference may be that some of the firms in fact are price-setters and by then control their prices.

Further, the hypothesis of no association between the correction term on the one hand and previous changes in the variable on the other hand are rejected for all four variables in more than 3/4 of the periods when running the LR-test, indicating both the efficiency- and unbiasedness property to be violated. The ϕ^2-test leads to rejection in fewer periods. The association between the correction term and perceived previous changes, when found, is neither positive nor negative for the two price variables. The association is positive for the demand variables, showing a tendency to underpredict future demand if the demand increased in the previous period. This may be due to firms forming expectations in accordance with the regressive expectations-model.

Most of the tests reject the REH in more periods when conducted on the domestic- than on the export market. This is the opposite of what I would have expected since one should assume firms have a better view of the situation at home than abroad.

One main weakness with the different tests presented in this paper is the lack of a specified alternative hypothesis. Unfortunately do not tests of different expectations hypothesis nest each other (except the adaptive and the pure extrapolative scheme). The results presented here are however just part of a project in which tests of extrapolative hypotheses will be included later.

APPENDIX I: Tables VI - XIII

Table VI: The efficiency-test - domestic-prices
H_0: $u_{s,k}=0$ vs. H_1: $u_{s,k}\neq0$

Period	Tests for nominal association			Tests for ordinal association				
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
74.1	2.16*	3.20	13.72**	-0.98**	-115.18	13.61**	-0.06	-0.33
74.2	0.02	0.41	2.08	0.06	0.17	1.30	0.17	0.88
74.3	1.17**	9.55	7.98	0.14	0.34	7.32	0.14	0.81
74.4	0.07	0.87	4.39	0.23	1.18	2.59	0.22	1.34
75.1	0.01	0.48	1.33	-0.07	-0.47	1.02	-0.08	-0.56
75.2	0.01	0.62	1.91	0.10	0.87	0.44	0.14	1.21
75.3	0.06*	1.98	19.84**	-0.16	-1.54	17.73**	-0.18	-1.45
75.4	0.05*	2.18	19.11**	0.01	0.09	19.00**	0.04	0.33
76.1	0.04	0.91	4.24	-0.25	-1.76	1.69	-0.26	-1.59
76.2	0.11**	2.74	27.00**	0.09	0.78	25.51**	0.15	1.22
76.3	0.05	1.69	14.24**	0.02	0.15	13.01**	0.16	1.11
76.4	0.03	1.35	10.72*	0.00	0.02	9.10*	0.18	1.27
77.1	0.03	1.76	11.79*	0.08	0.58	9.62*	0.22	1.47
77.2	0.13	1.84	24.58**	0.43**	3.36	4.99	0.63**	4.30
77.3	0.09	1.88	28.25**	0.28*	2.02	23.52**	0.34*	2.16
77.4	0.07*	2.44	21.12**	0.02	0.16	20.64**	0.12	0.69
78.1	0.06*	2.14	20.15**	-0.07	-0.59	19.65**	-0.11	-0.71
78.2	0.14**	3.35	34.78**	0.01	0.04	34.40**	0.10	0.62
78.3	0.06	1.72	14.96**	-0.12	-0.72	14.34**	-0.16	-0.79
78.4	0.20**	3.31	42.53**	0.03	0.17	41.78**	0.21	0.87
79.1	0.11	1.40	14.29**	0.26	1.20	13.02**	0.33	1.13
79.2	0.12	1.06	13.57**	-0.34	-1.45	12.79**	-0.23	-0.88
79.3	0.11	1.27	12.95*	-0.17	-0.58	12.57**	0.17	0.61
79.4	0.19	1.44	14.16**	-0.16	-0.55	13.35**	0.21	0.90
80.1	0.13	1.75	14.53**	0.23	1.31	8.76*	0.40*	2.38
80.2	0.03	0.74	4.18	-0.12	-0.63	4.15	0.02	0.17
80.3	0.05	0.99	9.49*	0.22	1.19	2.22	0.38**	2.67
80.4	0.09	1.83	19.46**	0.13	0.91	13.81**	0.33*	2.36
81.1	0.06	1.41	11.15*	0.10	0.47	6.70	0.35*	2.09

Table VI: The efficiency-test - domestic-prices
H_0: $u_{s,k}=0$ vs. H_1: $u_{s,k}\neq 0$

Period	Tests for nominal association			Tests for ordinal association				
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
81.2	0.04	1.14	10.37*	-0.04	-0.21	8.01*	0.24	1.53
81.3	0.07	1.89	20.25**	0.04	0.22	16.59**	0.32	1.90
81.4	0.06	0.80	4.13	0.22	1.07	3.45	0.15	0.83
82.1	0.06	1.89	13.68**	0.05	0.31	11.96**	0.25	1.31
87.4	0.14*	1.97	17.38**	-0.07	-0.42	17.11**	0.09	0.52
88.1	0.06	1.84	13.44**	0.11	0.65	8.81*	0.38*	2.13
88.2	1.50**	6.75	17.06**	0.96**	87.82	6.68	0.62**	3.15
88.3	0.11*	2.33	22.34**	0.17	1.04	19.85**	0.34	1.57
88.4	0.17**	2.81	30.86**	-0.09	-0.56	30.72**	-0.07	-0.37
89.1	0.13*	2.00	20.28**	0.36*	2.49	11.02**	0.57**	2.99
89.2	0.06	1.54	9.86*	0.09	0.57	8.00*	0.22	1.36
89.3	0.12*	2.27	21.08**	-0.07	-0.39	21.08**	0.01	0.06
89.4	0.06	1.39	7.84	0.08	0.42	7.53	0.14	0.56
90.1	0.06	1.72	12.36*	0.14	0.85	11.29**	0.21	1.03
90.2	0.08	1.66	13.57**	0.26	1.67	8.16*	0.42*	2.30
90.3	0.18	1.54	16.48**	0.45*	2.50	6.68	0.77**	3.08
90.4	0.08	1.40	12.37*	0.25	1.44	9.75*	0.36	1.61

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(3)=7.81$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(3)=11.34$ and $X^2_{.01}(4)=13.28$

Table VII: Cross-restrictions and unbiasedness-domestic prices

Period	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq0$			H_0:no ass.	H_0: $u_1=u_3$	Parameter-values		
	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
74.1	1.27	0.15	0.00	179.27**	1.13	-0.42**	1.05**	-0.63
74.2	0.02	0.02	8.42	160.00**	0.68	-0.42**	0.99**	-0.57
74.3	4.58	0.05	5.17	136.66**	2.23	-0.63**	1.00**	-0.37
74.4	0.01	0.36	0.70	114.14**	0.78	-0.43**	1.02**	-0.59
75.1	1.82*	2.21	4.33	130.77**	1.98	-0.53**	0.82**	-0.29
75.2	0.05	0.88	6.25	127.72**	2.97	-0.58**	0.89**	-0.31
75.3	0.01	0.58	2.10	161.63**	2.37	-0.58**	0.92**	-0.34
75.4	0.05	0.90	7.80	184.85**	0.24	-0.48**	1.03**	-0.55
76.1	0.03	0.75	5.27	156.63**	1.68	-0.39**	0.99**	-0.60
76.2	0.03	0.83	5.09	176.76**	0.46	-0.54**	0.98**	-0.44
76.3	2.32	0.03	7.16	192.02**	19.62**	-0.85**	0.99**	-0.14
76.4	0.13	1.35	15.14**	123.94**	1.86	-0.65**	1.07**	-0.43
77.1	0.02	0.60	4.65	156.44**	1.50	-0.58**	0.98**	-0.39
77.2	1.59	0.03	11.15*	141.56**	3.72	-0.75**	1.16**	-0.42
77.3	2.09	0.03	6.78	169.58**	9.79**	-0.81**	1.11**	-0.30
77.4	0.04	0.90	7.45	124.55**	6.51*	-0.85**	1.24**	-0.40
78.1	2.09	0.02	5.41	222.43**	18.58**	-0.86**	1.02**	-0.16
78.2	0.02	1.28	7.43	161.49**	1.05	-0.74**	1.29**	-0.55
78.3	0.01	0.40	2.10	227.32**	5.85*	-0.85**	1.27**	-0.42
78.4	1.29	0.51	12.75*	166.36**	7.77**	-1.09**	1.57**	-0.48
79.1	2.00	1.95	3.22	91.17**	7.78**	-0.43**	1.45**	-1.02
79.2	2.33	0.02	2.72	134.12**	3.69	-0.61**	1.67**	-1.06
79.3	2.05	1.92	5.03	144.81**	2.56	-0.61**	1.56**	-0.95
79.4	1.98	0.03	9.77*	141.08**	5.17*	-0.44**	1.31**	-0.87
80.1	0.02	0.65	5.20	179.18**	0.86	-0.55**	0.97**	-0.41

Table VII: Cross-restrictions and unbiasedness-domestic prices

Period	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq 0$			H_0:no ass.	H_0: $u_1=u_3$	Parameter-values		
	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
80.2	2.29	0.02	2.81	163.73**	8.66**	-0.21*	0.90**	-0.69
80.3	0.01	0.42	5.44	175.08**	1.48	-0.33**	0.85**	-0.52
80.4	0.02	0.97	7.87	210.20**	7.34**	-0.24**	0.89**	-0.66
81.1	1.94	0.02	4.40	134.96**	5.30*	-0.71**	1.02**	-0.32
81.2	0.04	0.77	8.32	130.11**	10.94**	-0.27**	1.16**	-0.89
81.3	2.04	0.03	8.39	184.53**	4.64*	-0.72**	1.07**	-0.35
81.4	1.42	0.04	2.74	165.36**	0.64	-0.50**	1.13**	-0.64
82.1	0.03	0.71	3.33	114.77**	11.57**	-0.85**	1.08**	-0.23
87.4	2.68	0.02	8.88	137.34**	0.29	-0.47**	1.04**	-0.57
88.1	0.02	0.63	8.25	125.54**	2.48	-0.60**	0.92**	-0.32
88.2	0.02	0.58	2.48	97.15**	3.63	-0.85**	1.28**	-0.43
88.3	0.01	0.47	2.12	82.84**	0.26	-0.66**	1.20**	-0.55
88.4	0.03	0.66	3.68	93.46**	1.08	-0.71**	1.20**	-0.49
89.1	2.65	0.03	12.46*	88.71**	5.06*	-0.74**	1.04**	-0.30
89.2	2.23	0.03	8.42	93.09**	0.04	-0.57**	1.18**	-0.61
89.3	0.03	0.93	4.78	161.03**	3.99*	-0.85**	1.27**	-0.42
89.4	2.19	0.02	1.99	80.56**	0.28	-0.67**	1.23**	-0.56
90.1	0.02	1.07	6.81	96.36**	3.53	-0.67**	0.98**	-0.31
90.2	1.85	0.02	5.47	99.10**	0.19	-0.68**	1.26**	-0.58
90.3	0.06	1.12	6.97	113.62**	9.49**	-0.99**	1.27**	-0.28
90.4	0.01	0.62	2.19	113.01**	0.26	-0.64**	1.17**	-0.53

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(1)=3.84$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(1)=6.63$ and $X^2_{.01}(4)=13.28$
1) u_3 is calculated from the restriction on the sum over the u-parameters.

Table VIII: The efficiency-test - export-prices
H_0: $u_{s,k}=0$ vs. H_1: $u_{s,k}\neq0$

Period	Tests for nominal association			Tests for ordinal association				
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
74.1	0.33	1.52	14.67**	-0.41	-1.89	12.68**	-0.26	-1.40
74.2	0.09	0.79	3.93	-0.30	-1.27	1.55	-0.29	-1.53
74.3	0.14	1.75	11.24*	-0.01	-0.06	11.24*	-0.01	-0.06
74.4	0.06	1.09	7.43	0.13	0.79	7.09	-0.09	-0.58
75.1	0.02	0.83	3.17	-0.09	-0.59	1.62	-0.18	-1.24
75.2	0.03	1.26	8.26	0.18	1.59	5.94	0.18	1.52
75.3	0.04	1.86	17.06**	-0.08	-0.72	16.55**	-0.09	-0.72
75.4	0.04	1.76	14.08**	0.07	0.56	14.01**	0.04	0.27
76.1	0.02	1.23	6.03	-0.01	-0.09	6.00	-0.03	-0.18
76.2	0.03	1.80	11.33*	0.07	0.68	10.37*	0.11	0.98
76.3	0.04	1.68	11.75*	0.05	0.41	11.01*	0.12	0.86
76.4	0.08	1.93	17.79**	-0.11	-0.86	17.59**	-0.06	-0.44
77.1	0.05	1.59	12.04*	0.14	1.21	10.78*	0.15	1.12
77.2	0.05	1.88	12.86*	0.04	0.35	11.95**	0.12	0.96
77.3	0.19	1.88	23.01**	0.39**	2.89	17.64**	0.37*	2.30
77.4	0.05	1.54	16.20**	0.18	1.28	11.81**	0.32*	2.08
78.1	0.04	1.29	11.43*	-0.19	-1.39	8.69*	-0.25	-1.65
78.2	0.07*	2.11	16.34**	-0.03	-0.19	16.34**	0.00	0.00
78.3	0.10*	2.27	22.92**	0.18	1.10	21.95**	0.20	0.98
78.4	0.11*	2.09	23.27**	-0.18	-1.18	22.20**	-0.20	-1.03
79.1	0.13*	2.13	27.33**	-0.15	-0.92	27.33**	0.01	0.06
79.2	0.06	1.24	12.45*	-0.16	-0.81	12.44**	0.02	0.12
79.3	0.16*	2.35	39.35**	0.32	1.56	15.21**	0.95**	4.70
79.4	0.36*	1.99	28.75**	0.16	0.81	23.87**	0.40*	2.19
80.1	0.06	0.89	13.33**	0.21	0.86	6.37	0.45**	2.60
80.2	0.08	1.17	7.96	-0.06	-0.31	7.95*	0.01	0.08
80.3	0.04	1.13	7.02	-0.07	-0.44	6.96	-0.04	-0.23
80.4	0.05	1.21	7.82	-0.17	-1.23	6.98	-0.14	-0.92
81.1	0.12*	2.27	25.03**	-0.18	-1.41	23.86**	-0.16	-1.08
81.2	0.07*	2.24	16.18**	0.07	0.51	14.82**	0.18	1.16

Table VIII: The efficiency-test - export-prices
H_0: $u_{s,k}=0$ vs. H_1: $u_{s,k}\neq 0$

	Tests for nominal association			Tests for ordinal association				
Period	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
81.3	0.12*	2.40	23.39**	0.29*	2.03	14.18**	0.55**	2.98
81.4	0.03	1.12	8.35	0.14	0.92	7.52	0.15	0.91
82.1	0.06	1.88	13.81**	0.06	0.39	12.66**	0.19	1.07
87.4	0.09	1.75	12.45*	-0.04	-0.21	12.45**	-0.00	-0.02
88.1	0.61	1.90	27.58**	0.78**	6.40	1.50	1.33**	4.89
88.2	0.15	1.04	7.72	0.40	1.93	4.98	0.34	1.64
88.3	0.18	1.86	21.02**	0.40*	2.33	13.77**	0.65**	2.66
88.4	0.27*	2.97	37.68**	-0.06	-0.37	37.43**	-0.10	-0.50
89.1	0.13*	2.05	20.48**	0.26	1.63	15.57**	0.45*	2.19
89.2	0.03	1.15	6.81	0.08	0.37	5.05	0.26	1.32
89.3	0.14*	2.24	23.68**	0.20	1.15	21.15**	0.38	1.58
89.4	0.23**	2.84	35.18**	0.30	1.64	26.87**	0.74**	2.84
90.1	0.09*	2.30	16.92**	0.08	0.45	16.35**	0.16	0.75
90.2	0.04	1.36	7.92	0.15	0.90	5.87	0.26	1.42
90.3	0.07	1.59	12.32*	-0.05	-0.27	12.17**	-0.09	-0.39
90.4	0.22	1.72	18.87**	0.52**	3.53	4.65	0.86**	3.66

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(3)=7.81$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(3)=11.34$ and $X^2_{.01}(4)=13.28$

Table IX: Cross restrictions and unbiasedness - export prices

Period	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq 0$			H_0:no ass.	H_0: $u_1=u_3$	Parameter-values		
	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 [1)]
74.1	0.09	0.96	5.25	173.85**	2.40	-0.35**	1.02**	-0.67
74.2	0.03	0.77	2.57	126.04**	0.92	-0.36**	0.91**	-0.55
74.3	2.90	0.02	7.26	108.27**	1.09	-0.58**	0.96**	-0.38
74.4	0.03	1.03	5.89	80.54**	1.01	-0.54**	0.90**	-0.36
75.1	1.62*	2.15	5.83	87.18**	11.61**	-0.75**	0.84**	-0.09
75.2	1.56*	2.16	7.26	82.49**	13.71**	-0.80**	0.92**	-0.13
75.3	0.03	0.99	5.01	122.41**	5.33*	-0.69**	0.98**	-0.29
75.4	0.03	1.00	6.70	141.89**	0.86	-0.39**	0.93**	-0.54
76.1	0.03	1.23	7.30	107.99**	0.42	-0.44**	0.78**	-0.34
76.2	0.02	1.00	5.29	154.39**	0.21	-0.43**	0.78**	-0.36
76.3	2.32	0.02	3.80	136.06**	16.53**	-0.82**	0.93**	-0.11
76.4	2.77	0.03	12.59*	110.15**	10.10**	-0.75**	0.95**	-0.20
77.1	0.01	0.72	5.86	138.51**	3.19	-0.54**	0.79**	-0.26
77.2	0.02	1.09	9.65*	151.58**	5.57*	-0.65**	0.91**	-0.26
77.3	2.05	0.02	13.64*	94.83**	23.71**	-0.98**	1.05**	-0.08
77.4	0.00	0.36	1.03	118.24**	13.39**	-0.87**	1.06**	-0.20
78.1	0.01	0.59	3.72	132.29**	1.75	-0.57**	0.92**	-0.35
78.2	0.04	0.97	9.62*	156.12**	1.26	-0.65**	1.09**	-0.44
78.3	2.33	0.02	5.05	128.09**	1.05	-0.67**	1.15**	-0.48
78.4	0.06	0.15	-	143.17**	0.58	-0.67**	1.19**	-0.52
79.1	2.44	0.03	7.78	123.94**	0.19	-0.46**	0.99**	-0.53
79.2	2.31	0.03	5.76	131.30**	16.08**	-0.19*	1.20**	-1.00
79.3	0.06	0.95	17.61**	122.16**	2.35	-0.44**	1.19**	-0.74
79.4	2.12	0.03	8.55	146.20**	8.81**	-0.26**	1.06**	-0.80
80.1	0.01	0.62	7.33	159.69**	5.68*	-0.28**	0.97**	-0.69
80.2	0.02	0.71	4.04	121.99**	0.01	-0.43**	0.88**	-0.45
80.3	0.05	0.79	3.52	94.35**	2.82	-0.62**	0.94**	-0.32
80.4	0.02	0.90	4.50	129.03**	0.03	-0.53**	1.04**	-0.50
81.1	0.06	1.05	8.43	128.37**	4.07*	-0.60**	0.85**	-0.25
81.2	2.28	0.03	8.68	91.40**	0.48	-0.64**	1.14**	-0.50

Table IX: Cross restrictions and unbiasedness - export prices

Period	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq 0$			H_0:no ass.	H_0: $u_1=u_3$	Parameter-values		
	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
81.3	0.04	0.94	7.73	98.44**	10.78**	-0.82**	1.01**	-0.19
81.4	0.01	0.41	0.93	123.23**	1.63	-0.69**	1.13**	-0.44
82.1	0.01	0.47	1.66	86.84**	19.83**	-0.94**	1.00**	-0.06
87.4	0.01	0.49	1.49	118.26**	2.16	-0.72**	1.12**	-0.41
88.1	0.07	0.95	10.02*	59.30**	2.17	-0.76**	1.18**	-0.42
88.2	2.55	0.02	5.67	81.29**	2.10	-0.82**	1.29**	-0.47
88.3	2.50	0.37	9.08	62.72**	1.10	-0.50**	1.24**	-0.75
88.4	1.57*	1.97	9.16	81.68**	2.75	-0.37**	1.11**	-0.74
89.1	2.96	0.02	11.91*	91.61**	0.01	-0.49**	1.00**	-0.51
89.2	2.07	0.02	3.64	96.43**	0.18	-0.55**	1.02**	-0.46
89.3	0.02	0.56	2.00	97.32**	0.32	-0.52**	1.17**	-0.65
89.4	0.03	0.83	5.23	59.75**	0.22	-0.65**	1.19**	-0.54
90.1	0.04	1.10	7.26	74.02**	4.56*	-0.68**	0.91**	-0.23
90.2	0.03	0.93	9.73	103.98**	0.76	-0.44**	1.07**	-0.63
90.3	0.02	0.96	4.32	82.14**	7.31**	-0.92**	1.18**	-0.27
90.4	0.02	0.73	5.54	80.99**	5.63*	-0.81**	1.09**	-0.28

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(1)=3.84$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(1)=6.63$ and $X^2_{.01}(4)=13.28$
1) u_3 is calculated from the restrictions on the sum over the u-parameters.

Table X: The efficiency-test - domestic-demand
H_0: $u_{s,k}=0$ vs. H_1: $u_{s,k}\neq 0$

Period	Tests for nominal association			Tests for ordinal association					
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
74.1	0.06	1.49	13.94**	0.19	1.49	9.80*	0.26*	2.02
74.2	0.07*	2.33	26.63**	0.20*	2.10	22.39**	0.22*	2.05
74.3	0.15**	2.82	41.78**	0.42**	4.65	16.21**	0.58**	4.85
74.4	0.02	1.15	6.67	0.16	1.70	3.32	0.20	1.82
75.1	0.06	1.87	14.65**	0.16	1.70	11.79**	0.18	1.68
75.2	0.02	1.01	4.19	0.16*	2.02	0.66	0.17	1.87
75.3	0.07*	2.16	20.57**	0.29**	3.80	8.58*	0.31**	3.41
75.4	0.06*	2.20	21.57**	0.22**	2.72	10.80*	0.30**	3.24
76.1	0.08*	2.36	27.36**	0.30**	3.81	13.05**	0.35**	3.72
76.2	0.07**	2.61	31.71**	0.29**	4.22	13.04**	0.36**	4.23
76.3	0.09**	2.64	34.06**	0.32**	4.13	12.96**	0.43**	4.48
76.4	0.10*	2.33	27.47**	0.38**	4.72	4.93	0.48**	4.61
77.1	0.03	1.64	14.31**	0.19*	2.29	7.92*	0.24*	2.51
77.2	0.05	1.94	19.01**	0.20*	2.41	12.29**	0.25*	2.57
77.3	0.06*	2.32	27.18**	0.22**	2.80	19.69**	0.25**	2.71
77.4	0.03	1.69	14.51**	0.19*	2.26	8.84*	0.23*	2.37
78.1	0.05*	2.05	20.17**	0.22**	2.83	11.73**	0.26**	2.88
78.2	0.10*	2.32	25.62**	0.38**	4.70	4.33	0.47**	4.49
78.3	0.05	1.68	12.19*	0.27**	3.46	0.86	0.32**	3.32
78.4	0.04	1.49	11.27*	0.21*	2.39	5.24	0.25*	2.44
79.1	0.08*	1.98	20.82**	0.29**	3.19	13.33**	0.29**	2.71
79.2	0.04*	2.11	20.41**	0.12	1.41	17.52**	0.17	1.69
79.3	0.12**	2.90	43.74**	0.36**	4.44	22.28**	0.46**	4.51
79.4	0.07*	2.08	24.25**	0.25**	2.77	14.80**	0.32**	3.04
80.1	0.04	1.31	15.55**	0.22*	1.99	6.46	0.34**	2.98
80.2	0.21**	3.26	57.52**	0.50**	5.99	21.21**	0.71**	5.70
80.3	0.03	1.63	11.86*	0.14	1.42	9.18*	0.18	1.63
80.4	0.03	1.51	12.05*	0.18	1.93	7.62	0.22*	2.09
81.1	0.07*	1.99	18.45**	0.34**	4.17	0.86	0.42**	4.09
81.2	0.14**	2.74	42.69**	0.43**	5.29	12.24**	0.57**	5.30

Table X: The efficiency-test - domestic-demand
H_0: $u_{s,k}=0$ vs. H_1: $u_{s,k}\neq0$

Period	Tests for nominal association			Tests for ordinal association				
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
81.3	0.04*	2.04	19.86**	0.16	1.95	15.33**	0.21*	2.12
81.4	0.11*	2.43	28.41**	0.38*	4.65	6.80	0.49**	4.51
82.1	0.04	1.45	9.69*	0.21*	2.34	4.06	0.25*	2.35
87.4	0.10*	2.43	28.92**	0.34**	3.81	12.93**	0.45**	3.89
88.1	0.02	1.27	7.15	0.09	0.90	5.97	0.12	1.08
88.2	0.08	1.86	19.52**	0.28**	2.77	11.96**	0.31**	2.72
88.3	0.05	1.90	18.92**	0.09	0.96	17.84**	0.11	1.03
88.4	0.01	1.02	5.88	0.11	1.04	3.31	0.18	1.60
89.1	0.07	1.65	12.40*	0.34**	3.53	1.07	0.39**	3.30
89.2	0.09*	2.22	24.01**	0.27**	2.95	15.40**	0.30**	2.89
89.3	0.06	1.79	15.78**	0.23*	2.37	10.18*	0.27*	2.34
89.4	0.05	1.84	16.64**	0.20	1.95	12.04**	0.25*	2.13
90.1	0.04	1.47	10.16*	0.25**	2.63	2.79	0.30**	2.68
90.2	0.06	1.75	15.13**	0.26*	2.52	8.65*	0.31*	2.51
90.3	0.03	1.41	9.49*	0.16	1.63	6.27	0.21	1.78
90.4	0.09*	2.00	20.19**	0.33**	3.38	8.24*	0.42**	3.38

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(3)=7.81$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(3)=11.34$ and $X^2_{.01}(4)=13.28$

Table XI: Cross restrictions and unbiasedness - domestic demand

Period	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq 0$			H_0:no ass.	H_0:$u_1=u_3$	Parameter-values		
	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
74.1	0.01	0.91	5.17	117.82**	10.16**	-0.04	0.59**	-0.55
74.2	0.01	1.09	5.00	125.10**	5.12*	-0.48**	0.62**	-0.14
74.3	0.04*	2.33	23.05**	119.34**	9.12**	-0.56**	0.66**	-0.10
74.4	0.00	0.78	2.71	119.79**	5.06*	-0.53**	0.72**	-0.19
75.1	0.02*	2.26	21.69**	127.40**	1.14	-0.40**	0.64**	-0.24
75.2	0.01	1.12	5.57	152.24**	3.53	-0.36**	0.48**	-0.12
75.3	0.01	1.48	9.22	164.33**	2.72	-0.41**	0.60**	-0.19
75.4	0.01	1.49	9.34	141.05**	0.02	-0.32**	0.66**	-0.34
76.1	0.01	1.53	10.02*	137.17**	15.29**	-0.02	0.57**	-0.55
76.2	0.02	1.77	14.92**	190.66**	0.30	-0.24**	0.55**	-0.31
76.3	0.03*	2.14	19.16**	181.48**	0.00	-0.32**	0.64**	-0.31
76.4	0.02	1.68	12.54**	159.86**	0.00	-0.36**	0.72**	-0.36
77.1	0.01	1.42	8.82	159.97**	11.65**	-0.10	0.66**	-0.56
77.2	0.01	1.43	9.02	129.34**	0.17	-0.34**	0.74**	-0.40
77.3	0.01	1.08	4.81	187.46**	0.59	-0.38**	0.66**	-0.28
77.4	0.00	0.77	2.53	123.52**	0.27	-0.31**	0.69**	-0.38
78.1	0.01	1.35	7.99	184.57**	5.92*	-0.17*	0.65**	-0.49
78.2	0.01	1.57	10.62*	122.86**	4.71*	-0.50**	0.70**	-0.20
78.3	0.01	1.40	8.17	163.19**	0.02	-0.37**	0.75**	-0.38
78.4	0.01	1.30	6.92	139.45**	7.72**	-0.59**	0.79**	-0.20
79.1	0.01	1.05	5.15	130.85**	9.52**	-0.15*	0.76**	-0.60
79.2	0.00	0.85	3.38	163.78**	3.89*	-0.24**	0.75**	-0.51
79.3	0.02	1.76	13.38**	172.09**	3.33	-0.20**	0.64**	-0.44
79.4	0.01	1.46	9.32	206.33**	27.82**	0.02	0.72**	-0.73
80.1	0.01	0.93	3.96	133.32**	32.55**	0.04	0.78**	-0.82
80.2	0.04*	2.05	18.35**	119.38**	2.54	-0.51**	0.77**	-0.26
80.3	0.01	1.48	9.22	143.64**	1.76	-0.50**	0.80**	-0.30
80.4	0.01	0.99	4.08	129.36**	0.83	-0.42**	0.71**	-0.29
81.1	0.02*	2.02	19.17**	154.85**	9.82**	-0.54**	0.64**	-0.10
81.2	0.04*	2.03	20.13**	142.81**	9.56**	-0.51**	0.59**	-0.08

Table XI: Cross restrictions and unbiasedness - domestic demand								
	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq0$			H_0:no ass.	H_0:$u_1=u_3$	Parameter-values		
Period	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
81.3	0.01	1.40	8.20	176.29**	0.22	-0.34**	0.62**	-0.28
81.4	0.02	1.74	12.76*	131.65**	3.97*	-0.50**	0.71**	-0.21
82.1	0.02	1.50	10.67*	136.36**	2.05	-0.44**	0.68**	-0.23
87.4	0.03	1.87	15.01**	143.41**	1.86	-0.44**	0.67**	-0.23
88.1	0.01	0.84	2.99	120.86**	0.48	-0.36**	0.62**	-0.26
88.2	0.02	1.40	8.26	89.38**	33.96**	-0.88**	0.72**	0.16
88.3	0.01	1.09	5.12	146.36**	21.42**	-0.68**	0.61**	0.07
88.4	0.00	0.43	0.88	113.98**	17.83**	-0.59**	0.52**	0.07
89.1	0.02	1.59	10.68*	128.14**	9.84**	-0.62**	0.71**	-0.09
89.2	0.03	1.52	10.02*	126.02**	3.18	-0.37**	0.47**	-0.10
89.3	0.01	1.31	7.00	108.25**	7.86**	-0.59**	0.71**	-0.12
89.4	0.00	0.71	2.12	107.15**	0.82	-0.29**	0.74**	-0.44
90.1	0.02	1.55	10.04*	140.49**	3.26	-0.15	0.59**	-0.44
90.2	0.01	1.10	5.01	89.45**	2.76	-0.51**	0.73**	-0.23
90.3	0.01	1.06	4.54	119.34**	4.48*	-0.47**	0.59**	-0.13
90.4	0.03	1.67	11.52*	122.57**	0.63	-0.39**	0.64**	-0.26

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(1)=3.84$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(1)=6.63$ and $X^2_{.01}(4)=13.28$
1) u_3 is calculated from the restriction on the sum over the u-parameters.

Table XII: The efficiency-test - demand from export markets
H_0: u_{sk}=0 vs. H_1: $u_{sk}\neq 0$

Period	Tests for nominal association			Tests for ordinal association				
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
74.1	0.01	0.89	3.10	-0.04	-0.31	2.58	-0.09	-0.72
74.2	0.17**	2.66	37.67**	0.35**	3.62	24.04**	0.43**	3.59
74.3	0.04	1.55	12.62*	0.14	1.20	10.60**	0.18	1.41
74.4	0.05	1.17	5.94	0.26*	2.38	1.14	0.28*	2.17
75.1	0.16	1.95	16.79**	0.38**	3.82	8.34*	0.36**	2.86
75.2	0.04	1.39	7.64	-0.02	-0.21	7.55	-0.03	-0.30
75.3	0.02	1.23	6.32	0.11	1.12	3.99	0.16	1.52
75.4	0.08	1.89	22.65**	0.30**	3.00	17.52**	0.22*	2.25
76.1	0.09*	2.16	25.01**	0.30**	3.36	16.73**	0.28**	2.84
76.2	0.04	1.69	12.32*	0.20**	2.61	4.99	0.24**	2.68
76.3	0.03	1.70	12.34*	0.12	1.40	9.13*	0.17	1.78
76.4	0.05*	1.96	19.33**	0.20*	2.22	12.59**	0.26*	2.57
77.1	0.01	0.94	3.77	0.11	1.35	2.20	0.12	1.25
77.2	0.04	1.73	15.89**	0.19*	2.21	9.79*	0.24*	2.45
77.3	0.15**	2.76	39.08**	0.36**	4.11	23.09**	0.44**	3.90
77.4	0.03	1.34	9.57*	0.08	0.81	9.04*	0.08	0.73
78.1	0.02	1.21	7.56	0.08	0.83	7.12	0.07	0.66
78.2	0.08*	2.07	23.89**	0.30**	3.08	14.02**	0.35**	3.09
78.3	0.06*	2.01	19.15**	0.23**	2.62	12.81**	0.25*	2.49
78.4	0.05	1.56	10.73*	0.25**	2.78	3.80	0.28**	2.60
79.1	0.08*	2.10	20.60**	0.33**	3.77	6.29	0.40**	3.70
79.2	0.02	1.24	7.43	0.15	1.68	4.50	0.17	1.70
79.3	0.12**	2.68	37.22**	0.34**	3.73	19.70*	0.46**	4.07
79.4	0.07*	2.28	26.34**	0.18	1.83	21.90**	0.23*	2.09
80.1	0.07	1.72	16.54**	0.30**	3.01	4.17	0.41**	3.45
80.2	0.06	1.95	16.94**	0.23*	2.16	10.29**	0.32*	2.54
80.3	0.04	1.29	7.29	0.16	1.48	5.66	0.16	1.28
80.4	0.03	1.12	6.34	0.11	0.96	5.70	0.10	0.80
81.1	0.07	1.66	13.82**	0.26*	2.52	8.45*	0.27	2.30
81.2	0.17**	2.58	34.11**	0.44**	5.00	12.42**	0.52**	4.49

Table XII: The efficiency-test - demand from export markets
H_0: $u_{sk}=0$ vs. H_1: $u_{sk}\neq0$

Period	Tests for nominal association			Tests for ordinal association				
	ϕ^2	t-value	$X^2(4)$	γ	t-value	$X^2(3)$	Beta	t-value
81.3	0.05	1.46	11.00*	0.28**	2.77	2.56	0.34**	2.86
81.4	0.12*	2.21	24.34**	0.40**	4.34	9.42*	0.43**	3.77
82.1	0.02	1.07	5.06	0.13	1.38	3.55	0.13	1.23
87.4	0.11*	2.17	23.90**	0.36**	3.54	10.45**	0.47**	3.57
88.1	0.07	1.92	16.20**	0.15	1.31	14.00**	0.19	1.48
88.2	0.07	1.66	13.65**	0.29**	2.75	5.87	0.35**	2.74
88.3	0.04	1.60	11.82*	0.14	1.34	9.72*	0.18	1.44
88.4	0.08*	1.97	18.82**	0.25*	2.29	12.28**	0.33*	2.52
89.1	0.07	1.78	16.24**	0.23*	1.99	11.60**	0.30*	2.13
89.2	0.06	1.70	14.25**	0.18	1.58	11.39**	0.22	1.68
89.3	0.06	1.85	15.72**	0.18	1.50	12.51**	0.25	1.78
89.4	0.06	1.34	9.32	0.27*	2.25	4.26	0.31*	2.22
90.1	0.06	1.69	14.10**	0.16	1.33	12.58**	0.17	1.23
90.2	0.12	1.86	16.24**	0.41**	3.95	3.43	0.46**	3.48
90.3	0.07	1.69	15.23**	0.27*	2.46	10.01**	0.28*	2.26
90.4	0.10*	2.01	19.73**	0.31**	2.85	10.65**	0.39**	2.95

*: Rejection on a 95%-level. Critical values: $t_{.025}=1.96$, $X^2_{.05}(3)=7.81$ and $X^2_{.05}(4)=9.49$
**: Rejection on a 99%-level. Critical values: $t_{.005}=2.576$, $X^2_{.01}(3)=11.34$ and $X^2_{.01}(4)=13.28$

Table XIII: Cross-restrictions and unbiasedness - demand from export market

Period	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}=0$ vs. H_1: $u_{m,k,d}\neq0$			H_0:no ass.	H_0: $u_1=u_3$	Parameter-values		
	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
74.1	0.01	1.51	9.62*	108.52**	1.53	-0.17	0.54**	-0.37
74.2	0.04	1.89	15.82**	115.16**	3.53	-0.50**	0.68**	-0.18
74.3	0.01	1.12	5.58	122.96**	14.86**	-0.71**	0.73**	-0.03
74.4	0.01	1.08	5.30	100.76**	14.99**	-0.69**	0.71**	-0.02
75.1	0.03*	1.98	16.07**	156.95**	29.82**	-0.92**	0.77**	0.15
75.2	0.00	0.46	0.91	189.86**	24.63**	-0.64**	0.53**	0.12
75.3	0.00	0.64	1.82	180.06**	12.78**	-0.55**	0.57**	-0.02
75.4	0.01	0.83	3.44	139.10**	1.24	-0.19*	0.53**	-0.34
76.1	0.01	1.11	5.08	100.13**	19.85**	0.09	0.46**	-0.55
76.2	0.02	1.64	12.95*	125.51**	1.07	-0.36**	0.58**	-0.22
76.3	0.01	0.90	3.43	159.68**	20.15**	-0.56**	0.49**	0.07
76.4	0.00	0.78	2.46	113.48**	17.91**	-0.60**	0.58**	0.02
77.1	0.01	1.15	5.48	124.04**	0.40	-0.33**	0.57**	-0.24
77.2	0.01	1.15	6.20	113.62**	15.55**	-0.60**	0.62**	-0.02
77.3	0.03	1.59	10.61*	128.96**	17.47**	-0.69**	0.74**	-0.05
77.4	0.00	0.45	0.94	135.56**	10.30**	-0.57**	0.67**	-0.10
78.1	0.01	1.11	5.11	140.94**	0.45	-0.41**	0.72**	-0.31
78.2	0.01	0.85	3.05	106.55**	1.43	-0.40**	0.62**	-0.22
78.3	0.02	1.56	10.95*	112.47**	0.00	-0.31**	0.63**	-0.31
78.4	0.02	1.45	9.84*	104.40**	0.05	-0.35**	0.66**	-0.31
79.1	0.01	1.33	7.41	108.21**	2.59	-0.17*	0.57**	-0.41
79.2	0.01	1.11	5.62	120.60**	6.95**	-0.13	0.67**	-0.53
79.3	0.02	1.67	11.69*	136.62**	6.88**	-0.13	0.64**	-0.52
79.4	0.00	0.59	1.41	138.87**	6.60*	-0.12	0.62**	-0.50
80.1	0.02	1.20	6.65	123.40**	3.87*	-0.18*	0.65**	-0.47
80.2	0.00	0.70	2.12	76.11**	5.16*	-0.54**	0.71**	-0.16
80.3	0.01	0.83	3.27	120.18**	12.20**	-0.71**	0.83**	-0.11
80.4	0.01	0.79	3.69	121.41**	5.43*	-0.53**	0.70**	-0.16
81.1	0.01	0.71	2.53	94.95**	20.78**	-0.70**	0.66**	0.04
81.2	0.06*	2.05	20.21**	117.66**	9.83**	-0.53**	0.58**	-0.05

Table XIII: Cross-restrictions and unbiasedness - demand from export market

	Cross-restrictions on equations			Unbiasedness				
	H_0: $u_{m,k,d}$=0 vs. H_1: $u_{m,k,d}$≠0			H_0:no ass.	H_0: u_1=u_3	Parameter-values		
Period	ϕ^2	t-value	$X^2(4)$	$X^2(4)$	$X^2(1)$	u_1	u_2	u_3 1)
81.3	0.01	1.06	4.87	96.30**	17.81**	-0.71**	0.73**	-0.01
81.4	0.02	1.42	8.64	115.28**	4.32*	-0.44**	0.56**	-0.12
82.1	0.01	1.17	5.68	142.12**	14.75**	-0.65**	0.67**	-0.02
87.4	0.03	1.53	10.29*	110.33**	0.06	-0.28**	0.60**	-0.32
88.1	0.01	1.06	4.62	104.45**	0.18	-0.31**	0.56**	-0.24
88.2	0.02	1.43	8.85	80.60**	1.59	-0.38**	0.54**	-0.16
88.3	0.00	0.67	1.81	103.09**	0.19	-0.35**	0.63**	-0.28
88.4	0.02	1.20	6.41	90.84**	0.03	-0.31**	0.59**	-0.28
89.1	0.00	0.51	1.06	75.01**	0.14	-0.32**	0.71**	-0.39
89.2	0.03	1.65	11.34*	104.30**	0.50	-0.24*	0.61**	-0.37
89.3	0.02	1.32	7.19	122.84**	0.32	-0.44**	0.77**	-0.33
89.4	0.02	1.27	7.28	81.02**	0.76	-0.22*	0.59**	-0.37
90.1	0.02	1.16	6.38	96.44**	0.40	-0.38**	0.65**	-0.27
90.2	0.03	1.69	12.37*	91.46**	0.07	-0.33**	0.62**	-0.29
90.3	0.02	1.18	6.05	90.22**	5.68*	-0.49**	0.57**	-0.08
90.4	0.01	1.18	5.78	86.68**	2.59	-0.49**	0.68**	-0.19

*: Rejection on a 95%-level. Critical values: $t_{.025}$=1.96, $X^2_{.05}(1)$=3.84 and $X^2_{.05}(4)$=9.49
**: Rejection on a 99%-level. Critical values: $t_{.005}$=2.576, $X^2_{.01}(1)$=6.63 and $X^2_{.01}(4)$=13.28
1) u_3 is calculated on the sum over the u-parameters.

References

Agresti, A. (1984): *Analysis of ordinal categorical data*, John Wiley & Sons, Inc. 1984

Aiginger, K. (1981): *Empirical Evidence on the Rational Expectations Hypothesis Using Reported Expectations*, Empirica, 1, 1981, pp. 25-72

Bishop, Y. M. M., S. Fienberg and P. W. Holland (1975): *The MIT Press*, 1975

Biørn, E. (1982): *Kvantifisering av konjunkturbarometerinformasjon*, Rapporter, SSB, 82/25

Blanchard, O. J. and S. Fischer (1989): *Lectures on Macroeconomics*, The MIT Press, 1989

Brown, B. W. and S. Maital (1981): *What do Economists Know?* An Empirical Study of Experts' Expectations Econometrica, 49, 1981, pp. 491-504

Carlson, J. A. and M. Parkin (1975): *Inflation Expectations*, Economica, 42, 1975, pp. 123-138

Carlson, J. A. (1977): *A Study of Price Forecast*, Annual Economic and Social Measurement 6, Winter 1977, pp. 27-56

De Leeuw, F. and M. J. McKelvey (1981): *Price Expectations of Business Firms*, Brookings Papers on Economic Activity, 1981. pp. 299-313

Dominguez, K. M. (1986): *Are Foreign Exchange Forecasts Rational?* New Evidence from Survey Data Economics Letters 21 (1986) pp. 277-281

Fienberg, S. E. (1980): *The Analysis of Cross-Classified Categorical Data (second ed.)*, The MIT Press, 1980

Figlewski, S. and P. Wachtel (1981): *The Formation on Inflationary Expectations*, The Review of Economics and Statistics, Vol. LXIII, february 1981, no. 1, pp. 1-10

Frankel, J. A. and K. A. Froot (1987): *Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations*, American Economic Review, March 1987, Vol.77, No. 1, pp. 133-153

Frenkel, J. A. (1975): *Inflation and the Formation of Expectations*, Journal of Monetary Economics, Vol.I, 1975, pp.403-421

Goodman, L.A. and W.H.Kruskal (1979): *Measures of Association for Cross Classifications, New York*, 1979

Husevåg, V. and G. Sollie (1988): *En forventningsbasert økonometrisk modell for industriproduksjon,* Sosialøkonomen nr.9 1988, pp. 35-39

Ito, T. (1990): Foreign Exchange Rate Expectations: *Micro Survey Data, The American Economic Review,* June 1990, Vol. 80 No. 3, pp.434-449

Kawasaki, S. and K. F. Zimmermann (1981): *Measuring Relationships in the Log-Linear probability Model by some Compact Measures of Association,* Statistiche Hefte 22, 1981, pp. 82-109

Kawasaki, S. and K. F. Zimmermann (1986): *Testing the Rationality of Price Expectations for Manufacturing Firms,* Applied Economics, 1986, 18, pp. 1335-1347

König, H., M. Nerlove and G. Oudiz (1981): *On the Formation of Price Expectations: An Analysis of Business Test Data by Log-Linear Probability Models,* European Economic Review 16, 1981, pp. 103-138

MacDonald, R. (1990): *Are Foreign Exchange Market Forecasters "Rational"? Some Survey-based Tests,* The Manchester School Vol LVIII No.3 September 1990, pp. 229-241

Mullineaux, D. (1978): *On Testing for Rationality: Another Look at the Livingston Price Expectations Data,* Journal of Political Economic, 1978, Vol. 86, no. 2, pp. 329-336

Muth, J. F. (1961): *Rational Expectations and the Theory of Price Movements,* Econometrica, Vol.29, No.3 , July 1961, pp. 313-335

Nerlove, M. (1983): *Expectations, Plans and Realizations in Theory and Practice,* Econometrica, Vol. 51, september 1983, no.5, 1251-1279

Pesaran, H. (1987): *The Limits to Rational Expectations*, Basil Blackwell, 1987

Pesando, J. E. (1975): *A Note on the Rationality of the Livingston Price Expectations*, Journal of Political Economy, 1975, Vol. 83, no. 4, pp. 849-858

Rich, R. W. (1990): *Another Look at the Rationality of the Livingston Price Expectations Data,* Applied Economics, 1990, 22, pp. 477-485

Sargent, T. J. and N. Wallace (1976): *Rational Expectations and the Theory of Economic Policy,* Journal of Monetary Economics, 2, 1976, pp. 169-183

Saunders, P. (1983): *A Disaggregated Study of the Rationality of Austrian Producers Price Expectations*, The Manchester School, 51, 1983, pp. 380-398

Stensrud, O. (1981): *Kvantifisering av Statistisk sentralbyrås konjunkturbarometer som grunnlag for korttidsprognose*, Interne notater, SSB, 23/6-81

Stålhammar, N. (1987): *Strukturomvandling, företagsbeteende och förväntingsbildning inom den svenske tillverkningsindustrien*, Ekonomiska studier 19, Handelshøgskolen vid Gøteborgs Universitet

Svendsen, I. (1993): *Empirical Tests of the Formation of Expectations - A Survey of Different Methods and Results*, Statistics Norway 1993.

Takagi, S. (1991): *Exchange Rate Expectations*, IMF Staff Papers, Vol. 38, No. 1 , Mars 1991, pp. 156-183.

Zimmermann, K. F. (1986): *On Rationality of Business Expectations: A Micro Analysis of Qualitative Responses*, Empirical Economics, Vol. 11, 1986, pp. 23-40

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